



**Field Marshal the Right Honorable Horatio Herbert, Earl Kitchener of Khartoum,
and of the Vaal and Aspall, KG, KP, GCB, OM, GCSI, GCMG, GCIE, PC**

HISTORY
OF THE
CORPS OF ROYAL ENGINEERS

VOLUME V
THE HOME FRONT, FRANCE, FLANDERS AND ITALY
IN THE FIRST WORLD WAR

CHATHAM
THE INSTITUTION OF ROYAL ENGINEERS

1952

**HISTORY OF THE
CORPS OF ROYAL ENGINEERS**

VOLUME V

**THE HOME FRONT, FRANCE, FLANDERS AND ITALY
IN THE FIRST WORLD WAR**

VOLUME VI

GALLIPOLI, MACEDONIA, EGYPT AND PALESTINE

VOLUME VII

**CAMPAIGNS IN MESOPOTAMIA AND EAST AFRICA, AND THE
INTER-WAR PERIOD, 1918 TO 1938**

Volumes V, VI and VII are published simultaneously.

FOREWORD

It is now thirty-eight years since the last volume (Vol. III) of *The History of the Corps of Royal Engineers* was published. The first two volumes were written by Major-General W. Porter and covered the period from early times till 1886. Colonel Sir Charles Watson then continued the story up till 1912 in Volume III. After an interval of time certain episodes of history can be seen in better perspective and it may be found that there are gaps that should be filled. It was to fill such gaps in the period covered by Volume III that Brigadier-General W. Baker Brown wrote Volume IV, which is now being published. These four volumes thus take us up to the eve of the first World War. As soon as official data became available after that war it was obviously our duty to continue the history, and this has been done, the events occurring during the period from 1914 until about 1939 being now recorded in Volumes V, VI and VII.

As explained in the Preface, these have not been the work of one man, as were Volumes I to IV, but many officers have helped with the writing and compilation. Their efforts have, however, been collected and co-ordinated by one Editor—Major-General H. L. Pritchard, who has also himself written a considerable part of the work. I feel that every member of the Corps should be most grateful to him for his labours, especially as he has continued unremittingly during the last few years although suffering from very seriously failing eyesight. He and his team have certainly produced a great work, and his personal example of devotion to duty must be an inspiration to us all.

Mention must also be made of the work done by Major-General Sir Eustace Tickell in preparing the typescript for printing and in correcting all the proofs, and by Colonel F. C. Molesworth in compiling the index.

It is always difficult to decide how long after the event history should be written. A regimental historian must certainly wait until the official histories, founded on allied and

enemy documents, have been published, but should not wait so long that the personal memories of those who took part in the events have faded. General Pritchard followed this happy mean, but could not complete his task before the second World War intervened. The result was that a considerable time elapsed before publication became possible. This in no way detracts from the value of his work as a history to be read by members of the Corps and others in years to come. It is, however, in some ways unfortunate that these volumes were not available for study before we once again embarked upon a war involving engineering of very great magnitude and diversity. I feel sure that we as a Corps could have profited more fully from the many lessons of 1914-18, had we been able to study them in time in the clearly marshalled form that is now available in these volumes.

As to their use for future generations who may have to repeat these things yet once again, there are many parallels between the two great wars, and lessons can still be learnt by comparing them in many of their details. It is only by studying how things have changed that one can make any sort of estimate as to their future trend. It is for this reason perhaps a pity that attention could not have been drawn in many places in this work to points of similarity or difference between the conditions of 1914-18 and those of a quarter of a century later. To have done so would have entailed much labour, and would, moreover, have still further delayed publication. This task is perhaps the duty of the author of later volumes.

To that ever dwindling body of sappers who took part in the events here recorded this history has a personal appeal; and to those who have since become, or are still to become, sappers this story of the deeds of their Corps in what was then the greatest war in history will certainly be of very great interest. It was a sapper war, and we entered it, through no fault of our own, both ill-prepared and under-manned, but, as these pages show, we achieved great things.

GUY C. WILLIAMS,

GENERAL,

CHIEF ROYAL ENGINEER.

1st January, 1951.

PREFACE

IN January, 1937, the Institution of Royal Engineers appointed an Editor to arrange for the continuation of the *History of the Corps of Royal Engineers* from the outbreak of the first World War on 4th August, 1914, to about the end of 1938, when preparations for the second World War were beginning.

The three volumes covering this period have been produced by team-work. The Editor advertised in the *R.E. Journal* for officers who would volunteer to write such portions of the history as they might select. He supplemented this advertisement by writing individually to many who had played prominent parts in certain events or in special types of work. The response to these appeals was most satisfactory, and as a result the history has been written by numerous authors. Some officers were good enough to act as sub-editors for a whole campaign or for definite portions of the history, finding the authors and compiling their work into a co-ordinated story. Others, invited by the Editor on account of the important part they had played in events, reviewed and commented upon the authors' and the Editor's productions. Amendments suggested by these commentators were usually accepted. The Editor asked some very senior officers to act as referees upon certain questions that he submitted to them. Several other officers undertook to search official historical records for information. The reader will notice variations in style, but there seems to be no necessity to apologize for this. The names of the 138 officers who have thus helped to produce Volumes V, VI and VII follow this preface.

On 3rd September, 1939, the second World War broke out. By that date a considerable quantity of valuable information had been received by the Editor. Several officers had finished what they had undertaken to write, others had made good progress and hoped to complete shortly, while some had not succeeded in getting very far. The outbreak of war brought

the production of these volumes to a standstill because practically everyone concerned, including the Editor, became involved in war work. The writing of history had to give way to the making of it. Moreover, all official historical records were hustled into air-raid shelters, and became inaccessible.

In 1943, the Editor was able to recommence the work of editing and compiling those papers that he had received, and some other officers resumed the work that they had promised. In 1945, after the conclusion of the war with Germany, the official records began to be brought back to London or to record offices, but, like many other evacuees, they were not in the condition in which they had left five years before. Their hasty evacuation had upset the filing systems, and the tracing of particular documents had become difficult. Time was required to re-establish order. In 1945, when the Editor tried to regain touch with some officers whose promised work had not yet been received, he found that there had been casualties among intending contributors. It is often said with truth that history should not be written too soon after the events concerned, but difficulties certainly arise if the work is postponed too long.

The Editor and authors have been helped by officers who have conscientiously searched through many cubic yards of war diaries, but, with some notable exceptions, the war diaries of the commanders of most R.E. units were, to put it mildly, thoroughly disappointing and of little value to an historian.

The history of the Corps in India has been written by Lieut.-Colonel E. W. C. Sandes, D.S.O., M.C., in two volumes, entitled *The Military Engineer in India*. He has followed these up by another one, published by the Institution of R.E. in 1948, entitled *The Indian Sappers and Miners*. In relating those events in which Sappers and Miners from India have played a great part in many theatres of war alongside the British R.E., we have utilized information from Lieut.-Colonel Sandes's volumes to co-ordinate the accounts of the great work of both British and Indian engineers. There remains much history of engineer work in India between 1914 and 1939 for which space could not be allotted in the present volumes, nor, so far

as the Editor knows, has it been written elsewhere. It is to be hoped that this will be done in due course.

It was not until July, 1920, that the Royal Corps of Signals was created. Before that date signal units belonged to the Corps of Royal Engineers, and they expanded enormously during the war. The history of their work is being produced by the Royal Corps of Signals themselves and will not be found in the present volumes.

These volumes contain the history of World War I, written after that war and before World War II. In other words, there has been no attempt to compare the two wars, although editing was not completed until after the second.

We have attempted to write a history and not a technical treatise. We have, however, tried to explain the organization and systems of command and administration, and to bring out their merits or faults. We have also tried to show the effects of military operations on engineer work and vice versa.

A history of the Royal Engineers, who have carried out tasks of great diversity in war and peace in nearly every part of the British Empire and in many allied and enemy countries, cannot contain descriptions of every operation. Our object has been to emphasize the exceptional variety of the work demanded of the personnel and units of the Corps; and we hope we have succeeded in bringing out the complexity and the ubiquity of their activities. *Quo fas et gloria ducunt.*

THE EDITOR.

TEAM OF OFFICERS WHO HELPED IN THE PRODUCTION OF VOLUMES V, VI AND VII OF THE HISTORY OF THE CORPS OF ROYAL ENGINEERS

EDITOR, SUB-EDITORS AND AUTHORS

Authors of several chapters or of important articles
are marked with an asterisk*

- | | |
|---------------------------------|----------------------------------|
| *Addison, G. H., Major-General. | French-Mullen, D. R., |
| Atkinson, Sir Edwin H. de V., | Colonel. |
| Lieut.-General. | Gaskell, H. S., Major- |
| Bassett, T. P., Colonel. | General. |
| Bell, A. H., Lieut.-Colonel. | Guinness, V. E. G., Colonel. |
| Biddulph, H. A., Brigadier- | Graeme, J. A., Colonel. |
| General. | Grant, Sir Philip G., Major- |
| Binney, E. V., Colonel. | General. |
| Bird, Sir Clarence A., Lieut.- | *Greenstreet, C. B. L., Colonel. |
| General. | Grey, W. H., Major-General. |
| Brough, A., Major-General. | Griffith, D. M., Lieut.- |
| *Brown, W. B., Brigadier- | Colonel. |
| General. | *Gunter, C. P., Colonel. |
| Burford, Major. | Gwynn, Sir Charles, Major- |
| Butterworth, R. F. A., Colonel. | General. |
| Campbell, J. D., Colonel. | Gidley-Kitchin, E. C., |
| Chippindall, J. E., Brigadier. | Colonel. |
| Colvin, Sir George L., | Haggitt, E. D., Major. |
| Brigadier-General. | Hammond, F. D., Brigadier- |
| *Davidson, A. E., Major- | General. |
| General. | Hards, F. W., Brigadier. |
| *Dickson, W. E. R., | Heyes, T. H. E. (Historian, |
| Brigadier-General. | Australian War History.) |
| Dobbie, Sir William G. S., | *Henniker, A. M., Colonel. |
| Lieut.-General. | Henniker, G., Lieut.-Colonel. |
| Dobson, A. C., Brigadier. | *Hyland, F. G., Major-General. |
| Drew, F. G., Colonel. | Jackson, Sir Louis C., Major- |
| Edmonds, Sir James E., | General. |
| Brigadier-General. | Joly de Lotbinière, A. C., |
| Eveleigh, E. N., Colonel. | Brigadier-General. |
| Fitzpatrick, N. T., Brigadier. | *Kelly, W. H., Lieut.-Colonel. |
| Fordham, H. M., Colonel. | Kerrich, W. A. F., Brigadier, |
| Foulkes, C. H., Major- | Kirkness, L. H., Lieut.- |
| General. | Colonel. |
| Fowle, F. E., Colonel. | Liddell, Sir William, Major- |
| Francis, H. S., Lieut.- | General. |
| Colonel. | Lightfoot, K., Captain. |
| *Fraser, Sir Theodore, Major- | *Lubbock, G., Brigadier- |
| General. | General. |

- Luck, S., Major.
 Lyell, D., Colonel.
 MacMunn, Sir George F., Major-General.
 Magniac, Sir Charles L., Brigadier-General.
 Mance, Sir H. Osborne, Brigadier-General.
 Malan, L. N., Colonel.
 *Manton, L., Brigadier.
 Martel, Sir Giffard le Q., Lieut.-General.
 *Maxwell, G. A. P., Colonel.
 Maud, P., Brigadier-General.
 *Molesworth, F. C., Colonel.
 Mount, Sir Alan H. L., Lieut.-Colonel.
 *Mozley, E. N., Lieut.-Colonel.
 Noble, N. D., Colonel.
 Paul, E. M., Brigadier-General.
 Pearson, H. L., Colonel.
 Pennycuik, J. A. C., Brigadier.
 *Perowne, L. E. C., Brigadier.
 *Phipps, C. C., Brigadier.
 Piggott, F. S. G., Major-General.
 Playfair, I. S. O., Major-General.
 Preedy, C., Colonel.
 Prichard, W. C. H., Colonel.
 *Pritchard, H. L., Major-General.
 *Rayfield, F. A., Lieut.-Colonel.
 Roberts, W. H., Brigadier.
 Robertson, F. W., Colonel.
 R.E.O.C.A., General Secretary.
 *Sandes, F. W. C., Lieut.-Colonel.
 *Sayer, A. P., Brigadier.
 Scott-Moncrieff, Sir George K., Major-General.
 Scudamore, E. W. V., Brigadier-General.
 Shakespear, A. T., Brigadier.
 Shelley, B. A. G., Colonel.
 Sheppard, S. H., Major-General.
 Shingleton, L., Major.
 *Shortt, A. C., Colonel.
 *Skey, F. E. G., Colonel.
 Smith, G. E., Brigadier-General.
 Squires, E. K., Lieut.-General.
 Smith-Skelton, Captain.
 Stevenson, A. G., Major-General.
 Stranack, F. K., Colonel.
 Stratton, W. H., Colonel.
 Swinton, Sir Ernest D., Major-General.
 Thompson, R. L. B., Major-General.
 *Thuillier, Sir Henry F., Major-General.
 Trench, A. H. C., Colonel.
 *Tyrell, W. G., Brigadier.
 Wait, H. G. K., Colonel.
 Waring, W. H., Major.
 Ward, Sir T. C., Captain R.I.M.
 Webb-Bowen, H. E., Colonel.
 Weekes, H. W., Colonel.
 White, F. A. K., Colonel.
 Williams, Sir Guy C., General.
 Wilson, F. H., Lieut.-Colonel.
 Wilson, Sir Samuel H., Brigadier-General.
 Winterbotham, H. St. J. L., Brigadier.
 Witts, F. V. B., Major-General.
 Wolverson, W. A.
 Wyatt, F. J. C., Colonel.
 Woodhouse, F. L., Brigadier.
 Yule, J. S., Lieut.-Colonel.

REFEREES AND COMMENTATORS

Addison, G. H., Major-General.	Luck, S., Major.
Arden-Close, Sir Charles F., Colonel.	Mance, Sir H. Osborne, Brigadier-General.
Bliss, T. S., Captain.	Magniac, Sir Charles L., Brigadier-General.
Bond, Sir Lionel V., Lieut.-General.	Malan, L., Colonel.
Boulnois, P. K., Colonel.	Manton, L. N., Brigadier.
Brough, A., Major-General.	Martel, Sir Giffard Le Q., Lieut.-General.
Brown, W. B., Brigadier-General.	Master, G., Lieut.-Colonel.
Capper, Sir John E., Major-General.	MacLeod, M. N., Major-General.
Cave-Browne, W., Major-General.	Mount, Sir Alan H. L., Lieut.-Colonel.
Charles, E. M. S., Colonel.	Noble, N. D., Colonel.
Charles, Sir Ronald J. E., Lieut.-General.	Painter, A. C., Colonel.
Collins, Sir Dudley S., Lieut.-General.	Pears, G. B., Colonel.
Davidson, A. E., Major-General.	Phipps, C. C., Brigadier.
Dobson, A. C., Brigadier.	Pitt, R. B., Lieut.-Colonel.
Dutton, R. B., Lieut.-Colonel.	Rayfield, F. A., Lieut.-Colonel.
Edmonds, Sir James E., Brigadier-General.	Rhodes, Sir Godfrey D., Brigadier.
Elles, Sir Hugh J., General.	Sandys, F. S., Lieut.-Colonel.
Fitzpatrick, N. T., Brigadier.	Skey, F. E. G., Colonel.
Fuller, F. G., Brigadier-General.	Swinton, Sir Ernest D., Major-General.
Fraser, Sir Theodore, Major-General.	Taylor, Sir G. Brian O., Major-General.
Freeland, Sir Henry F. E., Major-General.	Thuillier, Sir Henry F., Major-General.
Gibbon, J. A., Colonel.	Thompson, R. L. B., Major-General.
Grant, Sir Philip G., Major-General.	Tickell, Sir Eustace F., Major-General.
Hammond, F. D., Brigadier-General.	Webb-Bowen, H. E., Colonel.
Henniker, A. M., Colonel.	White, F. A. K., Colonel.
Jack, E. M., Brigadier.	Williams, Sir Godfrey, Major-General.
Kirkness L. H., Lieut.-Colonel.	Williams, Sir Guy C., General.
Lee, Sir Richard P., Major-General.	Wright, H. B., Major-General.
	Young, B. K., Major-General.

Grateful acknowledgement is also due to Mr. W. B. and Mrs. C. M. Elphick, both of whom, while the latter was engaged in typing with exceptional accuracy and speed a very large part of these volumes, volunteered to read the manuscript. They were able to suggest many improvements to the text and to draw attention to errors and omissions.

THE EDITOR.

THE SOVEREIGN AS COLONEL-IN-CHIEF

During the period covered by Volumes V, VI and VII the reigning monarch has been graciously pleased to confer the honour of becoming the Colonel-in-Chief of the Corps of Royal Engineers.

This was notified in London Gazettes as below :—

H.M. King George V.	L.G. dated 31st May, 1910.
H.M. King Edward VIII.	L.G. dated 18th February, 1932.
H.M. King George VI.	L.G. dated 18th December, 1936.

CONTENTS

VOLUME V

THE HOME FRONT, FRANCE, FLANDERS AND ITALY IN THE FIRST WORLD WAR

ROYAL ENGINEERS IN THE FIRST WORLD WAR

INTRODUCTION

EFFECTS OF PRE-WAR POLICY

Our lack of readiness for a great war—The effects of the Esher Committee—Talks between British and French Staffs prior to 1914—Causes of our lack of preparation summarized—Improvements in equipment since World War I—Predecessors of the E.-in-C. 1

CHAPTER I

EARL KITCHENER AND OTHER DISTINGUISHED ROYAL ENGINEERS

Earl Kitchener's appointment as Secretary of State for War—His previous wide experience—His achievements during two years—Munitions—The Dardanelles—Our debt to Earl Kitchener—Royal Engineers who held high appointments during the war. 11

CHAPTER II

EXPANSION OF THE CORPS DURING THE WAR

Magnitude and rate of expansion—Office of the A.A.G., R.E.—Provision of officers—Tables showing growth of the R.E. in strength, and number of units. 27

CHAPTER III

THE HOME FRONT

Department of the Director of Fortifications and Works—Defence against invasion by sea—Defence against air attack—Works at home. 44

CHAPTER IV

SUPPLY OF ENGINEER STORES AND EQUIPMENT

Lack of pre-war reserves—Liaison with overseas theatres, F.W.5.—Chief Mechanical Engineer, F.W.8.—Chief Electrical Engineer, F.W.9.—Effect of the creation of the Ministry of Munitions—Trench Warfare Department—Development of gas-warfare research—Separation of research from production of gas equipment—The Chemical Warfare Department—The R.E. Committee. ... 76

CHAPTER V

SURVEY

The Ordnance Survey in 1914—Pre-war policy of the Geographical Section, General Staff—Technical experience and training for war—Survey arrangements for the Expeditionary Force—The Geographical Section during the war—The Ordnance Survey during the war ... 109

CHAPTER VI

TRANSPORTATION AT THE WAR OFFICE

Historical background—Pre-war employment of regular officers on railways—Arrangements for mobilization—Raising and training of new units—Assistance rendered by the British railways—Railway material and stores—Inland water transport and docks—The great reorganization in 1916—Richborough cross Channel service—The Cherbourg-Taranto route—List of transportation units. ... 116

CHAPTER VII

TRAINING AT HOME

Chatham in the early days of the war—R.E. Training Depot, Aldershot in the early days—New Training Centres at Newark and Deganwy—The formation and training of a New-Army Field Company—Some remarks on pre-war training. ... 131

ROYAL ENGINEERS IN OPERATIONS ON THE WESTERN FRONT, 1914-18

CHAPTER VIII

E.-IN-C. AND CHIEF ENGINEERS IN FRANCE

Lack of higher engineer posts in 1914—The Brigadier-General, R.E. at G.H.Q., 1914—Appointment of Chief Engineer, B.E.F.—Appointment of E.-in-C. and C.Es. of armies and corps—Development of duties of E.-in-C. and C.Es.—Final distribution of duties in the E.-in-C's. office—List of Es.-in-C. and Chief Engineers. ... 153

CHAPTER IX

BATTLES OF 1914 IN FRANCE AND FLANDERS

Mons and the Retreat—Passage of the Marne—Passage of the Aisne—First battle of Ypres—Winter of 1914/15—R.E. Units of the initial B.E.F. ... 175

CHAPTER X

BATTLES OF 1915 IN FRANCE AND FLANDERS

Neuve Chapelle—Second battle of Ypres—Aubers Ridge—Festubert—Operations during the summer of 1915—Preparation for Loos—Loos—Defensive work in 1915. ... 212

CHAPTER XI

BATTLES OF 1916 IN FRANCE AND FLANDERS

Preparations for the Somme—Battle of the Somme—R.E. units engaged. ... 253

CHAPTER XII

BATTLES OF SPRING AND SUMMER 1917 IN FRANCE AND FLANDERS

German withdrawal in March—Preparations for Arras—Arras—Messines—Projected landing on the Belgian coast. 277

CHAPTER XIII

BATTLES OF AUTUMN 1917 IN FRANCE AND FLANDERS

Third battle of Ypres—Battles of Pilckem Ridge and Langemarck—Battles of Menin Road and Broodseinde—Battles of Passchendaele—Battle of Cambrai ... 311

CHAPTER XIV

GERMAN OFFENSIVES OF 1918 IN FRANCE AND FLANDERS

Preparations to meet the spring offensive—The German attack in March—German attacks in Flanders—Second battle of the Aisne—Battle of Tardenois.	336
---	-----

CHAPTER XV

THE FINAL PHASE ON THE WESTERN FRONT

Operations of the Fourth Army—The Hindenburg Line—Passage of the Sambre-Oise Canal—Operations of the Third Army—Operations of the First Army—Operations of the Fifth Army—Operations of the Second Army.	384
--	-----

CHAPTER XVI

WORK OF THE FIELD SQUADRONS IN FRANCE

Operations during 1914—Operations during 1915-16—The Indian Cavalry Corps—Operations during 1917—Operations during 1918.	426
--	-----

CHAPTER XVII

ROYAL ENGINEERS AND THE ROYAL TANK CORPS

Invention of the Tank—The Heavy Section, Machine Gun Corps—The Tank Corps in France—Maintenance—Bridging—Director-General of the Tank Corps.	443
--	-----

CHAPTER XVIII

FIELD DEFENCES, MINING AND CAMOUFLAGE

Field defences—Mining on the Western Front—Formation of tunnelling companies—Growth of mining during 1915—Appointment of Inspector Mines—Offensive mining operations—Decline of mine warfare in 1917—Tunnelling companies in 1918—Personnel of tunnelling companies—Camouflage—Products of the camouflage factories.	453
--	-----

CHAPTER XIX

SEARCHLIGHTS AND FORWARD WATER SUPPLY IN FRANCE

Searchlights during 1914-16—Expansion during 1917—	
--	--

Searchlights in 1918—Water supply for fighting formations—The Water Supply Committee—Water supply on the Somme, 1916—Water for the battles of 1917—Water problems in 1918.	488
---	-----

CHAPTER XX

GAS WARFARE

Defence against gas—The box respirator—Anti-gas organization in the B.E.F.—Offensive gas warfare—Gas at the battle of Loos—The Special Brigade, R.E.—The Livens projector—Use of gas in subsequent operations. ...	506
--	-----

CHAPTER XXI

SURVEY ON THE WESTERN FRONT

Provision of maps in 1914—The call for more accurate maps—Start of a new survey—Birth of sound ranging—Expansion in 1915—Improvements in artillery survey—Developments during 1916—Achievements of Artillery Survey—Achievements in map production on the Western Front.	526
---	-----

CHAPTER XXII

WORKS DIRECTORATE IN FRANCE

Initial organization for works services in the B.E.F.—Bases in France—Staff, units and unskilled labour—Works executed during 1914-16—Abolition of the I.G.C. and appointment of D.G.T.—Works during 1917—Events of 1918—The Director of Works, B.E.F.	539
---	-----

CHAPTER XXIII

SUPPLY OF ENGINEER STORES AND PLANT IN FRANCE

Initial difficulties—Growth of the Stores Organization during 1915—Stores supply during 1916—Water-supply plant and stores—Further expansion during 1917—Events of 1918—Transport of engineer stores and material—Quantities of stores required.	553
---	-----

CHAPTER XXIV

- TRANSPORTATION ON THE WESTERN FRONT, INTRODUCTION
 Introduction—Three phases of transportation during the war—Pre-war agreement with the French concerning railways, roads and ports—Comparison of the British and French systems for controlling railways in war. ... 573

CHAPTER XXV

- TRANSPORTATION ON THE WESTERN FRONT—PHASE I
 (UP TO OCTOBER, 1914)
 Work of the Intermediary Railway Staff (R.T.E.)—Visit to France of Sir Percy Girouard—Construction and repair of railways. ... 585

CHAPTER XXVI

- TRANSPORTATION ON THE WESTERN FRONT—PHASE II
 (NOVEMBER, 1914 TO SEPTEMBER, 1916)
 Operation of railways in 1915—Construction and repair of railways—Provision of rolling stock—Tramways and roads in 1915—Inland Water Transport—Intermediary Staff (R.T.E.)—Organization of D.R.T.'s. Office in 1915—Preparations for the battle of the Somme—Abortive demands for track and rolling stock—Tramways, Light Railways and I.W.T. in 1916—Congestion at the ports. 593

CHAPTER XXVII

- TRANSPORTATION ON THE WESTERN FRONT—
 APPOINTMENT OF THE D.G.T.
 Visit of Sir Eric Geddes to France—His dual appointment as D.G.M.R. and D.G.T., B.E.F.—Organization of the new Directorate-General of Transportation. ... 611

CHAPTER XXVIII

- TRANSPORTATION ON THE WESTERN FRONT DURING 1917
 Docks in 1917—Railways—Transportation Troops—Inland water transport in 1917—Transportation stores—Roads—Calais Conference, March 1917—Arras, Messines and Passchendaele—Overland route to Italy and the Middle East. ... 619

CHAPTER XXIX

TRANSPORTATION ON THE WESTERN FRONT IN EARLY 1918	
Preparations to meet the German spring offensive—	
Roads in early 1918—Shipping situation—Preparation	
for demolitions and withdrawal—Summary of trans-	
portation situation on 20th March.	634

CHAPTER XXX

TRANSPORTATION DURING THE GERMAN SPRING OFFENSIVES, 1918	
The attack on 21st March—Threat to the railway centre	
at Amiens—The German offensive against the First and	
Second Armies—Transportation tasks under schemes for	
withdrawal from the north—Transition period 30th April	
to 22nd July—Change in status of D.G.T.	643.

CHAPTER XXXI

TRANSPORTATION DURING THE FINAL ALLIED OFFENSIVE	
Railway situation in July 1918—Plans for reopening	
captured railways and roads—Reconstruction of railways	
during the advance—Lack of roads suitable for mechanical	
transport—Transportation statistics—Some of the regular	
R.E. Officers who held important transportation posts in	
France.	653

ROYAL ENGINEERS IN THE ITALIAN CAMPAIGN, 1917

CHAPTER XXXII

OPERATIONS IN ITALY

British and French troops sent to Italy, 1917—Crossing	
of the Piave, 1918—Survey—Works Directorate—Works	
for the Mediterranean L. of C.—Works for the B.E.F. in	
Italy—Transportation in Italy—Transportation work for	
the Expeditionary Force—Transportation work for the	
Mediterranean L. of C.—Officers of the Transportation	
Directorate in Italy.	669

APPENDIX

Particulars of distinguished officers whose portraits are	
included in the 1914-18 War Portrait Gallery... ..	696

MAPS

(In pocket at the end)

North-west Europe, scale 1:250,000.

Map 1 :—Antwerp—Dunkerque—Armentières—Lens.

Map 2 :—Lens—Arras—Cambrai—Amiens—Compiègne.

Map 3 :—Compiègne—Soissons—Chateau-Thierry—Reims.

Map 4 :—Railway Reconstruction, August to December 1918.

Map 5 :—Advance of XIV Corps in Italy, 27th October to 4th November, 1918.

SKETCH MAP

(In the text)

Sketch 1 :—Italian Plan and Situation on 24th October,	<i>To face 606</i>
1918. 	684

ILLUSTRATIONS

FIELD MARSHAL EARL KITCHENER	<i>Frontispiece</i>
The Engineer-in-Chief's Christmas Card	<i>facing 74</i>
Portraits of distinguished officers mentioned in this volume 	697
Index 	713

ROYAL ENGINEERS IN THE FIRST WORLD WAR

INTRODUCTION

EFFECTS OF PRE-WAR POLICY

Our lack of readiness for a great war. The effects of the Esher Committee—Talks between British and French staffs prior to 1914. Causes of our lack of preparation summarized—Improvements in equipment since World War I—Predecessors of the E.-in-C.

OUR LACK OF READINESS FOR A GREAT WAR

THE relative degree of preparedness for war and of ability to mobilize rapidly generally decides which belligerent is to have the initiative in the opening period of operations. This advantage may enable the better prepared nation to maintain an initial success, even against eventually superior numbers and material, for a very considerable period, the duration of which, possibly years, will again depend on that relative degree. The thirteen volumes of *The History of the British Army*, by the Hon. J. W. Fortescue, reveal that the British nation has never been suitably prepared for their entry into any war, and that on its termination (usually victorious) the people of our country have exercised pressure on their Government to reduce the numbers and organization of their fighting services nearly to vanishing point, thus ensuring that the next war will find them as unprepared as ever.

In 1914, thanks mainly to Lord Haldane's administration of the War Office from 1906 to 1912, the British Army was better prepared for war than it had ever been. Every soldier who co-operated with Lord Haldane, or served him even in a subordinate capacity, will bear enthusiastic testimony to the inestimable value of his reorganization and reforms. Lord Haldane has likewise publicly acknowledged the value of the military advice and co-operation given to him. But, while that may be said, it is equally true that Great Britain and the British Empire were quite unprepared and unorganized for

land-fighting on the Continent on the scale of the war of 1914-18*.

The preparation and organization of the Army, which the nation, cajoled by Lord Haldane, almost unwittingly permitted him to make, bore very little relation to the magnitude of the liabilities that the nation was about to incur by entering the war. A century had passed since the British people had been required to fight for their very existence. Confident in the power of the British Navy, they had been lulled into a false sense of perennial security, and were incapable of appreciating the size of the task which must be faced in such a struggle.

All nations on the continent of Europe, not excepting Germany, based their preparations on a completely false appreciation of the type of the forthcoming war. They prepared for a short campaign of rapid movement and decision. No one could conceive or believe that human nature could support the long drawn-out and colossal sacrifice of life and resources incidental to total war for four and a half years.

Our people believed that it was possible to wage war on the limited liability principle. Our General Staff, created only in 1904, nurtured on the lessons of the American Civil War by the teachings of the late Colonel G. F. R. Henderson, and having watched the Russo-Japanese war of 1902-04, were certain that the struggle with Germany would be a long one, and, in the nature of siege warfare in the field,† but France was providing 180 divisions to our 6 for fighting on the French frontiers, so army plans and preparations had to be dictated by France. Lord Haldane agreed with our General Staff, and tried to give them what they wanted, but the Cabinet was divided on the question of participating in the war, and Lord Haldane said to his Army Council, "You must not press me too much, for if I lose the confidence of my colleagues in the Cabinet, I shall be able to do nothing for you."‡

* Twenty-five years later (1939) we were even less prepared for the second World War. History repeated itself.

† The authority for these statements is Brigadier-General Sir James Edmonds, C.B., C.M.G., D.Litt. (late R.E.), the official historian. He was on the General Staff at the War Office prior to 1914.

Lord Haldane had with great difficulty persuaded the country to provide an army with six expeditionary divisions armed and equipped, not as he had wished, but suitably for the type of warfare generally expected, and so well trained that they could quickly adapt themselves to the use of new weapons. Behind them were fourteen Territorial divisions, but only a quarter of their men were enlisted for service overseas. Their state of training necessitated at least six months' interval between the outbreak of war and their entry into operations. There was a Regular Army Reserve of 130,000 to bring the Army from a peace to a war establishment and to provide about 30,000 replacements for the first casualties. A militia reserve of about 100,000 provided drafts to replace further casualties in the Regular Army. These reserves for casualties were in fact exhausted within four months. This was the limit of the liability that the nation was prepared to incur in peace. They did not pursue the matter further by inquiring whether it sufficed to provide reasonable security in war. They were relying for security upon the Navy and the fact that if we fought on the Continent it would be as an ally of France.

An army, whose preparations for war and type of organization and armament are not designed for the degree of strain that will be placed upon them by the enemy, will lose the initiative and be compelled to fight as and when and where the enemy chooses. Such conditions reveal in a flash all the shortcomings, all the mistakes in organization, but no short flash of effort can make good the deficiencies. While warding off desperate blows, any one of which may prove fatal, every part of the army and of the national organization behind it has to go back to first principles and put forth the utmost exertions to build up their efforts to the scale of the emergency. Such reconstruction takes time, a long time, and is a painful process. Every branch and every department of the army suffers from the whole having been cast in a mould too small and of the wrong shape.

It is impossible to record the story of the work of the Royal Engineers in the first World War, and make it comprehensible to the reader, especially to readers only conversant with the

events of the second World War, unless we first attempt in this introduction to present a true picture of the conditions and the limitations under which the army, and their engineers in particular, started to wage war in 1914.

THE EFFECTS OF THE ESHER COMMITTEE

We must begin by going back to that great milestone in army organization, the Esher Committee, which reorganized the War Office and the army during the years 1902 to 1904. Volume IV has dealt with this subject ; but as this Volume V has to deal with events so powerfully influenced in the first year of the war by the consequences of the Esher Committee's recommendations, we must remind the reader how that committee's work affected the Royal Engineers and their organization and preparation for war.

Prior to 1904 a selected Royal Engineer officer with the rank of Lieut.-General held the official title of Inspector General of Fortifications and Engineers (I.G.F. and R.E.). The official pedigree of that appointment, as recorded on boards that hang on the walls of the office of the Engineer-in-Chief at the War Office, is given on pages 8 and 9 of this introduction. It goes back to the year 1078 when Bishop Gundulph was officially appointed "The King's Engineer." Prior to 1904 there was no Army Council. There was a Commander-in-Chief with four principal Staff Officers, namely the Adjutant General, the Quartermaster-General, the Director General of Ordnance and the I.G.F. and R.E. There was no General Staff. Each of these four might be called into consultation with the Secretary of State for War. The I.G.F. and R.E., like his predecessors, recorded on the pedigree board, was in a position where he could powerfully influence questions of preparations for war from the engineer's point of view.

The Esher Committee abolished the appointment of I.G.F. and R.E. with its rank of Lieut.-General. At a much lower level in the hierarchy, and with the rank of Brigadier-General, they placed an officer the "Director of Fortifications and Works," as one of several other directors under the Master

General of Ordnance, the latter being one of four members of the Army Council. The Commander-in-Chief disappeared at the same time. The Esher Committee did not charge anyone with the responsibility for preparations for war from the engineer's point of view.

In organization, the old saying "What's in a name?" does not apply. On the contrary, everything is in the name, or should be, if each post in an organization is properly named and the duties thereof fully defined.

The senior engineer officer in the War Office, "the Director of Fortifications and Works," was now, by his name, by his lower position in the hierarchy and by the definition of his duties, cut off from direct responsibility for engineer preparations for war and could not exercise a powerful influence on them. It is true that in practice, the Director of Fortifications and Works, being always a selected engineer officer with considerable experience, was often consulted by members of the General Staff of various grades, but such informal and occasional consultation cannot make up for the lack of continuous and responsible planning of engineer preparations directed by an engineer at the highest level, advising the Chief of the General Staff and the other members of the Army Council.*

The author must repudiate any desire to belittle the very great value of the Esher Committee's reorganization scheme, which is generally acknowledged, especially the creation of a General Staff. But it would be surprising and most unusual if a scheme of such magnitude contained no blemishes. Time, and the events of the war of 1914-18 (and we may also say of 1939-45), have certainly produced overwhelming evidence that it was a serious error to fail to recognize the importance

* Here it will not be out of place to anticipate the period of history which will be dealt with in a future volume, and to record that we had to wait until the second World War, October, 1941, before an Engineer-in-Chief was re-established at the War Office. For further details of this appointment, reference should be made to the article in the *R.E. Journal*, published in November, 1941, dealing with the creation of the appointment of an Engineer-in-Chief at the War Office, and the duties and responsibilities of that appointment.

of engineer work in war and therefore to omit to provide in the War Office organization an Engineer-in-Chief at the highest level and supported by a suitable staff.

TALKS BETWEEN BRITISH AND FRENCH STAFFS PRIOR TO 1914

Prior to 1914 consultations between British and French General Staffs were carried on with the utmost secrecy, a secrecy that was enforced not only to avoid complications with other foreign countries, but also for political reasons. There would have been strong reactions against such consultations in many political circles and among the public in this country. The Prime Minister, the Foreign Secretary, the First Lord of the Admiralty and the Secretary of State for War were the only members of the Cabinet who knew that these conversations were taking place. Other Cabinet Ministers were not informed. Consequently only very few important officers at the War Office were brought into consultation, and only the Director of Military Operations met the French Staff.

Thus there was no exhaustive examination by the various branches of the War Office of the proposed working arrangements between the French and ourselves. In 1911, however, an exception was made, with many precautions for secrecy, in consulting railway managements about transport on English and French railways and through ports, but engineering work on the Lines of Communication did not receive thorough expert examination by the branches concerned at the British War Office.

As we have already explained, the scale of the effort required and expected from the British Army was greatly underestimated, not only by us, but by the French as well. Consequently, the French light-heartedly undertook to carry out all the transportation and all the work on the Lines of Communication required by our small army of six divisions. This contract, entered into by the French, which, as we shall explain, unavoidably broke down at a very early date, had the disastrous effect of stopping any preparation on our part before August, 1914, to carry out these essential services.

When officers of the British administrative or engineer staffs endeavoured to work out such preparations, they were met by the unanswerable argument that the French had undertaken to do the work and therefore preparation on our part was unnecessary.

It was not until the end of 1916, two years after the outbreak of war, that the full effects of the disastrous impracticability of such a contract were realized, and new arrangements at last conceived and rapidly executed on a suitable scale to deal with such work. Nevertheless, from the first month of the war large and ever-growing improvised organizations were built up by the British in France to mitigate the worst effects of the arrangements with the French which had broken down. These will be dealt with in their appropriate places in this volume.

CAUSES OF LACK OF PREPARATION SUMMARIZED

This introduction has been written that the reader may understand how it came about that the Royal Engineers went to war in 1914 very seriously handicapped (as were likewise other branches of the Army) by :—

1. A gross under-estimate of the scale and duration of the forthcoming war, and a false appreciation of the type of operations.
2. Lack of representation at the highest level of War Office organization of the engineer point of view and appreciation of the situation.
3. The undertaking by the French to carry out all services required by the British for transportation, and for work on harbours, bases and lines of communication, an undertaking soon proved to be impracticable.
4. The consequent lack of preparation to carry out the tasks with which the Engineers were forthwith confronted on reaching the theatres of war.

These facts have been recorded here to save a repetition at the beginning of several chapters of the causes of events which would otherwise seem inexplicable to the reader, who will frequently be referred to this introduction.

PANELS HANGING ON THE WALLS OF THE OFFICE OF THE
ENGINEER-IN-CHIEF

King's Chief Engineers

Bishop Gundulphus	...	...	...	...	1078
Waldivus Ingeniator	...	...	...	...	1086
Geoffrey Ingeniator	...	...	...	...	1131
Allnoth Ingeniator	...	...	...	...	1158
Magister Albertus Ingeniator	...	...	...	...	1200
Peter Ingeniator	...	...	...	...	1226
Richard, Magister Ingeniatorum	...	...	...	...	1287
Brother Robert de Ulmo	...	...	...	...	1300
John Gruynard	...	...	...	...	1354
Nicholas Merbury	...	...	...	...	1414
William Pawne	...	...	...	...	1509
Sir Richard Lee, KT.	...	...	...	...	1540
Sir William Pelham, KT.	...	...	...	...	1575
John van Cranvelot	...	...	...	...	1603
Bernard Johnson	...	...	...	...	1620
Captain Thomas Rudd	...	...	...	...	1627
John Lanyon	...	...	...	...	1627
Lieut.-Colonel John Paperill	...	...	...	...	1628
Cornelius Drebel	...	...	...	...	1630
Sir Godfrey Lloyd, KT.	...	...	...	...	1640

Parliament's Chief Engineers

John Lyon	...	...	...	...	1642
Major Morgan	...	...	...	...	1643
Peter Manteau van Dalem	...	...	...	...	1647
Eval Tercene	...	...	...	...	1654
Nathanial Nye	...	...	...	...	1657

Chief Engineers of England

Sir Charles Lloyd, KT.	...	...	...	...	1660-1661
Sir Bernard de Gomme, KT.	...	...	...	...	1661-1683
Colonel Sir Martin Berkman, KT.	...	...	...	...	1683-1702
(vacant 1702-11)					
Brigadier-General Michael Richards	...	...	...	...	1711-1714
Major-General John Armstrong	...	...	...	...	1714-1742
Lieut.-Colonel Thomas Lascelles	...	...	...	...	1742-1750
(vacant 1750-57)					
Lieut.-General William Skinner	...	...	...	...	1757-1780
Major-General James Bramham	...	...	...	...	1781-1786
General Sir William Green, BART.	...	...	...	...	1786-1802

Inspectors General of Fortifications

General R. Morse	1802-1811
General G. Mann	1811-1830
Major-General Sir A. Bryce, K.T., K.C.H., C.B.	1830-1832
Major-General R. Pilkington	1832-1834
Lieut.-General Sir F. W. Mulcaster, K.C.H.	1834-1845
Field Marshal Sir J. F. Burgoyne, BART., G.C.B.	1845-1868
Major-General E. Frome	1868-1869
Major-General Sir J. W. Gordon, K.C.B.	1869-1870
Lieut.-General Sir F. E. Chapman, K.C.B.	1870-1875
General Sir J. L. A. Simmons, G.C.B., G.C.M.G.	1875-1880
Lieut.-General Sir T. L. J. Gallway, K.C.M.G.	1880-1882
Lieut.-General Sir A. Clarke, G.C.M.G., C.B., C.I.E.	1882-1886
General Sir L. Nicholson, K.C.B.	1886-1891
Lieut.-General Sir W. Grant, K.C.B.	1891-1898
General Sir R. Harrison, K.C.B., C.M.G.	1898-1903
Lieut.-General W. T. Shone, C.B., D.S.O.	1903-1904

Directors of Fortifications and Works

Brigadier-General R. M. Ruck	1904-1908
Brigadier-General F. Rainsford-Hannay, C.B.	1908-1911
Major-General Sir G. K. Scott-Moncrieff, K.C.B., K.C.M.G., C.I.E.	1911-1918
Major-General Sir P. G. Twining, K.C.M.G., C.B., M.V.O.	1918-1920
Major-General Sir W. A. Liddell, K.C.M.G., C.B.	1920-1924
Major-General Sir H. F. Thuiller, K.C.B., C.M.G.	1924-1927
Major-General Sir P. G. Grant, K.C.B., C.M.G.	1927-1931
Major-General R. L. B. Thompson, C.B., C.M.G., D.S.O.	1931-1935
Major-General D. S. Collins, D.S.O.	1935-1939
Major-General G. B. O. Taylor, C.B.E.	1939-1940
Major-General W. Cave-Browne, C.B.E., D.S.O., M.C.	1940-1941
Major-General A. G. B. Buchanan	1941-1943

Engineers-in-Chief

Major-General C. J. S. King, C.B., C.B.E.	1941-1944
Major-General H. B. W. Hughes, C.B., D.S.O., O.B.E.	1944-1945
Major-General Sir Eustace F. Tickell, K.B.E., C.B., M.C.	1945-1948
Major-General A. D. Campbell, C.B., C.B.E., D.S.O., M.C.	1948-

Note the reduction in the rank and status of the senior Royal Engineer as the result of the recommendations of the Esher Committee in 1904.

IMPROVEMENTS IN EQUIPMENT SINCE WORLD WAR I

This may also be a suitable place to remind the reader of the very great improvements in army equipment that became possible between the two great wars. As explained in the Preface, our story of World War I was written before World War II, but it will be read from a very different viewpoint—the viewpoint of those who are used to the potentialities of a mechanized army. The reader should constantly bear this fact in mind, and remember that this is the story of engineers without modern powerful plant, without wireless sets or welded panel bridges, and above all without mechanical transport. It is the story of men who had to *dig* and to *march* long miles to their work. To them how very different must have seemed those many tasks so easy to dispose of by more modern means. As explained above, they were certainly men ill-prepared and poorly equipped, but we must be careful, more than thirty years later, not to be too scornful when we find that they lacked so many things not at that time developed or even invented. It is sometimes just because the workman lacked the tools that his achievement is worth recording.

THE EDITOR.

CHAPTER I

EARL KITCHENER AND OTHER DISTINGUISHED ROYAL ENGINEERS

Earl Kitchener's appointment as Secretary of State for War—
His previous wide experience—His achievements during
two years—Munitions—The Dardanelles—Our debt to Earl
Kitchener—Royal Engineers who held high appointments
during the war.

HIS APPOINTMENT

LORD KITCHENER, a Royal Engineer, was Secretary of State for War from 6th August, 1914, to 5th June, 1916, when he was killed in action by drowning at sea, in H.M.S. *Hampshire*.

When the European War broke out he was holding the appointment of British Consul-General in Egypt where the prestige of his dominating personality was such that he was to all intents and purposes virtually the autocratic ruler of that country.

The beginning of August, 1914, found him on leave in England. The post of Secretary of State for War was vacant. The Prime Minister had temporarily taken it over from Colonel John Seely, who had recently resigned over the grave incidents in the Army resulting from the Ulster troubles.

When the European crisis burst upon the Cabinet at the very end of July, 1914, the Prime Minister had to find someone at once to relieve him of duty at the War Office. In the first instance, he turned to his Lord Chancellor, Lord Haldane, who had previously made a reputation as Secretary of State for War that will live in history. Lord Haldane answered the call of duty but urged Mr. Asquith to replace him by Lord Kitchener, for whom the country had begun to call with unanimity. Mr. Asquith was not the man to be hustled into action by popular clamour. He hesitated to depart from the principle so dear to the English that under no circumstances should a soldier

be Secretary of State for War. Cromwell as Dictator and Wellington as Prime Minister rise from their graves to frighten the English by such a prospect. Mr. Asquith anticipated strong political reactions to such an appointment. He, therefore, proposed that Haldane and Kitchener should be partners in the office. Kitchener had his own ideas of the magnitude and scope of the task and knew that only as Secretary of State with undivided power could he accomplish it. He declined the offer and embarked at Dover to return to Egypt, but a telegram from Mr. Asquith recalled him before the boat sailed. On 5th August, he returned to London, attended the War Council which debated the strategy that should govern the opening movements of the British Expeditionary Force, and the next day took up the duties of Secretary of State for War. There were no political reactions, and the whole nation acclaimed the appointment with enthusiasm.

Let us consider the task that faced him. His great predecessor, Lord Haldane, to whom every soldier will always be grateful and to whom every one of his countrymen owes an apology for the way he was treated, had, between the years 1906 and 1912, entirely reorganized the military forces of the country. This is not the place to explain what he had done, but it is necessary for our purpose to note that, after consulting exhaustively his military advisers, to whom he has acknowledged his indebtedness, Lord Haldane evolved his own scheme for utilizing to the very utmost by good organization all the military resources in men and materials which the nation reluctantly placed at his disposal in preparation for the Great War.

But what the nation was cajoled into providing almost unwittingly beforehand was one thing, and what the situation urgently demanded on 4th August, 1914, was quite another. Lord Kitchener was almost alone, perhaps he *was* alone, in visualizing instantly with absolute clearness the great scale of the events that were about to occur and the efforts that our Country and Empire would have to make. He said at once that the war would last at least three years and that the United Kingdom would require an army of seventy divisions

in addition to what the rest of the Empire would produce. Hardly anyone believed him, but everyone was prepared to place full confidence in him and to co-operate wholeheartedly in his plans.

HIS PREVIOUS WIDE EXPERIENCE

For his new appointment Lord Kitchener possessed the great asset that he had played a leading rôle in almost every part of the Empire. He had been conqueror and Governor-General of the Sudan and during his short tenure of this appointment, from 1898 to 1899, he had laid deep and broad the foundations on which his successors raised an administration which gave such contentment to the population of the Sudan that they remained at peace throughout the Great War, except for a small rebellion on the outskirts in Darfur, quickly and skilfully suppressed.

Lord Kitchener had just returned from his important post in Egypt, a country in which he had spent many years of his service. He knew its defence problems by heart, he knew its great resources as a Mediterranean base for operations and he knew what risks could be taken in relieving its regular British garrison by a Territorial division in anticipation of reinforcement by Indian troops.

Lord Kitchener had been Commander-in-Chief in the latter part of the South African War, where at the peace negotiations he had formed a remarkable friendship with his opponent, General Louis Botha. They were kindred spirits, both big men in every sense of the word. Louis Botha was now Prime Minister of the Union of South Africa, and had told Mr. Lloyd George in 1911 that, in case of war with Germany, he would hold his country loyal and march 40,000 men into German South-west Africa. Kitchener knew Botha and knew that he might safely remove all the regular troops from South Africa.

Lord Kitchener had been Commander-in-Chief in India for seven years from 1902 to 1909. He had entirely reorganized the Indian Army and made it more efficient for war than it had ever been. He knew exactly what it could and could not do. He knew to a nicety what risks India would be running by

sending large forces to various places overseas to co-operate in the Great War, receiving in return three British Territorial divisions to complete their training. He knew to a hair's breadth the degree of risk in denuding India of nearly all her regular British troops. The C.-in-C. in India, Sir Beauchamp Duff, had been his own Chief of Staff. From London he was in correspondence with him on all these matters until this unconstitutional procedure was stopped. (It was revived with official sanction three years later by Sir William Robertson as C.I.G.S.)

Lord Kitchener when in India had formed another remarkable friendship with the Amir Habibullah of Afghanistan. As C.-in-C., he had been Habibullah's cicerone in the latter's visits to India, and had opened his eyes to the power of the British Empire and, incidentally, to the capacity of Lord Kitchener. On this knowledge and experience, the Amir—against the advice and wishes of nearly all the leading men of his country—formed the opinion that the British Empire was on the winning side, and that his right policy was a strict neutrality, which he persistently followed. He paid for this policy with his life but not until after the Great War had been won. It is difficult to compute in man-power and military resources, the value to India and to the British Empire of the neutrality of Afghanistan.

In 1909 and 1910, Lord Kitchener after leaving India had been invited by the governments of the Australian and New Zealand Dominions to advise them on the constitution and organization of their military forces, pledging themselves beforehand to follow his advice—a pledge which they duly kept.

All this stored-up experience and knowledge, and the associations he had created overseas, were of incalculable value in the urgent task of concentrating and then distributing to the various theatres such forces as were available in the Empire when the war broke out. Seven months were required to complete the complicated imperial concentration of these forces. During those seven months, six regular divisions were sent to France to take part in the early battles, followed at

intervals by four more regular divisions, collected from all over the world, and another regular division (29th) was similarly collected and held in England awaiting embarkation orders. Several Territorial battalions of infantry and some field companies, R.E., had been sent individually to France in response to our urgent calls for reinforcements, but Lord Kitchener had set his face firmly against the pressure of G.H.Q. in France to continue this process, which would have emasculated the Territorial divisions. He was determined to preserve their divisional structure and send them overseas as complete formations. Four Territorial divisions had been sent to Egypt and India to complete their training and to increase security. Five Indian divisions and two cavalry divisions had been dispatched to France, Egypt, Mesopotamia and East Africa. Nearly 40,000 Anzacs had landed in Egypt. The first Canadian division was in France, leaving depot units and strong reinforcements in England: a second Canadian division was forming in Canada. Botha had quelled a rebellion in South Africa and assembled 50,000 men, who were on the point of invading German South-west Africa.

At home, this intricate Imperial concentration was mainly the work of the War Office, the Admiralty and the Board of Trade, using the ships of the Royal Navy and the mercantile marine; and also, of course, of the India Office. Overseas, the Indian government boldly accepted the responsibility for risk and the arrangements for dispatch of so many of their troops to theatres of war across the sea. The Dominion governments had played their part well. But all these government ministries and departments were sustained and helped in this work by their confidence in Lord Kitchener's advice and plans. Undoubtedly, deliberations which would otherwise have been lengthy were cut short, hesitations and delays were avoided, thus reducing considerably the time required for this great Imperial concentration. Lord Kitchener's experience and knowledge and the confidence he inspired were the main-spring of this achievement.

Critics have placed on the other side of the balance the fact that Lord Kitchener had been so occupied in acquiring a unique

experience of all portions of the Empire and its leaders that he had never served at home since he was a young subaltern at Aldershot. He was, therefore, ignorant of War Office organization, of the ways of the various Ministries, of the Cabinet and the system of carrying on Government by committee work. He likewise knew nothing of the great industrial and labour organizations of the United Kingdom.

HIS ACHIEVEMENTS DURING TWO YEARS

He has been blamed for not founding the whole expansion of the army upon the Territorial Army system. But what are the facts? He found fourteen Territorial divisions whose organization and preliminary training were to prove of incalculable value, but they had been recruited for home service only, and but a small proportion had accepted liability for service overseas. These Territorial divisions included an appreciable percentage of elderly or partially fit officers and men who could render service at home only. The first task was to call upon the Territorial divisions to sort out those who now volunteered for overseas (about 60 per cent), to double this number by voluntary recruiting to complete establishment and to supply 25 per cent for first reinforcement. That done, the next task was to recruit and form a second line of fourteen more divisions to go overseas (actually eight second line divisions left the country), and then to form third line depot units to recruit and train men for drafts to maintain the divisions overseas. As fast as the divisions were formed, their administration and training were taken over by the War Office. Surely this triple task for the Territorial Force was as much as the existing organization could manage, and right well was it done.

Yet with all that the Territorial Force could do, the overseas army supplied by the United Kingdom would still be thirty divisions short of the figure of seventy which Lord Kitchener with prophetic vision, had laid down as essential to beat the Germans. Events were to confirm that estimate. The formation

of this balance of thirty divisions had to be started simultaneously with the triple expansion of the Territorial Force. Urgency would not permit postponement of the New Army until after the Territorials had completed their expansion. It is unsound to ask any unit to multiply itself by more than three. We have already noted how he saved the Territorial Army from emasculation. More creative "cells" had to be brought into existence and so the New Army of thirty divisions was called into being by Lord Kitchener, whose personality was invaluable in obtaining a marvellous response from the country. He would listen to no objections that there were no barracks, huts or tents; no clothes, no arms, no officers and no N.C.Os. for the New Army. He struck while the iron was hot, he accepted the millions who volunteered. Within a year his New Army divisions began to pour into the battles. Before the end of August, 1915, seventeen New Army divisions and fourteen Territorial divisions had gone overseas, and before he left England in early June, 1916, to meet his death, the last New Army division had left. Surely this was a unique accomplishment for a Minister of War; against this solid achievement we have the pure conjecture of the pundits that it might have been done better in some other way. Nowadays, people assert that we could have beaten the Germans without so many divisions. Ask our allies what they think of that. Ask any Britisher, from the Home Country or from the Dominions, who was in battle whether he ever felt that we had more troops than we required.

While creating these large armies, the Minister of War was also responsible for the great expansion of the Royal Flying Corps. Of course, this was the work of many distinguished men, but the official history *The War in the Air* pays grateful tribute to the sound, far-seeing views of Lord Kitchener, and the constant help, guidance and sympathy which he gave to those employed in this task.

In August, 1914, conscription was politically and administratively quite impracticable. Six months later it might have been made possible administratively, but at what stage it became practicable politically is a controversial subject.

Space is not available for the proofs of the foregoing statements, but probably few will dispute them. Few also among those who have studied the last war will dispute that, for a war on such a scale, voluntary enlistment was radically unsound.

Undoubtedly, Lord Kitchener's preference was for voluntary enlistment at the beginning, quite apart from its administrative necessity under the circumstances of August, 1914. He was certainly not amongst the earliest converts to conscription, but at what stage he became convinced of its necessity it is difficult to say. Nor is it necessary, since the only factor that settled the date of conscription was political expediency, and Lord Kitchener had not been made Minister of War in order to obtain his advice on politics. He considered that he had been called to the War Office to create, organize and equip an army adequate for its task and to advise on how to use it. Conscription was, after the first few months, a political question. It became more and more obvious that the Minister of War could not provide an army without conscription. Lord Kitchener seems to have considered that provision and distribution of man-power was a matter for the politicians to settle.

MUNITIONS

The provision of munitions has been the subject of much controversy. Their lack was a contributory, but not the primary, cause of the dissolution of Mr. Asquith's Liberal Cabinet and the formation of a Coalition Government in May, 1915. Our Country was not the only one in which cabinets, or at least ministers, were dismissed on the issue of munitions. The lack of or the possession of munitions influenced many decisions in the field. Starting from zero, trained soldiers can be provided much more quickly than adequate munitions. Every belligerent ran short of them, but with some this occurred earlier than with others and the period of recovery from the shortage varied considerably. At one end of the scale, Germany had made in peace what was then considered an adequate munition preparation for her large army and supply lasted

some time ; when the need for rapid expansion arose, she had to multiply her munition factories and resources by a comparatively small figure. At the other end of the scale, the small British army which was to grow so quickly had absurdly small stocks. Factories and resources had, therefore, to be multiplied by a very large figure to catch up the requirements of a rapidly expanding army in a war consuming munitions on an unprecedented scale.

When Lord Kitchener became Minister of War he was the heir to this totally inadequate provision. Had he possessed a fairy wand, had he taken every conceivable measure with the utmost rapidity and without a single mistake in conception and procedure, the needs of the expanding army could not have been overtaken for many months, perhaps even years. The question, therefore, is whether it is reasonable to expect Lord Kitchener and those who worked with him in this matter to have produced earlier and greater results.

It was not until the first Battle of Ypres, in October, 1914, that even those who were at the front really began to visualize the unprecedented scale of consumption of ammunition, and the great variety of new types of munitions required in a modern war between Great Powers.

In September, 1914, the Government had subsidized our armament firms with £20-million to expand their factories. Lord Kitchener and his advisers on munitions relied in the first instance on these expert armament manufacturers and on orders placed in America. It was considered that only those with long experience of technical procedure could manufacture arms and munitions. Nor was this an unreasonable assumption. When necessity forced us to depart from this principle, the first products included some very unreliable weapons and ammunition and added another risk to war. It was some time before it was realized that America was even less prepared than ourselves to fulfil the large contracts placed with her. There was serious disappointment over promised dates of delivery, both at home and in America. Skilful and experienced as our armament firms were, it was some time before it was realized that the task was beyond them and could only be

mastered by a national organization. Labour was wholeheartedly supporting the war, but time was required to convince them that hard-won Trade Union restrictions were incompatible with a war against enemies not bound by such checks in production.

These are only some of the unforeseen difficulties, the realization of which gradually unfolded a view of the enormous task before a nation totally unprepared for war on such a scale. Every individual in the nation must accept his share in the responsibility and should give some sympathy and consideration to the man who realized the situation, but accepted the task of directing the efforts to deal with it. In early 1915, it became obvious that a separate Ministry must be created to deal with the problem of provision, leaving to the Minister of War the responsibility for stating requirements. The new Ministry had to live for some time on what the War Office had arranged. Time was required for it to get into its stride. It was another eighteen months before a continuous increase in production amounted to a steady stream of everything our great armies required. Fourteen months after the outbreak of war the battle of Loos was fought with munitions produced under War Office direction. In this battle, the British soldier for the first time felt that he was giving the enemy what he had been compelled to suffer at their hands. To have worked up within fourteen months from almost nothing to a fairly satisfactory production for an army in the field, multiplied by five or six, is an accomplishment of which Lord Kitchener and the able men who did this work need not be ashamed. With all the knowledge and experience of the Great War at their disposal, those who were charged with the responsibility for rearmament in 1936-38 did not find it easy to equal the performance of 1914-15. They were probably great admirers of their predecessors.

HIS METHODS

In August, 1914, General Sir Charles Douglas who held the post of C.I.G.S. was unfortunately in bad health, and his gallant attempt to contend with his heavy task caused his very

early death. There was some delay in filling the vacancy. The Directors of the General Staff and most of their subordinates had been sent with the B.E.F. to France, a mistake which is unlikely to be repeated in any future war. The General Staff at the War Office was thus completely disorganized and took some time to recover. Some good men, *e.g.*, General Callwell, were brought in but Lord Kitchener did not know them. Decisions were required urgently. Lord Kitchener was accustomed to giving quick decisions on military problems and had had very little cause to regret them. He took it as a matter of course that the disorganization at the War Office would merely add to the War Office burden he had assumed, and that it would save time if he used his great experience and knowledge to answer the questions that would normally be examined by the General Staff.

Before the end of 1915, Sir Archibald Murray had done much to reconstitute the General Staff, and the advent of Sir William Robertson as C.I.G.S. in December, 1915, completely re-established it in the exercise of its proper functions.

Up to the end of 1914, the war policy and strategy of the British Empire was virtually directed by the Triumvirate Asquith, Kitchener and Churchill. In 1915, others were added to this War Council with doubtful advantage. Leading statesmen and soldiers of our allies had perforce to be consulted on war policy and strategy, because they disposed of considerably larger forces on land. This allied consultation was essential, but much council confused the issues and delayed decisions. We provided in 1914 less than 10 per cent of the forces fighting in France. In 1915 we were fighting in many theatres of war with larger numbers, but still much below those that France had put into the field. France, suffering invasion and providing by far the greater portion of the allied force in her country, rightly claimed and succeeded in exercising a dominant influence on war policy and strategy on the Western Front and, therefore, on the whole war. It was not until 1917, a year after Lord Kitchener's death, that the exhaustion and mutiny of the French army caused the British army in France, now greatly increased, to become and remain the paramount

military force on the side of the Entente, though still by no means the largest.

Lord Kitchener had been a Commander-in-Chief in two campaigns. He knew the value to a C.-in-C. of the trust and ungrudging support of a Minister of War, and he gave it in full measure to Joffre. He knew the history of friction between allies and the consequent loss of power. His main purpose was to avoid or reduce this inevitable friction as far as possible, and to support, not only the British Commander in Chief, but also the French Commander-in-Chief, who commanded by far the larger proportion of the allied land forces on the Western Front.

He certainly did not like committee work or large conferences. For sixteen years he had been a Commander-in-Chief, a Governor-General or a High Commissioner. Such people do not sit on committees; they read the reports of committees and give decisions. To him the idea of making war plans with a committee was the same as discussing them with the enemy. He had been accustomed to serving one ministerial chief to whom he opened his heart and his mind. From the Prime Minister, Mr. Asquith, he had no secrets and he co-operated heartily and openly with his two colleagues at the Admiralty—the First Lord and the First Sea Lord, but there were few others to whom he wished to give his confidences. Hence, we find Mr. Lloyd George likening him to a lighthouse which flashes out a momentary beam at very long intervals. With a lighthouse this is certainly the experience of a single observer stationed at one spot, but inside the lighthouse the light is always burning; it illumines in turn every dark spot within the arc of its sweep.

THE DARDANELLES

Unfortunately for the historian, Lord Kitchener has left no well-documented war diary explaining the reasons and motives for the actions he took and the counsel he gave. He was not in the habit of holding post-mortems on himself or on anyone else. To this there is one important exception—

the statement he read to the War Council on 14th May, 1915. Recorded in its proceedings is the following: "When the Admiralty proposed to force the passage of the Dardanelles by means of the fleet alone, I doubted whether the attempt would succeed, but was led to believe it possible by the First Lord's statement of the power of the *Queen Elizabeth*, and by the Admiralty staff paper showing how the operation was to be conducted. . . . I regret that I was led to agree to the enterprise by the statements made, particularly as to the power of the *Queen Elizabeth* of which I had no means of judging."

To the proposal for operations at the Dardanelles, the first reaction of the chief naval and military expert advisers of the Government, Lord Fisher and Lord Kitchener, was, that if the enterprise was undertaken at all, it must be done as a combined military and naval operation acting by surprise. The first estimate of troops given at random by Lord Kitchener was 150,000. Lord Fisher gave rather a larger figure. Lord Kitchener's second reaction was that in 1915 we had not the men or the resources for two large offensive campaigns in separate theatres of war simultaneously. In January, 1915, he said he had no troops to supply for the Dardanelles and added: "We shall not be ready for anything big for some time." Space does not permit us to thread our way laboriously through the maze of counsel which caused Lord Fisher and Lord Kitchener to be swept off the rock of the sound naval and military principles they laid down at the beginning. The controversy between those who discuss the relative advantages of the Western Front and the Dardanelles in 1915 will doubtless continue for ever, but there seems now to be no controversy over the opinion that in 1915 the Entente had not the resources for large-scale offensives in both theatres of war.

OUR DEBT TO EARL KITCHENER

Thus we see that Lord Kitchener in the making of war plans and in forming the strategy of the war, though he undoubtedly exercised for some months a powerful influence, never had a

free hand. Mr. Winston Churchill has said: "No one had supreme power." For the first three years, conditions almost compelled subservience to French strategy on land. Lack of early success brought about a Coalition Government, with an inevitable weakening of the power of the Prime Minister and with a great addition to the number of people who could demand that their opinions and advice should be considered. The number was much increased by the necessity for constant conference with the allies. Lack of success in 1915, and on our part lack of adequate previous preparation in peace, caused the initiative to pass to the enemy, with the usual consequence that we had to make war "not as we would but as we must." To sort out from this medley the degree of responsibility attributable to Lord Kitchener or to anyone else for the success or failure of any strategical decision is impossible within the space available.

In every belligerent country, every soldier in high command and every statesman charged with great responsibility has not only a credit but also a debit side to his account. One can, however, say with confidence that Lord Kitchener's account shows a credit balance of services rendered to his country and her allies at least as great as, and possibly greater than, that of any man on either side.

ROYAL ENGINEERS WHO HELD HIGH APPOINTMENTS DURING THE WAR

The list below includes the names of some of the Royal Engineer officers who held distinguished posts during the first Great War. The names of those who held appointments directly connected with engineer tasks will be found in the succeeding chapters dealing with the War Office, the home front and overseas theatres.

It should be remembered that, almost throughout the war, there were strict orders that Royal Engineers should not be employed on staff and other non-technical duties. These orders, of course, had the effect of reducing the numbers of

R.E. officers who were given command of formations, or staff appointments, but in actual fact many did serve on the General and Administrative Staffs and even as Brigade Majors of infantry brigades.

Lieut.-General Sir Fenton J. Aylmer,
G.O.C., Tigris Corps.

Brigadier-General W. H. Beach,
Director of Intelligence, Mesopotamia.

Major-General H. Bruce Williams,
Major-General, General Staff,
G.O.C., 37th Division.

Major-General Sir John E. Capper,
Deputy I.G.C., B.E.F.,
G.O.C., 24th Division,
Director-General, Tank Corps.

Brigadier-General Clifford Coffin, V.C.,
G.O.C., 25th Brigade.

Brigadier-General E. W. Cox,
Director of Intelligence, B.E.F.

General Sir Hugh J. Elles,
Commander, Tank Corps.

Lieut.-General Sir George H. Fowke,
Adjutant-General, B.E.F.

Major-General Sir Theodore Fraser,
G.O.C., 14th Indian Division,
G.O.C., 18th Indian Division,
G.O.C., South Kurdistan Field Force.

Lieut.-General Sir George F. Goringe,
G.O.C., Tigris Corps.

Lieut.-General Sir George M. Harper,
G.O.C. 51st (Highland) Division,
G.O.C. IV Corps.

Lieut.-General Sir Aylmer Hunter-Weston,
G.O.C., 29th Division,
G.O.C., VIII Corps.

- Major-General Sir Louis C. Jackson,
Director-General, Trench Warfare Supply
Department, Ministry of Munitions.
- General Sir George M. Kirkpatrick,
Chief of the General Staff, India.
- Field-Marshal Earl Kitchener of Khartoum,
Secretary of State for War.
- Major-General Sir Henry M. Lawson,
G.O.C.-in-C., Northern Command,
I.G.C., Italy.
- Major-General Sir Richard P. Lee,
G.O.C., 18th Division.
- Major-General G. A. J. Leslie,
G.O.C., 17th Indian Division.
- Lieut.-General Sir George M. W. Macdonogh,
Director of Intelligence, War Office,
Adjutant-General, War Office.
- Lieut.-General Sir Ronald Maxwell,
Quartermaster-General, B.E.F.
- Major-General G. A. F. Sanders,
G.O.C., 17th Indian Division.
- Major-General S. H. Sheppard,
Chief of Staff and various Commands,
East Africa.
- Major-General Sir Ernest D. Swinton,
Commander, Heavy Section, Machine Gun
Corps.
- Major-General Sir Henry F. Thuillier,
G.O.C., 15th (Scottish) Division,
Controller, Chemical Warfare Department,
Ministry of Munitions,
G.O.C., 23rd Division.

CHAPTER II

EXPANSION OF THE CORPS DURING THE WAR

Magnitude and rate of the expansion—Office of the A.A.G., R.E.
—Provision of officers—Tables showing growth of the R.E.
in strength and numbers of units.

MAGNITUDE AND RATE OF THE EXPANSION

THERE is an excellent typewritten report in the custody of A.G.7. at the War Office describing in considerable detail how the Corps of R.E. was expanded between August, 1914, and November, 1918, and giving the number, types, establishments and organization of R.E. units which came into existence. In the "Miscellaneous" volume of the series of books published by the Institution of R.E. entitled *Work of the R.E. in the European War 1914-19*, will be found, on pp. 5-71, a condensed account of A.G.7's report referred to above. The valuable tables on pp. 61-71 of the "Miscellaneous" volume give the reader a *coup d'œil* of the whole of this very complicated organization and the magnitude of its growth during the war.

Here, lack of space requires us to condense still further the description of this expansion of the Corps from peace to war strength. The reader's attention is drawn to the tables which we reproduce at the end of this chapter, copied from pp. 61-3 and 68-71 of the "Miscellaneous" volume. Information about the R.E. transportation units, given on pp. 34-7, is reproduced at the end of Chapter VI.

The reader is reminded that the Royal Corps of Signals was not created as a separate corps until 2nd July, 1920. Prior to that date it was an integral part of the Corps of Royal Engineers. The history of the Signal Service from 1914 to the date of its separation from our Corps, is being dealt with separately, but it will be necessary to refer to it occasionally.

The variety, complexity and the number of different types of R.E. units (159) that were required in war, as compared with the twenty-four types existing before the war, is a measure of the degree of improvisation required in this great expansion.

Studying the Tables of Units at the end of this chapter as one would study and comment upon a balance sheet of a commercial company, we note that upon 1st August, 1914, there were in the Corps of R.E., 1,056 Regular and Special Reserve Officers and 10,394 Other Ranks, 513 Territorial Officers and 13,127 Other Ranks. Whereas, on 1st November, 1918, the expanded Corps (excluding transportation units) contained 229,366 all ranks. In this total, the number of officers (not separately stated) must have been about 11,830 (the figure given for 1st August, 1918). By November, 1918, the number of officers in 1914 had therefore been multiplied by 7.6, and of other ranks by 9.3.

As regards the rate at which this expansion was made, we find that by 1st August, 1915, the total strength had increased fivefold, by 1st August, 1916, eightfold, and by 1st August, 1917, nearly twelvefold (always excluding transportation units). From then onwards the severe casualties in 1917 and 1918 more than balanced further expansion. We may say therefore that 42 per cent of the expansion had been made in the first year of war, another 24 per cent in the next year and in the third year the peak was reached. This was surely a very rapid rate in the face of severe casualties and the fact that the greatest effort had to be made in the first year.

The British portion of the Empire's forces in overseas theatres of war had increased from six divisions in August, 1914, to seventy divisions in 1917. Their L. of C. in all theatres including lateral communications, ran into thousands of miles, absorbing a very large number of men for their creation and maintenance.

Again, examining the tables, we find that, of 1,328 R.E. units of 147 different types, 226 were field companies, seventy-five were army troops companies and twenty-five were tunnelling companies. These three types of unit undertook all kinds of work in the zones of fighting formations. Signal units

numbered 589. The remaining units were mostly for the special kinds of work indicated by their names.

It should be noted that in 1914 only two field companies were included in each division, but the necessity for a third was at once realized and an additional company had been added by the end of 1914.

The transportation units, whose organization and work is described later, numbered about 500, and among their many types we note particularly forty-nine railway construction companies, sixty-three broad-gauge operating companies, thirty-eight road construction or quarrying companies and twenty-six companies for inland water transport and docks. A list of these units is given at the end of Chapter VI. Their total strength was made up as follows:—

Units raised in the United Kingdom	62,344
Colonial corps sent out from Home	22,608
	<hr/>
	84,952
Units raised in the Dominions	23,390
	<hr/>
	108,342
	<hr/>

Adding the above figure 84,952 for R.E. transportation troops to the figure 229,366, previously explained, we see that, after the great expansion, *the strength of the Royal Engineers was 314,318.*

In the report in A.G.7's office and in the "Miscellaneous" volume, already referred to, will be found far more information upon the establishments of these units, and why and how and when they were raised. In the following chapters we shall tell the story of their work, a story that will throw further light upon their organization and the causes that brought them into being.

THE OFFICE OF THE A.A.G., R.E. (A.G.7).

The expansion of the Corps was organized and administered in collaboration between the office of the A.A.G., R.E. (A.G.7)

at the War Office, and the office of the Officer in charge R.E. Records and Recruiting at Chatham. The organization of the expansion of transportation units was the work of the Director of Movements and Quartermastering, and later of the Director-General of Transportation.

In August, 1914, the appointment of A.A.G., R.E., was held by Colonel R. S. Curtis (Brigadier-General, November, 1915, and Major-General, 1916). On 1st January, 1917, overwork led to Colonel Curtis being placed on the sick list. He was succeeded by Brigadier-General T. A. Bigge. The appointment of Officer in R.E. Records and Recruiting was held in August, 1914, by Colonel B. R. Ward.

Prior to mobilization in August, 1914, Colonel Curtis had only one officer and nine other ranks besides himself on the establishment of his office. His Superintending Officer was Major W. G. C. Brown, who had enlisted in the Corps in 1871, and by exceptional ability and industry rose to the rank of Lieut.-Colonel in November, 1915. He was a remarkable personality, well known and liked by every officer in the Corps. After forty years' work in A.G.7 office he was reputed to know more than anyone else about the strategy and tactics required to pilot a difficult War Office file speedily to a satisfactory decision. In 1919 he died from overwork.

On mobilization this small establishment was increased by one Staff Captain (Major G. A. Travers from the retired list) and three other ranks.

On 1st January, 1915, the establishment was three officers and eighteen other ranks and civilians.

On 1st January, 1916, the establishment was still only three officers, but thirty-one other ranks and civilians.

On 1st January, 1917, the establishment was still only three officers, and thirty-one other ranks and civilians.

On 1st January, 1918, the establishment was still only three officers and thirty-seven other ranks and civilians.

On 1st January, 1919, the establishment was nine officers and thirty-seven other ranks and civilians.

The fact that only three officers carried on the work for the first three years of the war no doubt accounts for Colonel Curtis being invalided in 1917 and Lieut.-Colonel Brown dying in 1919. It must be remembered that A.G.7 was also dealing with the great expansion and organization of the Signal Service.

PROVISION OF OFFICERS

In selecting civilians to become officers to command and work with military engineer units in war there is one sound principle which was strictly adhered to throughout the war of 1914-18, and which greatly facilitated the difficult task of weeding out applicants who were not competent to fill such posts. It was stipulated that they must have technical qualifications of sufficient quality. The youngest need have technical education only, but older men must have both technical education and also experience in the execution of engineering, constructive or scientific work of some sort.

A maximum age of 30 was fixed for men who were to be granted temporary commissions as subalterns or captains, but some exceptions were made for very well qualified men above that age, who were given temporary rank up to colonel. In addition, prominent and experienced engineers or scientists of any age were of course taken into consultation, *e.g.*, the Sub-committees of the Royal Society formed to assist the Government.

These two requirements—technical qualifications, and a maximum age of 30, reduced the very large number of applicants who had to be examined by interview and by inspection of proofs of experience and merit. In this examination, physique, vigorous character and capacity for leadership were important considerations in making selections.

A qualified engineer of good health and physique, with practical experience in supervising some form of engineering, scientific or constructive work, already possesses four-fifths of the qualifications required by an engineer officer in war. He

has education and experience of managing men, and of ensuring that orders are carried out strictly in accordance with plans. He is fully acquainted with the properties of materials for construction. He is accustomed to arranging for the assembly of materials, stores, plant, skilled and unskilled labour in suitable proportions, and for transport to move them to and from the work. He is accustomed to planning and orderly management. To these qualifications one must add for war, training in the use of weapons, horsemanship and animal management (in the war of 1914-18), the rudiments of the system of military discipline and law, drill to a sufficient standard, some knowledge of military organization and administration, the governing consideration of *time* in war, the art of improvisation with inferior and insufficient materials and finally leadership under active service conditions. These additional military qualifications were very rapidly picked up by the men whose training qualifications in civil life have already been described. Nearly all of them proved to be capable of speedy adaptation to the work and responsibilities of a military engineer officer in war. The amalgam of the regular and the temporary or the territorial engineer officers in the proportion of about one to eight, proved to be very strong and appropriate, and this amalgam succeeded in "delivering the goods." An eminent engineer in civil life (Sir John Cadman), called into frequent consultation requiring many visits to theatres of war, said that he could never tell whether he was talking to a regular or a temporary engineer officer. For the formation of this amalgam the regular and the temporary or territorial officer were equally necessary. They were complementary and supplementary to one another.

In improvising and developing engineer units and organization for a national army in total war it is just as necessary to have a regular military engineer cadre of all ranks for a nucleus on which to build, as it is for the remainder of that army to have such regular nuclei. The smaller the proportion of the nucleus to the whole, the longer will be the time required to reach the standard of efficiency required in war.

The reader will need some further explanation of how the

foregoing principles were applied in providing and appointing officers for the many types of engineer units employed in fighting formations and on the thousands of miles of communications, and in training them for this military work. It has already been stated that it was one of the main responsibilities of A.G.7. to organize a system for this purpose. F.W.4 and F.W.5 branches of the Office of the Director of Fortifications and Works undertook the provision of many officers and subordinate staff for work on the lines of communications (see next chapter). The Railway Directorate at the War Office were responsible for establishments of officers and units for railway work, and for their training.

The Royal Military Academy, Woolwich, continued to function throughout the war, turning out as usual regular officers for Royal Artillery and Royal Engineers, but the course was shortened from two years to only six months. From the R.M.A., young R.E. officers proceeded as formerly to Chatham for technical instruction, but here again the course was shortened from two years to only six months. Thus after one year at Woolwich and Chatham they joined units in a theatre of war with their technical training considerably crammed. In a later chapter we shall see that those who survived the war resumed technical instruction for a further two years.

As regards Territorial, Special Reserve and Temporary officers, we must first note that from 1914 to March, 1916, we relied upon voluntary recruitment for all ranks. Prior to the passing of the Compulsory Military Service Act in 1916, the arrangements for selecting and training officers were as follows.

Territorial officers for field and L. of C. units were nominated by the Presidents of Territorial Associations and appointed by the Territorial branch at the War Office. They were trained in Reserve T.A. groups supplemented by courses at reserve training centres, particularly Chatham and the Signal Training Centre.

Special Reserve and temporary commissioned officers were selected from :—

- (a) Candidates recommended by the President of the Institution of Civil Engineers.
- (b) Candidates who were members of University Officers Training Corps and in possession of an engineering degree and recommended by O.C., O.T.C.
- (c) Candidates from abroad with practical engineering experience, after interview by A.G.7.

S.R. and T.C. Officers were trained at first at Chatham Reserve Training Centre in a seven-weeks course of drill, riding and military engineering. In June, 1915, another Reserve Training Centre was opened at Newark and later in the year a third at Deganwy. In 1915 the course was increased to eleven weeks.

After the passing of the Compulsory Service Acts in March, 1916, it became possible for any N.C.O. or man who believed that he had the necessary technical qualifications to apply for a commission in the R.E. Strange to say, it was not until 1918 that men serving on Regular Army attestations were permitted so to apply. Candidates were no longer interviewed by the President of the Institution of Civil Engineers but by a C.R.E. On being approved, candidates were sent as cadets to a Reserve Training Centre for a course now extended to sixteen weeks. If they passed out satisfactorily they then received their commissions and were posted to units. The course was later increased to six months, but officers with special technical qualifications did a four-month course at Deganwy.

In 1917 the appointment and administration of Territorial officers was transferred to A.G.7. They were trained at Reserve Training Centres and were then liable to be posted to any unit, regular or Territorial.

Officers for the Signal Service with regular commissions went from the R.M.A., Woolwich, to the Reserve Signal Depot, Aldershot for four month's training. For temporary commissions they were either selected from university O.T.Cs. having been recommended by the commanding officer, or from candidates abroad with the necessary technical qualifications.

The Signal Reserve Training Depot expanded in 1915 into the Signal Training Centre comprising six depots at different places. Officers and cadets under training went to the depot at Haynes Park.

Officers for anti-aircraft searchlight units were drawn from the small regular establishment of coast defence units, or from the London or Tyne Electrical Engineers. The two last named were pre-war Territorial units which were expanded considerably to absorb cadets for temporary commissions. A school for electric light training was established at Gosport.

Officers for tunnelling companies. These units were formed early in 1915. Officers were appointed on recommendations received from all the Mining Associations in Great Britain. Candidates from abroad were examined for technical qualifications at a special office in London and then interviewed by A.G.7. At first the urgency for their work was such that officers and men received only one week of military training at Chatham. This was gradually increased to five weeks. Later the Tunnelling Depot was abolished and cadets went to Reserve Training Centres with the cadets for other R.E. units.

The Royal Anglesey and the Royal Monmouthshire R.E. were the only Special Reserve R.E. units in existence before the war. They were expanded from four to ten companies each. The officers required for the expansion were at first nominated by the commanding officers and trained at the depots of the units, but later cadets were selected and trained for commissions in the normal way.

With regard to officers required for railway work, there were about fifty regular R.E. officers with experience of railway construction or traffic management available at home or in India, Egypt, the Sudan and the colonies. There were also a few Special Reserve, supplementary list, officers and some in Supplementary Reserve units, but the vast majority of the railway officers were temporarily commissioned. Most of the construction officers came from abroad, especially from South America, the numbers from the British railways being relatively small, as little actual railway construction had been done

for a long time in the United Kingdom in comparison with the developments in other parts of the world. Locomotive officers came from home and abroad, especially South America, but were always scarce. They were mainly drawn from the class of young man who, having served his time on a British railway, was holding a position as assistant shed foreman before going abroad as a district locomotive superintendent. Workshop officers with good qualifications were difficult to find, but good men were obtained with experience in locomotive and wagon shops. Traffic officers were plentiful, the majority coming from the South American and British railways. Stores officers had to be over age or of low medical category but presented no difficulty, some regular quartermasters doing invaluable work. Many officers were commissioned from the ranks of the railway troops and also, if they had suitable qualifications, from other corps. The number of technical railway officers in France reached a total of 1,760.

The foregoing paragraphs explain the general principles on which officers were selected and trained for the great expansion of the Corps, but for many of the numerous specialized units there were variations in this procedure and exceptional measures were taken to find and train suitable officers. The special depots (e.g., the transportation depots) are included in the tables at the end of this chapter.

Having thus described the system and the sound principles followed by A.G.7's office in organizing this great expansion of the Corps, it is necessary to add that it could not have succeeded without the co-operation, initiative and enterprise displayed by the executive officers who had to carry out the work. Officers at depots and in the newly formed units willingly accepted responsibility for interpreting the spirit rather than the letter of regulations, and in doing so often had to ignore financial limitations. Moreover, it is quite impossible to praise too highly the spirit and keenness of the vast numbers of civilians who voluntarily rushed to the colours early in the war, a spirit which enabled them to endure cheerfully the hardships unavoidably imposed upon them by the unreadiness of our war machine to cope with such an enormous improvisation.

To illustrate how the expansion worked in practice and how it affected officers and other ranks at the beginning of the war we shall in Chapter VII include descriptions of life at Chatham, at the R.E. Training Depot, Aldershot, and at Newark in the early days of the war. We shall also include the experiences of an officer commanding a field company in raising and training his New Army unit.

GROWTH OF THE ROYAL ENGINEERS

Regular Units

Type of Unit	Aug. 1914			1st Aug. 1915				
	Home	Colonies	Total	Home	Colonies	S.E.F.	M.E.F.	Total
Field Squadrons	1	—	1	—	—	3	—	3
Field Troops... ..	1	—	1	—	—	—	—	—
Field Companies	13	2	15	12	—	27	14	103
Fortress Companies... ..	16	15	31	34	9	6	14	49
Army Troop Companies	—	—	—	—	—	—	—	—
Artisan Works Companies	—	—	—	—	—	—	—	—
E. and M. Companies	—	—	—	—	—	—	—	—
Water Boring Sections	—	—	—	—	—	—	—	—
Land Drainage Companies... ..	—	—	—	—	—	—	—	—
Coast Works Companies	—	—	—	—	—	—	—	—
A.A. Searchlight Companies	—	—	—	—	—	2	—	2
Tunnelling Companies	—	—	—	—	—	9	—	9
Special Companies (Gas)	—	—	—	—	—	5	—	5
Meteorological Sections	—	—	—	—	—	—	—	—
Special Works Park (Camouflage)	—	—	—	—	—	1	—	1
Survey Companies	3	—	3	2	—	—	—	2
Printing Companies	1	—	1	—	—	1	—	1
Topographical Sections	—	—	—	—	—	—	—	—
Printing Sections	—	—	—	—	—	2	—	2
Ranging Sections	—	—	—	—	—	2	—	2
Engineer Services	1	—	1	1	—	—	—	1
Postal Services	1	—	1	1	—	1	—	2
Forestry Companies	—	—	—	—	—	—	—	—
Road Construction Companies	—	—	—	—	—	—	—	—
Quarrying Companies	—	—	—	—	—	—	—	—
Railway Units	2	—	2	—	—	3	—	3
Railway Operating Divisions	—	—	—	—	—	—	—	—
Wagon Erecting Companies	—	—	—	—	—	—	—	—
Inland Water Transport Depots	—	—	—	1	—	1	—	2
Inland Water Transport Sections... ..	—	—	—	—	—	—	—	—
Bridging Trains	2	—	2	1	—	2	—	3
Cavalry Corps Bridging Park	—	—	—	—	—	—	—	—
Pontoon Park Companies	—	—	—	—	—	—	—	—
Advanced Park Companies	—	—	—	—	—	1	—	1
Base Park Companies	—	—	—	—	—	1	—	1
Depots	3	—	3	5	—	1	1	7
Signal Units	15	1	17	5	—	74	31	110
Carrier Pigeon Service	—	—	—	—	—	—	—	—
Signal Depots	—	—	—	6	—	1	1	8
Total	59	19	78	68	9	1193	47	317

GROWTH OF THE ROYAL ENGINEERS (contd.)

Regular Units (contd.)

1st Aug. 1906					1st Aug. 1917							1918	
Home	Colonies	B.E.F.	M.E.F. etc.	Total	Home	Colonies	B.E.F.	Egypt	Salonika	E. Africa	Mesopot.	Total	
—	—	3	—	3	—	—	5	—	—	—	—	5	See next table
—	—	4	—	4	—	—	1	2	—	—	—	3	
—	—	95	14	109	—	—	98	—	11	—	—	113	
12	9	—	—	21	11	5	—	—	—	—	—	26	
2	—	36	9	47	—	—	46	3	2	—	—	50	
—	—	2	—	2	—	—	2	—	—	—	—	2	
—	—	1	—	1	—	—	8	—	—	—	—	8	
—	—	—	—	—	—	—	5	—	—	—	—	5	
—	—	2	—	2	—	—	1	—	—	—	—	1	
—	—	—	—	—	2	—	—	—	—	—	—	2	
—	—	2	—	2	—	—	4	—	—	—	—	4	
—	—	25	—	25	—	—	25	—	—	—	—	25	
—	—	5	—	5	—	—	29	—	—	—	—	29	
—	—	2	—	2	—	—	1	—	—	—	—	1	
—	—	1	—	1	—	—	1	—	—	—	—	1	
1	—	4	—	5	1	—	5	—	1	—	—	7	
—	—	1	—	1	—	—	1	—	—	—	—	1	
—	1	—	1	2	—	—	—	—	—	1	—	1	
—	—	4	2	6	—	—	—	1	1	1	—	3	
—	—	1	—	1	—	—	1	1	—	—	—	2	
1	—	—	—	1	1	—	—	—	—	—	—	1	
1	—	1	—	2	1	—	1	1	1	—	—	4	
—	—	—	—	—	—	—	5	—	—	—	—	5	
—	—	—	—	—	—	—	33	—	—	—	—	33	
—	—	2	—	2	—	—	10	—	—	—	—	10	
—	—	17	8	25	—	—	105	6	11	—	—	122	
6	—	18	1	25	1	—	1	1	1	—	—	4	
—	—	—	—	—	—	—	4	—	—	—	—	4	
2	—	—	—	2	2	—	—	—	—	—	—	2	
10	—	11	3	24	6	—	14	1	1	—	1	23	
—	—	—	—	—	—	—	—	—	—	—	—	—	
—	—	—	—	—	—	—	—	1	—	—	—	1	
2	—	10	—	12	—	—	12	—	—	—	—	12	
—	—	2	2	4	—	—	1	1	1	—	—	3	
—	—	2	3	5	—	—	3	1	1	—	1	6	
13	—	1	1	15	15	—	1	1	1	—	1	19	
11	—	187	70	268	3	—	228	37	30	11	12	321	
—	—	1	2	3	—	—	1	1	1	—	—	3	
7	—	1	1	9	6	—	1	1	1	1	1	11	
68	10	436	123	637	50	9	652	58	90	14	21	824	

See
next
table

GROWTH OF THE ROYAL ENGINEERS (*contd.*)*Special Reserve Units*

	1st Aug. 1914	1st Aug. 1917						
	Total	Home	Colonies	B.E.F.	Egypt	Salonika	E. Africa	Mesopot.
Field Companies	—	—	—	—	2	—	—	2
Siege Companies	2	—	—	6	—	—	—	8
Army Troops Companies	—	—	—	2	—	—	—	2
Railway Companies	3	—	—	3	—	—	—	3
Depots	2	4	—	—	—	—	—	4
Total	7	4	—	11	2	—	—	17

Territorial Force Units

	1st Aug. 1914	1st Aug. 1917						
	Total	Home	Colonies	B.E.F.	Egypt	Salonika	E. Africa	Mesopot.
Field Companies	28	31	—	58	43	5	—	110
Reserve Field Companies	—	25	—	—	—	—	—	15
Army Troops Companies	15	—	—	12	2	—	—	14
Works Companies	24	14	1	—	—	—	—	15
Anti-Aircraft Companies	—	35	—	—	—	—	—	35
Anti-Aircraft Sections	—	—	—	42	—	—	—	42
Electric Light Companies	18	43	1	—	—	—	—	44
Searchlight Companies	—	3	—	—	—	—	—	3
Tyne E.E. Companies	4	2	—	—	—	—	—	2
London E.E. Companies	6	5	—	—	—	—	—	5
Aeroplane Squadron, Search- light Sections	—	3	—	—	—	—	—	3
Demolition Sections	—	2	—	—	—	—	—	2
Postal Service	1	1	—	—	—	—	—	1
Depots	—	3	—	—	—	—	—	3
Signals	14	12	—	16	6	2	—	36
Total	110	169	2	128	21	7	—	130

FINAL SIZE OF THE ROYAL ENGINEERS

Royal Engineer Units, November, 1918

Type of Unit	Home	Colonies	B.E.F.	Egypt	Salonika	E. Africa	Mesopot.	Italy	Total
Field Squadrons ...	—	—	5	2	—	—	—	1	7
Field Troops ...	—	—	—	2	—	—	1	—	3
Field Companies ...	27	—	163	12	13	—	6	5	226
H.Q. Divisional Engineers ...	4	—	43	6	4	—	1	1	59
Army Troops and Siege Companies ...	—	—	60	7	7	—	—	1	75
Artisan Works Companies ...	—	—	16	—	—	—	—	—	16
Works Companies ...	11	1	5	—	—	—	1	—	18
E. and M. Companies ...	—	—	7	—	—	—	2	—	9
Water Boring Sections ...	—	—	5	—	—	—	—	—	5
Water Supply Companies ...	—	—	—	3	—	—	—	—	3
Fortress Companies ...	27	10	—	—	—	—	—	—	37
Fortress Works Companies ...	4	—	—	—	—	—	—	—	4
Land Drainage Company ...	—	—	1	—	—	—	—	—	1
H Company K.G.O. Sappers and Miners ...	—	—	—	—	—	—	1	—	1
Telegraph Construction Company ...	—	—	—	—	—	—	—	1	1
Inspector of Searchlights ...	—	—	1	—	—	—	—	—	1
Field Searchlight Company ...	—	—	1	—	—	—	—	—	1
A.A. Searchlight Sections ...	17	—	75	—	—	—	1	—	93
School of Electric Lighting ...	1	—	—	—	—	—	—	—	1
London and Tyne Electrical Engineers ...	2	—	—	—	—	—	—	—	2
Controller of Mines ...	—	—	1	—	—	—	—	—	1
Tunnelling Companies ...	—	—	25	—	—	—	—	—	25
Mining Company ...	—	—	—	—	1	—	—	—	1
Army Mines Schools ...	—	—	5	—	—	—	—	—	5
Mining Stores Depot ...	—	—	1	—	—	—	—	—	1
H.Q. Special Brigade (Gas) ...	—	—	1	—	—	—	—	—	1
Special Brigade Battalions ...	—	—	4	—	—	—	—	—	4
H.Q. Special Company ...	—	—	1	—	—	—	—	—	1
Special Companies ...	—	—	5	—	—	—	—	—	5
Special Store ...	—	—	1	—	—	—	—	—	1
Gas Directorate ...	—	—	1	—	—	—	—	—	1
Meteorological Sections ...	1	—	1	1	1	—	—	—	4
Anti-Gas Service ...	—	—	1	—	—	—	—	—	1
Anti-Gas Establishment ...	1	—	—	—	—	—	—	—	1
Anti-Gas Schools ...	—	—	—	—	5	—	—	—	5

Continued on next page.

FINAL SIZE OF THE ROYAL ENGINEERS (contd.)

Royal Engineer Units, November 1918 (contd.)

Type of Unit	Home	Colonies	B.E.F.	Egypt	Salonika	E. Africa	Mesopot.	Italy	Total
Special Wks. Park (Camouflage)	—	—	1	—	—	—	—	—	1
Camouflage Park	—	—	1	—	—	—	—	—	1
Camouflage School	1	—	1	—	1	—	—	—	3
Postal Service	1	—	1	1	1	1	—	1	6
Army Postal Ser. Home Defence	1	—	—	—	—	—	—	—	1
Field Survey Battalions	—	—	5	—	—	—	—	—	5
Field Survey Companies	7	—	1	1	1	—	—	—	10
Printing Company	—	—	1	—	—	—	—	—	1
Printing and Topo. Sections	—	—	—	1	—	2	—	—	3
Overseas Branch Ord. Survey	—	—	1	—	—	—	—	—	1
Directorate of Forestry	—	—	1	—	—	—	—	—	1
L. of C. Forestry Group	—	—	1	—	—	—	—	—	1
L. of C. Forests	—	—	1	—	1	1	—	—	3
Forestry Companies	—	—	11	—	—	—	—	—	11
Forestry Control for Army Areas	—	—	1	—	—	—	—	—	1
Bridging and Eng. Field Parks	—	—	1	—	—	—	2	—	3
Advanced Park Companies	—	—	1	1	1	—	—	—	3
Pontoon Park Companies	—	—	1	1	—	—	—	2	4
Raise Park Companies	—	—	4	2	1	1	—	—	8
Royal Engineer Workshops	—	—	5	—	—	—	—	—	5
Reserve Battalions	8	—	—	—	—	—	—	—	8
Cadet Battalion R.E.	1	—	—	—	—	—	—	—	1
Depots	11	—	6	1	1	—	1	—	20
Group Depot Companies	2	—	—	—	—	—	—	—	2
H.Q. Reserve Field Company	1	—	—	—	—	—	—	—	1
Bridging School	—	—	1	—	—	—	—	—	1
R.E. Staff Army Training Sch.	—	—	—	—	1	—	—	—	1
Sections at R.M.A. and R.M.C.	2	—	—	—	—	—	—	—	2
Experimental Companies	3	—	—	—	—	—	—	—	3
Emergency Sections	2	—	—	—	—	—	—	—	2
Messenger Dog Service	—	—	1	—	—	—	—	—	1
War Dog School	1	—	—	—	—	—	—	—	1
Cinema Company	—	—	—	—	—	—	1	—	1
Engineer Section G.S. Intell.	—	—	—	1	—	—	—	—	1
G.H.Q. 3rd Echelon	—	—	1	1	1	—	1	—	4
Signal Units (77 Types)	35	—	401	65	42	3	24	17	539
Total	105	11	584	108	80	7	41	27	1328
Transportation Units*	82	—	300	30	11	5	70	6	504
Total R.E. Units	187	11	1184	138	91	12	111	33	1832

* These figures are approximate only. For details see end of Chapter VI.

STRENGTH OF THE R.E., 1914-1918

Date		Regulars and Special Reserve	Territorial Force		Total all ranks
Aug. 1914	Officers Other ranks	1,056 10,394	513 13,127		25,090
Aug. 1915	Officers Other ranks	3,049 82,932	1,262 38,924		126,165
Aug. 1916	Officers Other ranks	6,823 154,361	48,000*		209,000*
Aug. 1917	Officers Other ranks	8,886 230,500	56,282		295,668
		Total Royal Engineers, excluding Transportation		Transporta- tion all ranks	
Aug. 1918	Officers Other ranks	11,830 225,540		80,000*	310,000*
Nov. 1918	All ranks	229,366		{ 62,344 22,668‡	314,318†

* Approximate figures.

† Of this figure, approximately 15,000 were officers.

‡ Colonial corps sent from home.

CHAPTER III

THE HOME FRONT

Department of the Director of Fortifications and Works—Defence against invasion by sea—Defence against air attack—Works at home.

DEPARTMENT OF THE DIRECTOR OF FORTIFICATIONS AND WORKS

IN August, 1914, the D.F.W. was Major-General G. K. Scott-Moncrieff, C.B., C.I.E. (later K.C.B.). His experience included the Afghan Campaign, 1879-80, operations in China, 1900-01, and many years on public works and military works in India. He had been Chief Instructor in Construction at the S.M.E. from 1893 to 1898.

Prior to the outbreak of war the D.F.W.'s office had been organized in five main branches and three sub-branches:

- F.W.1. Rifle ranges.
- F.W.2. Barracks and hospitals at home. A design office was included in this branch.
- F.W.3. All fortifications and Army Ordnance buildings at home and abroad. Barracks and hospitals abroad only.
- F.W.4. Personnel for R.E. Services, and supervision of the following three sub-branches:
- F.W.4(a). All electrical services and provision of R.E. stores under an "Inspector of Lights."
- F.W.4(b). R.E. technical stores, except for railways, their design, pattern, scales and reserves. The officer i/c was also "Secretary of the R.E. Committee" which investigated proposals for new types.

- F.W.4(c). Mechanical services and supply of machinery and building stores for foreign stations. The officer i/c was called "Inspector of Iron Structures" (I.I.S.).
- F.W.6. Quantity surveyors' work for building contracts and bills, under a "Chief Inspector of Works" (later "Chief Surveyor").

A Technical Audit Office (not under D.F.W.) in charge of a "Chief Examiner" checked contract bills. At that time there was also a civilian "Director of Barrack Construction" carrying out certain specified work. This directorate was abolished in 1917.

The great expansion during the war of all these types of engineering work and the addition of several new types necessitated a very large expansion of the D.F.W.'s office in personnel and accommodation.

This was effected as under :—

- (i) F.W.3 threw off a new department named "Trench Warfare" under Colonel L. Jackson, who handed over the normal work of F.W.3 to Colonel E. Kent.
- (ii) F.W.4 was left to deal only with personnel. His sub-branches, 4(a), 4(b) and 4(c), became two branches—F.W.8 under a "Chief Mechanical Engineer," and F.W.9 under a "Chief Electrical Engineer," both reporting to D.F.W. direct.
- (iii) F.W.5, previously non-existent, was staffed to receive demands from all overseas theatres for personnel and stores for works, and to arrange for their provision with the Government departments concerned, or direct with civilian contractors.

The officer i/c was a liaison officer with other engineer branches to help D.F.W. to co-ordinate their work, and with the G. and Q. staffs to obtain advanced knowledge about engineer work likely to be required. Sir George Scott-Moncrieff called F.W.5 "a switch-board and a clearing house."

This important branch had an unofficial beginning. When Colonel A. M. Stuart left for France to be Director of Works, he arranged that he would deal by private correspondence with Major R. L. B. Thompson (a D.A.D.W. at the War Office) on subjects of special urgency that he wished to be "followed up" and "seen through." This at once became Major Thompson's entire preoccupation. He later became Staff Officer to the Director of Works in France, and Colonel Brady was officially posted to F.W.5 to expand for all theatres of war the work which Major Thompson had been doing.

- (iv) Another new branch, F.W.7, was formed to deal only with buildings for the Army Ordnance Corps, the demands for which had become very large.
- (v) A new branch, F.W.2(c), was formed to deal with the buildings and other works required for the rapidly expanding Royal Flying Corps. In 1918, this branch moved to the newly formed Air Ministry, taking with it a portion of the design branch of F.W.2(b), and becoming the Works Directorate for the R.A.F.
- (vi) The design office of F.W.2 expanded into a sub-branch F.W.2(b).

Thus early in the war the five pre-war branches and three sub-branches of D.F.W.'s. office increased to eleven branches and one sub-branch. In addition they provided the heads and the nuclei of a very large Trench Warfare Department and an Air Ministry Works Directorate. Moreover every branch was largely increased by personnel of all grades and in office accommodation, particularly F.W.8.

The names of the principal officers just prior to mobilization, and the changes during the progress of the war are as follows:—

- D.F.W. Major-General Sir George Scott-Moncrieff, succeeded in February, 1918 by Major-General P. G. Twining.
- F.W.1. Colonel J. H. Cowan.

- F.W.2. Colonel E. H. Hemming who mobilized as Deputy Director of Works (France) and was succeeded by Colonel S. D. Cleeve.
- F.W.3. Colonel A. M. Stuart who mobilized as Director of Works (France) and was succeeded by Colonel Louis Jackson, who was himself succeeded by Colonel E. Kent.
- F.W.4. Colonel W. R. Stewart, who was succeeded by Colonel S. H. Powell.
- F.W.5. Colonel D. Brady.
- F.W.6. Lieut.-Colonel T. S. Jerome.
- F.W.7. Colonel T. J. W. Prendergast.
- F.W.8. Captain, later Major and Brevet Lieut.-Colonel, R. Oakes, who was succeeded by Colonel S. L. Craster.
- F.W.9. Major A. W. Dumaresq who died, and was succeeded by Lieut.-Colonel E. C. Seaman who also died towards the end of the war.
- F.W.2(b). Major, later Lieut.-Colonel, B. O. Armstrong.
- F.W.2(c). Colonel MacAdam, later Director of Works Air Ministry.

Among distinguished R.E. officers who joined the staff of D.F.W. from the retired list were Colonel Sir Edward Raban, formerly Director of Works at the Admiralty, Captain M. P. H. Sankey who had retired in 1889 to become a well-known consulting engineer, Colonel L. Jackson, Colonel S. D. Cleeve and Colonel E. Kent.

Summarizing the organization, we may say that the D.F.W., having quickly expanded existing branches, and created new ones, used F.W.1, 2, 3, 6 and 7, for the execution of works of all kinds, including coast defence at home and abroad, and F.W.2(c) for works for the R.F.C. He used F.W.5, 8 and 9 for the supply of engineer stores, material, plant and machinery for the foregoing works at home, and also to meet the demands which poured in from Engineers-in-Chief and Directors of

Works in every theatre of war. F.W.9 was also responsible for supply of all stores and material for the Signal Service.

F.W.8 installed Captain and Quartermaster Tucker at Southampton with the necessary subordinates to receive and dispatch to France the stores, material and plant required by the Director of Works. In the early days it required all Captain Tucker's well-known personality and persistence to arrange for shipping space to be allotted. Later this organization was transferred to the West India Docks, where suitable accommodation was allotted and a more regularized procedure adopted.

The D.F.W. also arranged for Colonel L. Jackson (later Major-General Sir Louis Jackson) to create a new branch to deal with invention and supply of trench warfare requirements to meet urgent demands from the B.E.F. in France. As there was no Engineer-in-Chief at the War Office (see Introduction) these demands had to be passed to Colonel Jackson to deal with. During peace it was the R.E. Committee, secretary, F.W.4(b), who had handled the question of invention and testing of types of equipment likely to be required by the R.E. in war, but all the members of this committee had been posted overseas. The demands from France were of great variety, and many of them, e.g., trench mortars and hand-grenades, were really matters for the Royal Artillery or the Army Ordnance Corps, who, however, were already overwhelmed with problems of their own. Neither the D.F.W. nor Colonel Jackson was, however, disposed to "pass the file to another branch," and Colonel Jackson willingly undertook to find the answer and to supply the articles. He was relieved of the ordinary duties of F.W.3, and concentrated upon the work of the new Trench Warfare Branch, which became very large. When the Ministry of Munitions was created, Jackson and his now important branch were transferred from the War Office to become a Department of the new ministry. The story of this Trench Warfare Department is related in Chapter IV.

The D.F.W. was responsible for the administration by the War Office of the organization for the execution of works and fortifications at home. The system in war was the same

as it had been in peace, i.e., works were executed by Major-Generals i/c Administration and their Chief Engineers in the seven Commands of the United Kingdom, the pre-war command boundaries not being altered. Greater financial powers and powers of decision and initiation were, of course, given to Commands, but general technical and contract instructions and designs were issued by the War Office. Some account of the works and fortifications executed at home during the war is given later in this chapter.

In Chapter VIII will be related how the necessity for an Engineer-in-Chief and for Chief Engineers of corps and armies in a theatre of war became apparent in France in September and October, 1914, and how such organization was created. Similarly at home the creation of a "Central Force" to defeat possible invasion likewise required a Chief Engineer for that force. Later "Central Force H.Q." became the headquarter organization of the "Commander-in-Chief Home Forces," who was appointed at the end of 1915. Field-Marshal Sir John French was the first holder of this post, to be succeeded, in 1918, by General Sir William Robertson. At Headquarters Home Forces an Engineer-in-Chief was appointed, responsible to the C.-in-C. for the engineer work of fighting formations, but not for L. of C. and base works, which remained under the Chief Engineers of the seven Commands of the U.K., who took their orders from the War Office.

The important part played by the D.F.W's. office in co-operating with Engineers-in-Chief and Directors of Works in the execution of work in every theatre of war is related in the chapters dealing with each campaign.

DEFENCE AGAINST INVASION BY SEA

On numerous occasions prior to 1914 the defence of these islands against attack from overseas had occupied the attention of experts, and a series of committees had reached the conclusion that, while a force larger than 70,000 men could not be landed on these shores against the active intervention of the Navy, it was possible for raiding attacks to be made against

particular points such as the ports and dockyards used as the bases for our Navy, or the larger commercial ports used as bases and coaling stations for our merchant ships. Such raids might be accompanied by a small landing force, but the latter would not be able to operate at a distance from its landing place, and could not be accompanied by heavy artillery or elaborate transport.

Based on these conclusions a system of coast fortification had been built up during thirty years preceding the war, a system which was far less elaborate and costly than that designed in the 1860s after the experience of the Crimean War. The heavier armament consisted of 9.2-in. and 6-in. guns, with a few 10-in. guns, and an inner defence against torpedo craft of 4.7-in. and 12-pounders, combined with a system of electric lights for use at night. The defences were designed to keep the enemy out of bombarding range of the dockyards and ports, the big gun defences being pushed further out as the effective range of naval guns increased. There had been a system of submarine mines to limit the movement of the attack, the minefields having been worked by the Royal Engineers until 1904, when they were handed over to the Royal Navy. They were subsequently abolished under conditions which are dealt with in Volume IV. On the other hand, the development of the destroyer had increased the threat of night attack, and this caused an increase in the electric-light defences which were still in charge of the R.E. When the responsibility for submarine mining was transferred, Territorial Force units were formed at all ports to work the electric light and telephone services. There was a nucleus of regular R.E., found in some cases from the remaining companies and sections of the Coast Battalion. The strength was carefully based on the actual requirements of each port, and all units underwent annual training. Schemes for fighting the defences were prepared, and included a precautionary stage, which was intended to precede the actual declaration of war by some days, during which sufficient personnel was to be mobilized to man the whole of the defences. The actual defence works, including guns and lights, were enclosed in self-contained batteries, each with

local defence sufficient to repel any landing attack. In addition, schemes of field defences were prepared for the intervals between batteries and for any landing place in the neighbourhood that could be used by a possible enemy. Arrangements were made, such as the preparation of detailed plans and the storage of barbed wire and other material, so that the work of constructing these defences could commence in the precautionary stage. For this purpose fortress units of the Royal Engineers, Territorial Force, were raised in the various port areas. Each defended area formed a military unit under a commander who reported direct to the General-Officer of the Command in which the port was situated. The command of the coast defence areas was given to selected officers of the R.A. and R.E., and in August, 1914, the following commands were held by R.E. officers :—

Thames and Medway Defences, Major-General R. C. Maxwell.
Scottish Coast Defences, Brigadier-General F. C. Heath
Caldwell.

South Irish Coast Defences, Brigadier-General C. Hill.

Liverpool Coast Defences, Colonel R. F. Edwards.

Tyne Coast Defences, Colonel F. Bayley.

Major-General Maxwell soon proceeded to France and was succeeded by Major-General H. Mullaly. Brigadier-General C. Hill was succeeded by Brigadier-General W. J. H. Stafford, and Major-General Sir Spring R. Rice was in command of the Scottish Defences from early in 1918.

The history of these defended ports during the war may be written in a few words. The precautionary stage was put into force about a week before 4th August, 1914, and from this time everything went according to plan and the defences continued to operate as designed until the end of the war. Except for a raid by two cruisers on Hartlepool in November, 1914, they were not seriously attacked, and may thus be regarded as having fulfilled the preventive function for which they existed.

As the war proceeded, opinions changed, as described later, and additional defences were added, both of guns and lights.

In some cases, such as the Dover Straits, heavy guns were mounted on shore to assist the naval control of traffic. All these additions were designed in the office of the Director of Fortifications and Works by Colonel H. V. Kent, who was the Assistant Director in charge of the Fortification branch, and made all preliminary arrangements for their construction.

It is noteworthy that defence minefields laid by the Navy were extensively used, especially for the control of the Channel at Dover. The mines were normally of the naval automatic type, dangerous to all traffic, but in the friendly channel off the south coast, electrically fired observation mines were used. To lay and operate these defence minefields it was found necessary to create, early in 1915, a new service styled the Royal Marines Submarine Miners, and many former members of the Royal Engineers Submarine Miners were transferred to this service or enrolled into it.

The general schemes of defence provided that as soon as mobilization was ordered the coastline between the defended ports should be watched by yeomanry and cyclists, while behind these outposts, there was an organized force of Territorial divisions. There was no provision for the local defence of any towns or centres away from the coast, except in the case of London. The security of the capital was so vital to the country that a scheme of defence had been prepared after the South African War, and a number of small defensible posts had been constructed along the lines of the downs to the north and south. These posts were not only pivots in the scheme of field defences, but held reserves of tools and materials so that work on the field defences could be commenced at short notice, the work being carried out by civilian working parties. All these defences were in the area of the Eastern Command.

In the various discussions that had taken place from 1905 onwards, the Committee of Imperial Defence had reached the conclusion, as stated above, that no landing in force was possible on any part of our coast, unless the Royal Navy should be defeated, and Mr. Haldane had accordingly prepared his scheme for an Expeditionary Force of all our six divisions to proceed overseas immediately it could be mobilized. When

Lord Kitchener was appointed Secretary of State for War in August, 1914, he did not accept this scheme in its entirety, and, on his insistence, the 4th Division, quartered in the Eastern Counties, and the 6th Division from Ireland, were kept in this country until the mobilization of the Territorial Force had been completed. These divisions did not therefore form part of the British Force at Mons though they joined a little later. Nor was it until 1918 that the Admiralty consented to withdraw their statement that the enemy might land 70,000 men.

At home the peace organization of the forces into Commands was continued, and each Command was responsible for the safety of its coastline, and controlled the Territorial divisions in its area.

Before November, 1914, nine of these divisions and two divisions of yeomanry were formed into the "Central Force." This was put under the command of General Sir Ian Hamilton, who established his headquarters at the Horse Guards. The Force was organized in two cavalry divisions and three armies with headquarters at Cambridge, Dunmow in Essex, and Tonbridge. This Force took over the control of the cyclists and others watching the coast from the Wash round to Chichester and also of the defences of London, but did not control the defences of the Thames and Medway (Chatham, Gravesend and Sheerness) or the defended ports of Harwich and Dover. Major-General R. M. Ruck was appointed Chief Engineer of the Central Force and there were Chief Engineers (colonels) at the headquarters of each army. These officers dealt with the preparation of defence positions and the training of the R.E. units. Each army had a staff organized on a war basis (General Staff, Adjutant General and Quartermaster General) and made its own arrangements for movement and quartering. The Commands, however, continued to operate as in peace, each with a Major-General in charge of Administration and a Chief Engineer. This staff dealt not only with the garrisons of the fixed defences but also with all the pre-war barracks and with the hutments constructed for the new formations. The engineer work required for the Central Force and that carried out in

Commands under War Office direction is described later in this chapter.

The coast defence electric light and fortress companies not only grew in number, as additional ports became of military significance and required defence, but also the scope of their work expanded considerably. We soon find these units engaged in the construction of coastal batteries, camps and hutments, and in the erection of many technical works such as warning systems, electrified prisoner-of-war cages, aerodrome landing lights, and other specialized items too numerous to mention.

In March, 1915, General Sir Ian Hamilton was selected for the command of the troops at Gallipoli, and was succeeded by General Sir Leslie Rundle. By this time it was realized that the organization of the Central Force overlapped in many ways that of the two Commands (Eastern Command and London District) in which the force was quartered, it was therefore amalgamated with Eastern Command in May, 1915, under General Rundle. The headquarters staff of the Central Force was broken up, except that the appointment of Chief Engineer was retained to control the construction of the London defences and other local defence works. The organization of the Central Force into armies was retained but General Rundle altered the disposition of his troops. Up to this time the infantry divisions had been kept well back from the coast occupying a line of towns from the Wash, through Bedford, St. Albans and London, to the south coast. General Rundle moved these divisions forward into the Eastern Counties.

At the end of 1915, Sir John French was withdrawn from the command in France and was appointed General Officer Commanding the Forces at Home, and was also put in charge of all arrangements for training. Sir John revived the independent organization of the Field Force round London, and formed two field armies with headquarters at Brentwood and in Norfolk, and placed the cavalry at King's Lynn. At the same time he ordered the main line of defence to be moved forward to high-watermark all round the coast. He withdrew the yeomanry to the flanks, and the cyclist units were distributed to the armies. The supreme control of the administra-

tive services at home was, however, still retained by the War Office who continued to deal direct with the Major-Generals in charge of Administration in the Commands. The staff of Sir John French was organized on the war basis of a G.H.Q., but no officer was appointed as Engineer-in-Chief. The appointment of Chief Engineer of the Central Force was abolished, but Major-General R. M. Ruck was appointed G.O.C. London Defences in addition to his other duties. In the summer of 1916, Colonel Sir Edward Raban was attached to the staff of the G.O.C.-in-C., Home Forces, to deal with the question of defence against aircraft, and to advise on other engineer questions. Early in 1917, he was, however, transferred to the War Office as Deputy Director of Fortifications and Works, and it was proposed that he should be succeeded by Major-General R. S. Curtis, who was holding the appointment of A.A.G., R.E. (A.G.7). This proposal had to be cancelled owing to his illness, and Colonel S. H. Powell was appointed Chief Engineer with the rank of Brigadier-General.

During 1916 and 1917, the Government was still anxious about the possibility of invasion, but early in 1918, on Admiral Wemyss succeeding Admiral Jellicoe as First Sea Lord, the whole question was again considered, and the trend of opinion reverted to the earlier policy advocated by the Committee of Imperial Defence. In March, 1918, Lord French was appointed Governor-General in Ireland and was replaced, as G.O.C.-in-C., Home Forces, by General Sir William Robertson. The Central Force having by this time been much reduced by the transfer of Territorial divisions to France, the headquarters of the separate armies were abolished.

DEFENCE AGAINST AIR ATTACK

Prior to the outbreak of war, the air forces of the world powers were so small, and the state of technical development so imperfect, that the uses to which aircraft might be put in the event of war had hardly begun to be considered. In 1913, however, the responsibility of the War Office for the protection of defended ports in the British Isles was extended to include

defence against air attack, but little had been actually achieved in the provision of air defences by the time that war started.

When the threat developed it was on the nucleus of regular and Territorial personnel trained with coast defences that an organization for working searchlights for anti-aircraft defence had to be hastily improvised and eventually expanded and multiplied by a large factor. The early raids of 1914 were sufficient to show, however, that the army, fully pre-occupied with the onerous task of providing men and material for the expeditionary forces overseas, was not at that time capable of effectively discharging its responsibilities for the defence of the British Isles from air attack. Accordingly, it was decided that the Admiralty with the Royal Naval Air Service (R.N.A.S.) should be responsible for the A.A. defence of the country outside the defended ports, and especially of the capital. On 12th September the Admiralty appointed Admiral Sir Percy Scott to command the London Defences and he at once collected an assortment of naval guns and searchlights for the defence of the city. This was the beginning of an improvised organization, and, as air attacks developed over the country, the naval defences were supplemented by fire from any available land guns, and in some cases by rifle fire.

The army, however, continued with experiments in the defended ports, making use of the existing coast defence electric-light units both regular and Territorial Force. There were no searchlights specially designed for the purpose and these had to be improvised, together with the technique for their application in this novel rôle. In the earliest efforts both oxy-acetylene and electric lights were tried, and the first attempt at aircraft location made use of the megaphone as a listening device.

The first bombing attack from the air was made by German aeroplanes which dropped bombs in the sea off Dover in December, 1914. On 24th December, one bomb fell and exploded on British soil, but the first real raid over England was by airship on the night 19th/20th January, 1915, over Norfolk, and the second was over the Tyne. During 1915 attacks by aeroplane and seaplane did little damage and the aerial warfare during

this year was carried on by airships of the Zeppelin type. On 19th January, 1915, two of these ships bombed Yarmouth and Cromer, and on 14th and 15th April, L.9, commanded by Mathy, who was the most enterprising of the German commanders, flew over the northern counties and over Suffolk.

As the raids spread, so did the need for extemporized defences, and in the defended ports the responsibility of the army garrisons was gradually extended to include the protection of the great munition factories, shipyards and other vulnerable military objectives.

On the 31st May, an airship attacked London, causing forty-one fires with five people killed and fourteen injured. On 4th June Yorkshire and Kent were attacked, and on the 6th June Hull was bombed. But the L.37 on its return flight was brought down by an aeroplane in charge of Lieutenant R. A. J. Warneford, R.N., near Ghent, and a little later a Zeppelin was hit by a 3-in. gun at Dover and finished off by aeroplane. On 8th September, a ship under Mathy bombed London, doing damage estimated at £500,000, and on 13th October, the same ship bombed Woolwich.

In 1914, and early 1915, the first schemes for air defence were based on the advice of Colonel L. Jackson (late R.E.) in the office of the D.F.W. These schemes provided for the erection of a certain number of lights and guns in the immediate vicinity of each place to be defended, each light being allotted to a particular gun, but the actual guns available were few and quite inadequate. The lights provided were mostly of only 60-cm. size, but had a mounting which permitted an all-round traverse. For engines and generators there were available several efficient forms which had been evolved for coast defence work. These lights proved much more effective than had been anticipated, and were able to pick up an airship early and keep it illuminated at heights of more than 9,000 ft.

In September, 1915, a valuable unit became available almost by chance to reinforce the A.A. defences of London. The regular 50th Field Searchlight (F.S.L.) Company, R.E., had been raised a few years before 1914 with a view to operating with the B.E.F. overseas. In 1913, however, its

utility for that purpose was questioned and its personnel was transferred to other R.E. units, its equipment being returned to store. In August, 1915, it was decided to re-form this unit with personnel partly from the instructional staff of the School of Electric Lighting and partly from regular fortress units which had been relieved by Territorials. It was proposed to dispatch it to France. The Officer Commanding was Captain W. C. H. Prichard, R.E., an instructor at the School of E.L. While forming the unit, Prichard pondered over its probable employment in France. He doubted whether his lights would be mounted in the foremost trenches to light up no-man's-land, and whether they would survive long if so employed. He conceived that it was more likely that he would be asked to light up attacking aeroplanes. His lights were not constructed for more than a moderate degree of elevation above the ground, although they had an all-round traverse, and he therefore improvised in his workshop at Gosport special U-shaped arms to hold his lights and allow the elevation required in A.A. defence. In September, 1915, a priority telegram from the A.A. Command of London was received by Prichard inquiring whether his lights could be elevated for A.A. defence. The reply was "Yes." Moreover, the unit's equipment (lights and generators) and its personnel was completely mobile, all being carried in lorries, with a car for the O.C. and motor bicycles for the subalterns. It may be said to have been the most mobile and modern field unit in the British army at that time.

Forthwith the unit was instructed to proceed to London for A.A. defence, picking up at Woolwich Dockyard more lights and equipment. It was in action that night, and did valuable work in the A.A. defence of London until April, 1916, when the C-in-C., B.E.F., asked for its transfer to France. We shall see, in Chapter XIX, that its O.C. became the creator *ab initio* of the Searchlight A.A. defence of the B.E.F., and his unit the prototype of many more in France.

Meanwhile, in October, 1915, a bomb struck a building in Woolwich Arsenal, and the General Staff of Eastern Command asked for the advice of their Chief Engineer, Colonel W. Baker

Brown (late R.E.), who had had considerable experience in the use of lights for coast defence, and had in 1913 tried to develop a theory of defence against aircraft. This theory followed the analogy of land fortification, and was based on the necessity of meeting the attackers before they got within bombing range of their proposed target. As attackers from the air could arrive from any direction, this new theory of defence involved the provision round each defended area of a belt of guns and lights, so sited that an enemy approaching from any direction would be picked up by two or more of the lights and exposed to the fire of two or more guns. At the same time some defence should be maintained over the object defended, so that the whole system—too large to bomb indiscriminately—would present to the enemy an illuminated area inside which individual targets could not be distinguished. This theory was accepted as the basis for A.A. gun defence by night.

By December, 1915, it was decided that the army was once more in a position to take a hand in the defence of London and of other vulnerable points, in addition to the naval ports. Development of A.A. Defence began in earnest. To man the searchlights, A.A. searchlight units were raised as part of the Royal Engineers (T.F.), and from then until the Armistice, there was a continually expanding demand for searchlight personnel for A.A. Defence, not only at home, but also in France (see Chapter XIX). Most of them were found from the London and Tyne Electrical Engineers, and these were later nominated as the official parent units for all Territorial searchlight units, but units were also produced in Scotland (especially Edinburgh, Glasgow and Dundee), Yorkshire, Lancashire (especially Liverpool), Essex, Kent, Hampshire, Dorset, Devon and Cornwall. At Stokes Bay, Gosport, there was the School of Electric Lighting and Workshops, with an instructional staff of regular R.E. officers and other ranks, and upon them fell the burden of training the officers and men of all the searchlight units. In the summer of 1915 this school was taken over by the Tyne Electrical Engineers and was operated by them until the end of the war.

For London the first draft of T.E.E. left Haslar on the 13th

December, 1915, to join the nucleus of a new company, called No. 2 (Tyne) Searchlight Company, commanded by Captain C. M. Forster. Further companies were dispatched by the T.E.E. at intervals to London, Hull and other districts. In December, 1915, the L.E.E. also raised No. 1 (London) A.A. Company, R.E. (T.F.). A ring of lights ten or twelve miles in radius was then established round the outskirts of London. Plants of various types were collected, including motor generators run from the public electric supply systems, various types of mobile and portable engines, and even motors and dynamos in tramcars with projectors on the top decks. During the winter No. 3 (Yorkshire) A.A. Company was raised from personnel of the North and East Riding Fortress Company, R.E. (T.F.), No. 5 (Lancashire) A.A. Company by the Lancashire Fortress R.E. (T.F.), and the L.E.E. contributed Nos. 4, 6, 7 and 8 A.A. Companies.

On the 16th February, 1916, the War Office took over from the Admiralty the A.A. defence of London, and by April of the entire country. The responsibility for this was placed upon the C-in-C. Home Forces, his adviser for this purpose being Colonel Edward Raban (late R.E.), while Colonel M. St. L. Simon (late R.E.), was brought from France to take charge of the A.A. defence of London.

Meanwhile the defences were being considerably extended, and one of the earliest actions of the new organization was the formation of mobile anti-aircraft brigades intended to provide defence for threatened localities pending the provision of fixed defences. For this purpose, mobile searchlight companies were developed. The first T.F. units of this type, No. 9 (Tyne) Mobile Searchlight Company (following the example of the 50th (F.S.L.) Company of August 1915), was formed at Haslar on 11th March, 1916, with three sections of four lights each, under the command of Major N. H. Firmin. The establishment was seven officers and 138 O.R.

The German airships had been driven by the lights and guns to a height of over 9,000 ft., at which height they were unable to attack individual targets and had, as the Germans admitted after the war, "lost the Thames." The Germans had mean-

while been building larger airships, increasing their ceiling from 8,000 to 13,000 ft., and later to 27,000 ft. Our reply to this was to use aeroplanes to attack the airships, and to increase the ceiling of our searchlights. By the end of April, 1916, there were three Aeroplane Squadron Searchlight Sections, two of the L.E.E. and one of T.E.E., and No. 33 (Tyne) A.A. Company had also been formed for the same purpose. The plan was to supplement the naval air stations on the coast with a barrage line of aeroplane patrols and searchlights, extending from Northumberland to Sussex and about twenty-five miles inland from the coast. Through this line any aircraft attacking the industrial heart of England must pass and could be engaged. From this Aeroplane Barrage is to be traced the origin of the Aircraft Fighting Zones (A.F.Z.) of later years. These "Aeroplane Lights," as they were called, were quite distinct from the "Gun Lights" which were to work in conjunction with artillery.

The scheme initiated towards the end of 1915 for the A.A. defence of London was now well advanced, with two concentric rings of lights and guns round the suburbs in a circle 30 miles in diameter. The principle was also applied to Chatham, Dover, Harwich and other selected localities, and, on the advice of Colonel Sir Edward Raban, it was gradually extended to all the more important industrial and manufacturing towns of the North and Midlands.

In this way there grew up, quite independently of the Aeroplane Barrage, the Gun Defended Areas (G.D.A.) which continue as an integral part of our air defence system to the present day. In these static defences increased searchlight range was sought first by such expedients as twin projectors, and later by increasing the diameter to 90 cm., and eventually to 120 cm. and even more. The supply of generating plant was always a major problem, and every available type of steam, gas, oil, petrol and electrically driven generator had to be pressed into service.

On the 31st March, 1916, L.15 was hit by a gun at Purfleet and was attacked by an aeroplane in charge of Lieutenant Brandon. On the 15th April there was a series of airship

flights over England and Scotland in which eighty-four people were killed. On the 25th April there was another attack on London, but by this time the efficiency of the defences had so increased that the raiders were driven up to 13,000 ft. and could not see any targets on which to drop bombs. On the return journey one Zeppelin came down in Norway. On the 24th August there was a raid on Harwich and London was attacked by Mathy. On the 2nd September London was attacked by fourteen ships, one of these, the S.L.11 being engaged by Lieutenant Robinson in an aeroplane and brought down at Cuffley. On the 23rd September eleven ships again attacked from the south-east coast; of these the L.33 was hit by gunfire and was then attacked by Lieutenant Brandon and brought down near Colchester; The L.31, commanded by Mathy, was the only ship to attack London, crossing from south to north and dropping bombs indiscriminately; the L.32 crossed the Thames near Dartford, was attacked by gunfire and finally brought down at Billericay by Lieutenant Sowrey. On the 25th September seven ships raided the North Country. On 1st October eleven ships attacked London, but were stopped by the defences, only one man being killed. In this raid L.31, again commanded by Mathy, was stopped by gunfire and finally brought down at Potters Bar by 2nd Lieutenant W. J. Tempest. This was the last German airship raid on the metropolis. The defence had mastered the attack.

The enemy did not, however, entirely cease to use his Zeppelins. On the 27th November, 1916, ten ships attacked the north of England; one of these was destroyed by gunfire at Hartlepool, another, the L.21, after a daring flight across England to Chester, was caught off Yarmouth and fell in the sea. No further attacks by airships were attempted till 21st August, 1917, when eight ships made an abortive attack on the Midlands, and the next month, on the 24th September, ten airships attacked the North Country, flying very high. On the 19th/20th October, 1917, the last attack was made by eleven airships which came over at 16,000 ft. The weather was peculiar as there was still air and a heavy mist near the ground, while at higher levels there was a strong northerly gale. By this time,

the defences had been fully organized and the Commander of the London defences, realizing that the electric lights could not penetrate the mist, ordered all guns to remain silent unless actually attacked. The result was that the Zeppelins, who had come in from the north, had nothing to indicate their whereabouts and gradually drifted south. One bomb was dropped by a ship before leaving and fell in Piccadilly Circus causing some casualties, but these were quite incidental as the airship had no idea of its location. Only one of the attacking ships got back to Germany by the usual route north of Holland; the others were carried by the gale over the continent; of these, six got back safely by crossing Holland and the allied lines, while the remaining four crashed in south-east France. On 12th and 13th March, 1918, there was a raid by airship at an immense height, and on 5th and 6th August there was the *last airship raid* by five ships, the L.70 being destroyed.

An Army Order dated 1st June, 1916, had doubled the establishment of the Territorial Force, and new establishments for the A.A. searchlight units were evolved. At this date there were in existence the following T.F. A.A. searchlight units, in addition to the T.F. fortress units manning coast defence lights:—

- (Special) Tyne Searchlight Company.
- (Special) London Searchlight Company.
- No. 1 (London) A.A. Company.
- No. 2 (Tyne) A.A. Company.
- No. 3 (Yorkshire) A.A. Company.
- No. 4 (London) A.A. Company.
- No. 5 (Lancashire) A.A. Company.
- No. 6 (London) A.A. Company.
- No. 7 (London) A.A. Company.
- No. 8 (London) A.A. Company.
- No. 9 (Tyne) Mobile Searchlight Company.
- No. 20 (London) Aeroplane Squadron Searchlight Section.
- No. 21 (London) Aeroplane Squadron Searchlight Section.
- No. 22 (Tyne) Aeroplane Squadron Searchlight Section.
- No. 23 (Tyne) A.A. Company.

The development of the Aeroplane Barrage and the expansion of Gun Defended Areas continued rapidly throughout 1916, and further A.A. searchlight units were formed, while others were reorganized or redistributed. Thus, in July of that year, the aeroplane squadron searchlight sections were reorganized as companies, and in December redesignated A.A. Companies, R.E., and increased in size to enable them to man not only the barrage lights but certain gun lights as well. By April, 1917, the T.E.E. had increased to 15 A.A.S. companies all with an expanded establishment, and the L.E.E. had twelve A.A. companies. In all, there was then a total of forty-two A.A. companies, R.E. scattered about the country.

To cope with this great expansion the School of E.L. at Stokes Bay, Gosport, had to work at very high pressure to maintain a steady flow of trained officers and O.R. to draft to units. At the peak, instruction was given at the school during twenty-two hours of each day, including Sundays. Captain Monkhouse (T.E.E.) was Commandant of the School which was staffed by T.F. personnel selected from many units. In October, 1916, the school came under C.-in-C., Home Forces, and was re-christened the "A.A. Searchlight and Sound Location School." Later it moved to Ryde. Haslar Depot was commanded by Colonel E. Robinson, formerly Commanding Officer of the T.E.E. To his exceptional ability and power of organization was due much of the credit for the continuous and efficient expansion of searchlight units for A.A. defence at home and overseas. His second-in-command at Haslar was Major C. M. Short.

The first daylight raid over London was on the 28th November, 1916, but nothing further of note occurred till, on the 25th May, 1917, a flight of sixteen aeroplanes (Gothas) made the coast of Essex but failed to reach London. They turned south and followed the coast, inflicting a hundred casualties on the Canadians at Shorncliffe and Folkestone. On 5th June, eighteen machines attacked Sheerness, one being hit by gunfire. On the 13th June a squadron of eighteen machines attacked in daylight, reaching the coast at 5 a.m. and arriving in London at noon, when they dropped seventy-two bombs on and near

Liverpool Street Station, causing serious casualties, 104 killed and 423 injured. This raid was repeated on 7th July by twenty-four machines, who dropped seventy-six bombs, killing forty-six, injuring 123 and doing damage to the extent of £200,000.

These raids showed that the defences which had beaten the Zeppelins were not able to deal with the aeroplanes, the guns not being effective against the smaller targets. Steps were at once taken to improve the defences, and Major-General E. B. Ashmore (late R.A.) was brought from France to take command of the London Air Defence Area (L.A.D.A.), which was officially established on the 31st July, 1917. Additional defences were organized and communications improved, while in September balloon aprons were added. There was also an important development of barrages of gunfire, which though expensive in ammunition, were effective in stopping raiders.

On 12th August, 1917, twelve Gothas reached Harwich, but the defence squadrons were ready and the attack was turned over Southend. On 18th August an attack failed owing to bad weather. On 22nd August thirteen Gothas attacked Sheerness and Dover, but naval machines at Sheerness turned away the attack, two enemy planes being shot down off Ramsgate and a third off Dover. *This was the last daylight raid on England.*

The first night attack, by aeroplane was made on Chatham on 13th and 14th September, 1917. It was met by coastal machines and the recently organized barrage fire. On the 14th September ten machines reached London and on 24th, 25th, 28th, 29th and 30th September and 1st October, there were night raids by from ten to twenty machines, but only a few of these reached London. On 24th and 31st October there were two more attempts, and others on the 6th, 18th and 22nd December. One or more Gothas were brought down on most of these dates; but a raid on 18th December caused damage valued at £225,000 in London. In 1918 raids were made by giant airships on the 28th January, 16th February and 7th March, and on 19th May there was a general attack by thirty to forty Gothas of which thirteen reached London,

doing £130,000 damage. Seven of the raiders were brought down, three by air action, three by gunfire and one by engine failure. This success was final and *there was no more bombing of London.*

By this date the London Air Defence Area (L.A.D.A.) extended from Bishop's Stortford to Reigate, north to south, and from Beaconsfield to Tilbury, west to east, while there were advanced bands of guns and light defence extending from Chatham and Sheerness up the coast to Harwich, and also from Margate to Folkestone and Herne Bay to Lympne. Early in May, 1918, the Portsmouth defences were included in L.A.D.A. and the remaining anti-aircraft defence commands in the Midlands and North coalesced to form what became known as Northern Air Defences (N.A.D.) under Colonel, later Brigadier General, P. Maud (late R.E.). He had been working on the General Staff of the Home Forces in organizing an improved system of intelligence of air raids for the whole country.

Meanwhile, during the latter half of 1917, it was decided that the existing system for providing A.A. searchlight defence was extravagant in personnel, and a comprehensive scheme of reorganization was embarked upon. Under the new scheme the personnel required for the searchlights co-operating with guns was to be attached to the various companies of the R.G.A. for operations. In each A.A.D.C. an R.E. officer was attached as second-in-command and as technical adviser. The result of this scheme was the saving of a considerable number of officers and administrative personnel which had hitherto formed part of the many A.A. companies. It was in October that the first move was made to give effect to this scheme by disbanding the company headquarters of the mobile companies attached to artillery brigades, and by attaching individual searchlight sections to batteries. Then followed the break-up of the Gun-Light companies. At the same time, a new series of A.A. companies, R.E., numbered 1 to 12, came into existence absorbing the personnel serving the aeroplane barrage. By January, 1918, the reorganization was complete, and there were then in the British Isles fifty-five

A.A. companies, R.G.A. and twelve A.A. companies, R.E., of which twenty-three and five respectively were in the Northern Air Defences. The others, and also nine mobile batteries were all in the London Air Defence Area.

Certain developments in equipment and organization proceeded throughout the year. Sound locators were first provided, the searchlight detachments being increased by two men for their manipulation. The replacement of 60-cm., by 120-cm. projectors was continued. Telescopes were attached to locate the smaller, faster and higher targets which the aeroplanes now presented. The use of the searchlight for height-finding and track plotting on the so-called "fixed azimuth" principle was evolved. Some minor changes in establishment and organization took place, and by July, the number of A.A. companies, R.E., had again risen to seventeen, but further enemy action was by then negligible, and the searchlight units endured an uneventful and monotonous existence until the Armistice intervened in November, 1918. There were then 629 searchlights deployed in the United Kingdom. Of these, 264 were in Northern Air Defences, 357 in the London Air Defence Area, and eight training lights at the School of Electric Lighting.

During the whole period of the war there were 105 air raids on Great Britain, and 8,776 bombs were dropped by 643 airships and aeroplanes. The total casualties were 1,413 killed and 3,407 injured. The Zeppelin effort was practically abandoned by the end of 1916 and during the remaining two years of the war only fourteen airship raids occurred. The aeroplane raids were at their peak during 1917, when twenty-seven attacks were made, causing 2,208 casualties. In 1918, by which time our defences had been much improved, there were only six raids with a casualty list of 612.

The share of the Royal Engineers in the air defence organization was mainly in the working of the searchlights, but they also constructed gun and searchlight positions and the communications to them. In so far as this organization reduced to a minimum the loss of time, and consequently of output, due to air raids over Great Britain, its efficiency may be said

to have borne a very close relationship to the ultimate success of the armies in the field.

Authorities consulted :—

- A memorandum by Brigadier-General W. Baker Brown, C.B.
The History of the Tyne Electrical Engineers, R.E., (T.F.) by Captain L. E. C. M. Perowne, R.E.
The Miscellaneous Volume of R.E. Work in the European War by Major-General G. H. Addison.
Air Defence by Major-General E. B. Ashmore.
An Article in the *Encyclopædia Britannica* by Major-General E. B. Ashmore.
The Defence of London 1915–1918 by Rawlinson.
The German Air Raids on Great Britain 1914–18 by Captain J. Morris, R.A.F.

WORKS AT HOME

We have seen at the beginning of this chapter that the organization and control of the engineer services at home was continued on the same lines as in peace, but was much expanded. General control was retained by the War Office, and in each Command the Chief Engineer continued to be responsible to the G.O.C.-in-C. for the construction of defences and to the Major-General i/c Administration for other works.

The most urgent work of the Royal Engineers, and of great importance throughout the war, was the construction of the defences against invasion, described earlier in this chapter, but of almost equal urgency and quite the largest of the engineer responsibilities were those connected with the accommodation of troops. On the outbreak of war the total accommodation available in the barracks of the United Kingdom was for 174,800 N.C.Os. and men. This was increased by permitting a reduction of the air-space allowed per man from 600 to 400 cu. ft., giving an increase of nearly 50 per cent and by housing troops in married quarters, the families being sent to their homes and placed on the lodging list. These steps increased the accommodation in barracks at home to a total of 262,000 men, in addition to the quarters provided in

defence buildings at defended ports. As reservists were called to the colours and new recruits poured in, accommodation for a further 800,000 men was provided under canvas or in hirings and billets. All these changes involved much engineer work in order to provide additional cooking, water and sanitary facilities and semi-permanent accessories in camps.

Hutting.—As soon as Lord Kitchener started his scheme for the first 100,000 men of the New Armies, it was realized that only part of these could be accommodated in barracks, and proposals were at once considered for the construction of hutting. As soon as the orders for the provision of this hutting were issued on 12th August, 1914, the design branch of the D.F.W.'s Office, under Major B. H. O. Armstrong and Mr. J. D. Michel, the Chief Draughtsman, began the preparation of plans and by 14th August a complete set of designs for a typical hutted camp for one battalion had been prepared and approved by the Army Council. These were lithographed in large numbers and distributed to Commands, and were followed by similar type-plans for groups of artillery, engineer and A.S.C. Units. Plans were also prepared for hospitals, for large remount depots to contain 1,000 horses, each near ports of embarkation, and also for many other buildings.

Meanwhile, the selection of sites was begun, at first by Colonel J. H. Cowan representing D.F.W. and an officer of the Q.M.G. branch. But at the end of August, the Q.M.G. formed a separate Directorate for Barracks under Major-General C. E. Heath (late A.S.C.), with, as Assistant Director, Brigadier-General F. G. Bond (late R.E.) from the retired list. This Directorate then arranged for the selection of sites. Lord Kitchener, however, took a personal interest in the hutting scheme and was anxious to provide more accommodation in the north of England. He cut through the routine of the Army Council, ordered the D.F.W., Major-General Scott-Moncrieff, to report to him direct, and sent him to the Yorkshire area to look for sites. These were selected at Catterick, Ripon and other places.

The unit of quartering was the division of twelve battalions—about 15,000 men, including the additional 10 per cent

who went with their units to the overseas base. The design of the hutments was based on the use of sleeping huts each 60 ft. long by 20 ft. wide with an average height of 10 ft. With a gangway down the centre for table and benches, they each accommodated thirty men, and forty huts were provided for each battalion. Armstrong's design also included a large central cookhouse with half-battalion dining-rooms on each side.

As in France, mud was a serious enemy. It was in fact so serious that the camps had to be vacated in November and the troops accommodated for the winter in billets and hirings, but by the spring of 1915 the provision of roads and other services had made the hutted camps habitable. Water supply and drainage produced many difficult problems, especially as many local authorities and those responsible for the conservancy of rivers objected to the use of any form of soak pit or surface disposal. The huts were normally provided with electric light and when a local gas or electric station was not available, power stations were built in the camps.

To provide the stores and accessories, the War Office continued their peace-time practice of arranging contracts for the supply of the different fittings, but the number of contracts was increased to include the leading manufacturers of each type. This proved very successful and the supply of fittings never failed during the whole four years of the war. Contracts were also placed with the leading wood-working firms and all huts required by Commands were ordered through the War Office.

Centres for the Barrack Officer responsible for the supply of furniture and equipment were provided in each brigade lines by allotting two huts, which with the space between them were fenced off to form a barrack store.

Rifle Ranges.—Colonel J. H. Cowan of the D.F.W.'s. Office was given the task of providing army camps with efficient rifle ranges. In time of peace the siting of a rifle range presents very considerable difficulty as modern rifles require a very large safety-area behind the butts. By the careful selection of ground, Cowan succeeded in reducing the size of the safety-

area formerly laid down, and finally selected 200 ranges which, in spite of criticism, proved perfectly safe. They were not taken into use, however, when first completed in 1915, as ammunition could not be spared. Miniature ranges were constructed at all camps.

Horse Lines.—In the original scheme horse lines, in groups of 1,000 horses, were placed near the ports of embarkation. The first provision was for a total of 150,000, but this was much increased later. In addition, horse lines were provided in each camp for the full number of animals included in the war establishment of the unit, although they were never fully occupied, because units at home were not made up to strength.

Hospitals.—Schemes were prepared by Major Armstrong for hutted hospitals of 600 beds with all accessory buildings. Several hospitals of this size were often required at one place, and it was then possible to arrange sections for different types of case and to provide for dental, eye and other specialists. The capacity of all existing military hospitals was increased by the addition of hutted wards, extra operating theatres and sleeping accommodation for the staff. Many existing buildings especially in London and the larger towns were occupied as hospitals, often at the expense of heavy structural alterations. Buildings were made available by the Metropolitan Asylums Board, who discharged non-dangerous patients and concentrated the remainder. Many of these institutions, when cleared, could each hold from 2,000 to 3,000 beds, but considerable hutted additions were required for operating theatres and for the extra staff both male and female. An emergency hospital of about 200 beds was usually provided near each of the larger camps. In addition to the official hospitals, a number of large private houses all over the country were converted into hospitals by their owners, who in many cases formed a voluntary nursing staff. By 1917 there were 320,000 military hospital beds in Great Britain.

Prisoners of War Camps.—A special branch was formed at the War Office to deal with prisoners of war and at first this branch provided the accommodation it required. Later this duty was taken over by the Barrack Directorate and several

large prisoner of war establishments were formed, notably at the Alexandra Palace in North London.

The Royal Flying Corps.—A very important task and one which increased rapidly in size and urgency was the provision of accommodation for the Royal Flying Corps. On the outbreak of war this corps was in its infancy, and the accommodation available (other than the old Balloon Factory at Farnborough, which had been growing under R.E. tutelage for some years) was limited to the establishments at Upavon and Dover, but further aerodromes had been planned at Orfordness in Suffolk and on Salisbury Plain.

On the outbreak of war Colonel W. MacAdam (late R.E.), who had been an Assistant Director under the Director of Flying Services, was transferred to the office of the D.F.W., where he concentrated on the provision of flying grounds and buildings. In concert with the Flying Branch he selected the sites for these grounds, and arranged all questions of leases and clearance, especially the removal of overhead wires in the vicinity. Plans for the buildings were then prepared and handed over to the Command concerned for execution. The schemes provided for one or sometimes two squadrons at each aerodrome. For each squadron three hangars were constructed to a design prepared by Armstrong. The main engineering difficulty was the provision for the wide doors, having a span of 60 ft., later increased to 80 ft. Special timber trusses were designed, this being the only available material. The original schemes cost from £50,000 to £60,000 a squadron, but by 1918 the cost of the squadron, aerodrome and buildings had risen to £250,000. Accommodation for a dirigible balloon was constructed at Pulham in Suffolk. The shed was built under a special contract, but the other buildings and accessories were provided by the local R.E.

When the Royal Air Force was formed in April, 1918, and started its own offices in London, Colonel MacAdam and Lieut.-Colonel Armstrong were transferred to the new headquarters, MacAdam becoming the first Director of Works of the R.A.F.

Ordnance Depots.—There were great increases in the Army

Ordnance Depots. At Woolwich Arsenal, where the Superintendent of Building Works was Colonel N. H. Hemming (late R.E.), the establishment spread right over the Plumstead Marshes. At Weedon, one of the buildings was altered to make a store for 1-million rifles. At Didcot a new depot was constructed for the issue of equipment. It expanded to large dimensions and has become part of our permanent organization.

Roads.—The construction of roads at first proceeded slowly, owing to the difficulty of obtaining material, but early in 1915 the War Office applied for assistance from the Road Board. The Secretary of this Board, Mr. H. Maybury, had at his disposal not only information concerning all sources of road material but also lists of road-making plant in the possession of local authorities. By drawing on these resources, he was able to organize squads under expert supervision, which gradually improved the system of roads both inside and outside the camps. The services of the Board were also used for making hard-standings in horse lines and in mechanical transport depots.

Command orders, which originated in the Eastern Command, were also issued for the construction of paths in camps, the use of scrapers and the metalling of horse watering points. They at least reduced the trouble from mud.

Contracts.—In order to carry out the mass of engineer work outlined above, it was necessary to simplify and shorten the ordinary peace procedure for placing contracts. Many methods were tried, but in general it was found impossible to avoid *cost plus fixed percentage* contracts. Sir John Jackson, a leading contractor offered his services on this basis and other contractors followed his example.

Land.—In 1914 the R.E. were the responsible custodians of all land and property held by the War Office, in the large Commands a special civilian Lands Officer being appointed to the R.E. Staff. All records of lands and buildings were held in the D.F.W's. office under a retired Quartermaster R.E., who was graded as a Chief Draughtsman. The D.F.Ws'. organization had soon to be greatly expanded by the appointment of land agents, or the employment of local agents, to deal with the

large areas of landed property taken over for camp sites and in connexion with the extension of the defences. A special Lands Branch was formed at the War Office and a special Land Commission under Mr. H. Duke (afterwards Lord Merrivale) was formed to deal with claims. Towards the end of the war this organization had grown so large that it was formed into a separate branch, and the senior land agent in each Command was made independent of the Chief Engineer and reported direct to the Major-General i/c Administration.

Hired Buildings.—The large number of troops which had to be accommodated in billets in the winter of 1914 made it necessary to take over many buildings at short notice. When the units left their billets to go overseas or into summer camps, the divisional Billeting Committees received far more claims for damages than they could handle. They usually solved the problem by handing over all the papers to the local C.R.E. before leaving. Owing to the existence of the Central Force, this question became very large in the Eastern Command, and on the initiative of the R.E. a Command Quartering Committee was formed. This put forward to the War Office a proposal for the division of the Command into quartering areas, each controlled by a local committee of which the president was a specially appointed officer with the status of A.Q.M.C. and the members the local representatives of the R.E., the lands branch, the barrack branch and the medical service. Rules for the guidance of these committees were drawn up by Colonel E. H. Hills who was the Secretary of the Command Committee. The whole scheme involved the appointment in this Command of twenty officers as presidents, and about twenty additional land agents, the latter being combined with the similar number already employed. The whole scheme worked very well, and after a few weeks the Director of Barracks at the War Office, Brigadier-General F. G. Bond, late R.E., embodied the scheme in Barrack Regulations, where it still remains.

Summary.—Work connected with hutting continued throughout the war as more and more accommodation became necessary for additional training centres, for prisoners of war, for con-

valescent camps, for units from the Dominions and Colonies and towards the end for large numbers of American troops. There had to be many major moves. The development of the tank necessitated the Tank Corps taking over the hutsments at Wareham, Bovington, Swanage and Lulworth. In 1917 the huts and barracks at and near Longmoor were allotted to the Director General of Transportation as a centre for the transportation service. The barracks and hutsments in Kent and Sussex, which had been occupied by Canadians since 1915, were transferred to the Air Ministry in 1918.

The following table gives the distribution of the first hutting programme in the winter of 1914 and of the total hutting up to the autumn of 1918 :—

<i>Command</i>	<i>Programme, 1914.</i>		<i>August, 1918.</i>
		<i>Men housed</i>	<i>Men housed</i>
Aldershot	60,000	100,000
Eastern	80,000	290,000
Eastern (Central Force)	...	50,000	
Ireland	40,000	90,000
London	10,000	10,000
Northern	200,000	280,000
Scottish	15,000	50,000
Southern	250,000	310,000
Western	80,000	155,000
Channel Islands Garri- sons and Misc.	15,000	15,000
		<hr/> 800,000 <hr/>	<hr/> 1,300,000 <hr/>

CHAPTER IV

SUPPLY OF ENGINEER STORES AND EQUIPMENT

Lack of pre-war reserves—Liaison with overseas theatres, F.W.5.—Chief Mechanical Engineer, F.W.8—Chief Electrical Engineer, F.W.9—Effect of the creation of the Ministry of Munitions—Trench Warfare Department—Development of gas-warfare research—Separation of research from production of gas equipment—The Chemical Warfare Department—The R.E. Committee.

LACK OF PRE-WAR RESERVES

THE Expeditionary Force that the Government intended to send overseas in time of war was limited to one cavalry division and six divisions of all arms. The name and size of this force indicates the limits of the Government conception of their overseas commitments. Moreover they envisaged but one line of communication, and had contracted with the French to carry out all work upon it.

During peace the Treasury, through its Finance Branches at the War Office, saw to it that the army was rigidly confined to this strait-waistcoat conception of war, and the funds to cover war munitions and stores for the whole army (over and above mobilization equipment) was limited to £5-million, known as the Mowatt Reserve. It was quite clear that the amount that could be allotted for engineer stores and equipment was ludicrously inadequate.

Within twenty-four hours of Lord Kitchener's entry into the War Office, the size of our overseas commitments was raised from seven to seventy divisions, with as many more from the Dominions as they would send, and the Indian army was to be expanded to over 2 million fighting men.

As soon as the whole scope of our war commitments was multiplied by this large factor, and when the French found it impossible to carry out their contract for the L. of C. works,

it was even more obvious than it had been before that the organization for supply of engineer plant and material was faced with the necessity for an enormous and very rapid expansion. It has already been related that the Director of Fortifications and Works expanded the organization of his office from five main branches and three sub-branches to eleven branches. Here, we will endeavour to give some idea of the work done by the various branches of his office responsible for supplying stores and plant. It would be waste of space to describe the paltry pre-war preparations that had alone been possible within the limits of the Government's straight-jacket.

LIAISON WITH OVERSEAS THEATRES, F.W.5

Early in the war a new branch of the Fortifications and Works Directorate, called F.W.5, was formed at the request of the Director of Works in France. The head of the branch was Lieut.-Colonel D. Brady who had been in France under the Director of Works at the commencement of the war, but had been transferred home early in 1915. He was assisted by one Staff Captain and five lady clerks. His original duty was to act in England as the representative of the Director of Works, B.E.F., who put demands on F.W.5 for everything he required, including personnel. F.W.5, for instance, obtained the names of British contractors who would accept service in France, and made the arrangements for the passages of their staff and workmen. This arrangement worked very well, and very soon the Engineer-in-Chief in France and the Chief Engineers of armies were making demands on F.W.5. As new theatres of war developed in the Dardanelles, Egypt, Mesopotamia, Salonika and Africa, other Chief Engineers also made use of his services. One of the great advantages of this branch was that F.W.5, being in touch with all the sources of supply at home was often able to suggest alternative articles which would do as well as those demanded. F.W.5 kept in close touch with the forces in France by personal visits to that country, and many of the senior officers responsible for works made a practice of calling at his office whenever they came home on

duty or leave. There was also constant telephone communication with the offices of the Engineer-in-Chief and Director of Works in France.

The work of F.W.5 in connexion with stores consisted mainly of sending out the demands and distributing them to the branches of the War Office concerned, usually F.W.8, F.W.9, or the Army Ordnance Corps.

F.W.5 was a member of the Timber Committee formed in London, and when the Canadian Forestry Corps was formed, nearly the whole of the War Office work involved in administering this Corps, fell upon him. The importance of these duties will be seen from the fact that, of the large total of engineer stores required by the armies in France, about three-quarters consisted of timber or timber articles.

CHIEF MECHANICAL ENGINEER, F.W.8

The head of this branch in August, 1914, was Captain R. Oakes, later promoted Major and Brevet Lieut.-Colonel. He was Inspector of Iron Structures in the D.F.W. Office. His pre-war staff consisted of one officer (staff captain), two quartermasters, and twenty-one other ranks; one additional staff captain and three clerks were added on mobilization.

In 1914 the branch was in occupation of a few rooms in the War Office, but the enormous increase of work necessitated a large expansion in both staff and accommodation. After many rebuffs, Oakes carried his point and on 1st April, 1917, moved his whole staff to Adastral House, Blackfriars. At the same time his status was raised to that of an Assistant Director with the title of Chief Mechanical Engineer. Oakes was then able to organize his staff into sections, each under an officer who was either an R.E. officer or an experienced civil engineer, many of whom had had actual experience of work in the field. As demands increased new sections were formed by subdivision of the existing staff, and eventually in November, 1918, the staff at Adastral House numbered forty-nine officers and 143 clerks and draughtsmen. In addition to this, there was the staff of the Shipping and Stores Branch at the London

Docks, non-existent before the war, and also a large staff of inspectors who were continually at work visiting and helping contractors. In peace time the number of inspectors in permanent employ had been three, but by November, 1918, this had expanded to a total of forty six commissioned and twenty-eight civilian inspectors and examiners.

As trench warfare developed, demands were received for many new forms of plant, such as excavators and mining stores, all of which fell to the lot of F.W.8. The French railways also appealed for assistance, and later, when the Americans arrived they made large demands for machinery and stores. At the end of 1916, when Transportation became a separate organization, the Director-General of Transportation took over the responsibility for his own stores, plant and material, for the railways, light railways, roads, inland waterways and docks, and a year later the Royal Flying Corps formed its own supply organization.

In September, 1917, Oakes, who had been given the Brevet rank of Lieut.-Colonel, was selected to fill an important railway post in Mesopotamia and Colonel S. J. Craster from the retired list succeeded him at Adastral House.

Sandbags.—Though issued through the A.O.D. these were provided and inspected by F.W.8. The total number supplied reached 1,300-million, costing about £15-million. A shortage of sandbags occurred in France in the early stages, but this was traced more to difficulties in distribution than to shortage of supply.

Water supply, mining and miscellaneous stores.—The duty of F.W.8 covered the supply of service types only, though the numbers dealt with were very large, e.g., 223,000 miners' hammers, 235,000 picks and shovels, 10 million steel posts and the same number of screw-pickets for wire entanglements. Many commercial patterns of mining and excavating tools and machinery were used.

Bridging Equipment.—Bridging also provided much new work, as the rebuilding of broken bridges from local material had proved too slow, at least taking several weeks. The total bridging equipment for the original expeditionary force included

only 108 pontoons. This number was increased to nearly 3,000 almost the whole of the equipment having to be designed anew to meet manufacturing difficulties. Oakes was asked to design and obtain a series of steel bridges up to 85-ft. span, which could be transported in sections and put together rapidly on the spot. Some details of these are given in Chapter XXIII. A new form of bridge was designed by Professor C. E. Inglis of Cambridge University and was extensively used in many theatres of war.

Hutting.—The rapid provision of sufficient huts presented great difficulties. At first supplies were of sectional huts of Armstrong design, but they proved too bulky for shipment. In 1916, the Engineer-in-Chief in France adopted a design proposed by Captain Nissen, for a semi-circular hut constructed of corrugated steel sheets on a wooden foundation. A first order for 27,000 Nissen huts was placed at the end of 1916 and for 20,000 more a few months later. The first order was completed by the autumn, but the second was delayed till 1918. In the autumn of 1917, the manufacture of the wooden bases and ends was undertaken by the Director of Works, B.E.F., in base workshops. A demand for another 20,000 Nissen huts was made for the winter of 1918-19, but these were not required as the Armistice intervened. A large task connected with hutting was the provision of stoves, of which 53,000 were demanded in 1917.

Special plant.—This included laundry and woodworking machinery, machine tools for engineer workshops, fire engines, destructors, disinfectors, cranes, concrete mixers, boring rigs, pumps, airlifts and water purifying plant. Baking plant was supplied to the American Army for a total of $1\frac{1}{2}$ million bread rations a day. Every theatre of war added its quota to the work of the branch. Thus Mesopotamia asked for spare parts for hundreds of pumps of English manufacture seized in the country. Palestine, in April, 1918, demanded a special bridge to cross the Jordan, 240 ft. over all; this was supplied and erected in September, 1918.

Perhaps the largest item of all was the supply of 10 and 12-in. water pipes and four complete pumping stations to carry water

from Egypt to Palestine along the caravan road across the desert for a distance of 87 miles. The order was received in July, 1916, and the work was completed, with the assistance of supplies from America, by February, 1917.

Demands from various theatres of war entailed much experiment with commercial forms of plant. A trial ground was, therefore, established at Claygate, Surrey, for testing tunnelling machines, pipe pushers, trench diggers, ropeways, etc.

During 1918, there was a large increase in demands from all theatres, and in the third quarter of that year engineer stores shipped to all fronts exceeded 210,000 tons, with a value of £2,400,000.

Shipping.—Another new service arose in connexion with the shipping of stores overseas. Under the pre-war organization of the army all such movements were arranged by the Army Ordnance Department, but as this department was overwhelmed with the movement of ammunition and military equipment, Captain Oakes was called on to act as Engineer Shipping Officer. Captain and Quartermaster A. N. Tucker, was placed in charge of this sub-branch and at first was posted to Southampton, but, this port proving unsatisfactory, Tucker was transferred to the S.W. India Docks (Port of London), where he remained until the end of the war. At first all stores were shipped as soon as possible after arrival at the port, but this arrangement caused considerable congestion at ports overseas. In April, 1917, on the representation of the Director of Works in France, a store depot was, therefore, established at Abbey Mills near the docks, where stores not immediately required could be unloaded and kept till wanted. To provide the shipping required a fleet of some twenty small vessels was allotted by the Admiralty. They proved very convenient, as with their small draught they could enter any of the French ports used by the army. In addition to the Port of London, Liverpool was used for the shipment of steel sheets, Rochester for cement, and other ports for special stores. In 1917, the activity of the submarine caused the western ports to be given up and steelwork was diverted to the Newhaven-Dieppe

route. The growth of Richborough as a port for barge movements to Calais caused a diversion of the Rochester traffic and of many other articles required for the northern part of the L. of C. in France.

CHIEF ELECTRICAL ENGINEER, F.W.9

The head of this branch, in August, 1914, was Major A. W. Dumaresq, assisted by a staff of two officers and six subordinates. In May, 1917, Dumaresq died suddenly in his office and was succeeded by Lieut.-Colonel E. C. Seaman. In May, 1919, he died and Lieut.-Colonel H. G. K. Wait took his place. The status of the head of this branch was raised in 1917 to that of Assistant Director, and in 1918 to that of Deputy Director, with the title of Chief-Electrical-Engineer. The staff at the end of 1918 was twelve officers with thirty-four subordinates. The equipment dealt with by the branch during the war was worth about £55-million. It fell into certain main groups, dealt with below.

Searchlights for Coast Defence.—Many new stations were formed for which equipment had to be provided, but at all existing stations the equipment worked well throughout the war—a striking testimony to the care which had been given to its design in peace-time.

Searchlights for Anti-Aircraft Defence.—Some details of the development of this new branch are given in Chapters X and XIX. At first only a few lights were installed, but in the summer of 1915 seventy-five sets were ordered, some to be mounted on 3 ton lorries complete with generating plant; in December, 1915, the number was increased to 500 sets, raised to 620 in the spring of 1916. In 1917, when attacks by aeroplanes were commenced, the diameter of the projectors was increased to 120 and 150 cm., and an order was placed for 800 lights of these sizes; only 125 had, however, been supplied by the date of the Armistice.

In 1917, sections of A.A. lights were sent to France, and by the end of the war one hundred fixed and one hundred mobile lights had been issued.

Towards the end of the same year a special searchlight committee was formed including representatives of France and the United States and from the Admiralty.

Electric Light.—Portable sets for lighting offices in the field were designed and sent out, and the branch also supplied all the electric-light fittings for the various camps at home and abroad. The work grew to large proportions, and a total of $4\frac{1}{2}$ million yards of cable was issued during the war.

Signal Stores—were dealt with by a separate branch of the office. Their number grew enormously as the army made increasing demands for more and better communications. The resources of the Post Office were used from the first and their stocks were heavily drawn upon, to the tune of 100,000 telephone and telegraph sets, 53,000 miles of cable and 13,000 tons of line wire.

The signal stores supplied through F.W.9 included 11,000 telegraph sets, 120,000 telephone sets, 100,000 signalling lamps and 600,000 miles of telephone cable, with other items in proportion.

Wireless Stores.—In August, 1914, there was in existence at Aldershot the Wireless Telegraph Experimental Section, which had carried out a series of experiments and had evolved two forms of apparatus—a service 80-ft. mast station and a service pack transport set. These equipments had not, however, been included in any organized unit of the field army. Trials with wireless had been carried out under the R.E. Committee from the first arrival of Mr. Marconi in this country, but the work was partially suspended during the S. African war. From 1902 onwards they had been continued under the officer commanding the 1st Telegraph Company at Aldershot, and in the last few years before 1914 had included experiments in working to and from aircraft.

On the mobilization and departure of the Telegraph Company, this work devolved on the Chief Inspector of R.E. Stores at Woolwich. The work increased so much that, in 1916 a separate Signals Experimental Establishment was formed at Woolwich and a Chief Experimental Officer appointed, with a staff eventually comprising seventeen officers and 267 subordinates.

W.D. Signal Factories.—In July, 1915, it became evident that the resources of the country would not suffice to provide the stores required for the signal and wireless services. Many of these were of new and experimental patterns, so a small factory at Soho was taken over for their construction, and this was soon followed by three others. These factories were administered by the Chief Inspector of R.E. Stores, but as work increased a special superintendent was appointed and the factories were reorganized, extended and multiplied. Expenditure reached £1-million a year and the output averaged 1,000 instruments a week, the staff employed being eight officers and 3,233 subordinates.

Up to April, 1918, F.W.9 was responsible for the provision of wireless apparatus for the Royal Flying Corps, and even after a separate Air Ministry was formed he continued to act as a contractor for the supply of apparatus to the R.A.F.

EFFECTS OF THE CREATION OF THE MINISTRY OF MUNITIONS

When a Surveyor-General of Supply was appointed in 1917, this officer, Mr. Andrew Weir, wished to take over the supply of engineer stores. This procedure was, however, opposed by the D.F.W., Major-General G. K. Scott Moncrieff, who represented how intimately the question of engineer stores was linked up with the progress of military operations. The Surveyor-General accepted this argument, but appointed a representative, Mr. Peters, to ascertain whether business methods were being applied and whether the country was getting full value for its money. Mr. Peters, who was a leading civil engineer thereupon investigated the work at Adastral House in great detail and also visited the store depots in France. He reported that the work was being carried out in a completely satisfactory manner and that he could not suggest any improvements. It was left in the hands of the R.E. The Trench Warfare Supply Department under Colonel Louis Jackson was, however, transferred to the Ministry of Munitions, as will be explained in the following section which deals with that department.

THE TRENCH WARFARE DEPARTMENT

This important branch was evolved from small beginnings by Colonel Louis Jackson, C.M.G., late R.E. (afterwards Major-General Sir Louis Jackson, K.B.E., C.B., C.M.G.), and developed by him into a very large organization. On the outbreak of war Colonel Jackson, who had retired in 1913, was recalled to take over the section of the Fortifications and Works Directorate which dealt with Coast Defences. It very soon became apparent that a special executive organization was necessary to deal with the numerous urgent questions concerning materials and appliances for field engineering. The R.E. Committee, which had for many years before the war conducted all investigations and experiments on such matters, became practically defunct on the outbreak of war, since its members, all of whom held other full-time appointments, either sailed with the expeditionary force or became immersed in other pressing work. Colonel Jackson's Section was therefore appointed to deal with field engineering problems as they arose.

As soon as the position on the Western Front began to become static and to develop into trench warfare urgent demands arrived from G.H.Q., particularly from the Engineer-in-Chief, for all kinds of new warlike devices such as hand-grenades, smoke bombs, catapults and spring guns, listening apparatus and other mining contrivances, mining explosives, trench pumps, bullet-proof shields, loophole plates, trench mortars, signal flares etc. Later came demands for camouflage material, rifle grenades, steel helmets, flame-throwers and gas warfare appliances of all kinds, including gas and smoke shell for artillery and trench mortars. These are only some of the numerous articles the invention and production of which was the responsibility of Colonel Jackson's organization.

To deal with all these new and difficult problems he sought for and secured the able and willing service of many leading scientists, engineers, inventors and manufacturers. When the Germans had made use of gas in an attack in the Ypres Sector in April, 1915, a demand instantly arose for appliances

to protect our troops against it. It had happened that Colonel Jackson, acting with commendable foresight on certain rumours which had reached this country, had already got into touch with the Chemical Sub-committee of the Royal Society, formed to advise on chemical problems arising out of the war. He had persuaded Sir William Ramsay, F.R.S., a member of that body, to consider the problem of devices to protect our troops against gas in the event of the rumours proving to be well founded. As soon as the first gas-attack took place Lord Kitchener dispatched Dr. J. E. S. Haldane, an eminent physiologist, and Professor H. B. Baker, a chemist from the Imperial College of Science, to France to investigate the nature of the gas used and the problem of protection. Sir William Ramsay quickly produced to Colonel Jackson the first respirator of wool and flannel soaked in hyposulphite of soda, and Jackson passed it on to the Medical Department who were responsible for the defence of the troops against gas. Large quantities of this type of respirator were soon dispatched to the front, and were quickly followed by the first issue of flannelette helmets which were also produced by Jackson's department. The decision to retaliate by using gas ourselves necessitated much work in the investigation of the types of gases to be employed and of the means of discharging them from cylinders or otherwise. This work was entrusted by Lord Kitchener to Colonel Jackson.

The establishment of the Ministry of Munitions under Mr. Lloyd George, in June, 1915, was followed by the transfer of Colonel Jackson (who received the rank of Brigadier-General and the designation of Director-General, Trench Warfare Department), with his whole organization from the War Office to the Ministry of Munitions. At the same time the Medical Department at the War Office was given complete responsibility for the design and supply of anti-gas appliances for the protection of troops.

Under Jackson's direction this department grew into a very large organization producing immense quantities of field appliances and lethal weapons, perfected from the ideas of many inventors and carried through the experimental stages

into production. In this connexion one should realize the difficult maze that has to be traversed between the conception of a brilliant idea in the inventor's brain and the final production of a finished fool-proof article operating in the hands of the private soldier. In war and in peace great credit is rightly given to the man who has the original inspiration, but few inventors are capable of exploiting their ideas or of putting them on the market in a practical form. This generally has to be done for them. Jackson's department waded through the proposals of numerous inventors, the majority fantastic and unpractical, but seized on many, turning them into useful weapons or military devices. Among the outstanding successes of the department was the production of large supplies of the early types of hand-grenade, the War Office having entirely failed before the war to admit the necessity for such a weapon. The famous grenade invented by Mr. Mills, was developed, and the urgent demand for it was met by the expansion of its manufacture in the course of six months, from about 3,000 to 800,000 a week, mainly through the energy of Mr. Alexander Roger, one of Jackson's assistants. Another development of great value was the production in its ultimate practical and fool-proof form, and the manufacture in great numbers, of the Stokes mortar, invented by Mr. (afterwards Sir Frederick) Stokes. It was first made with a 4-in. bore for use with gas and smoke shells by the Special Brigade, R.E. (see also under Chapter XX), but soon afterwards with a 3 in. bore for use by infantry with H.E. shell.

Among other achievements of the Trench Warfare Department was the establishment of an experimental ground at Wembley, where many dangerous but productive experiments were carried out. Jackson also realized that in the scramble for raw materials for explosives it was possible and necessary to make use of ammonal which had been discarded by the Admiralty and the Ordnance Board; it served the Royal Engineers well throughout the war and still does so. He also discovered by experiment that phosphorus was a most suitable material for making smoke screens, and he secured for its production the services of Sir Richard Threlfall, whose firm, Messrs.

Allbright and Wilson of Birmingham, were the only manufacturers of this substance in the country. Jackson, at the instigation of Colonel E. D. Swinton, late R.E. (afterwards Major-General Sir Ernest Swinton, K.B.E., C.B., D.S.O.), started experiments to produce a "Tank," and his assistant, Captain Hetherington, had reached the stage of making a promising chassis, before it was discovered that the Admiralty had completed their first models, which were tried and subsequently adopted.

Another difficult problem was the development of flame projectors. The Germans having introduced this form of warfare, it was considered that we should give it a practical trial in the field. The first British flame projectors were of a portable type carried on a man's back. A unit of the Special Brigade was formed under the command of Captain W. H. Livens, R.E., and its personnel were trained in their use. Types of long-range flame projector were also devised by Captains Vincent and Livens and developed by the Trench Warfare Department. The Livens type, with a range of about a hundred yards, had to be installed in an underground gallery in the front trench system, and two of them were successfully used in the opening phase of the Somme battle in 1916. The great labour, however, involved in the installation and the high probability of damage by shell-fire, led to this weapon being abandoned, and the energies of Captain Livens and his unit were turned to the development of the Livens gas projector, a weapon subsequently developed by the Trench Warfare Department and used in large numbers.

DEVELOPMENT OF GAS WARFARE RESEARCH

As soon as the demands of gas warfare had begun to develop Jackson had formed a Scientific Advisory Committee to consider these and other scientific problems. For its personnel he secured the most active members of the former Chemical Sub-committee of the Royal Society, namely, Professors H. B. Baker, J. F. Thorpe, and Sir George Beilby, and its Secretary, Professor A. W. Crossley, all of whom rendered most

valuable help throughout the rest of the war in the development of this branch of warfare. Their first problem concerned experiments with various gases in order to choose those most effective for use in the field, and the best form of apparatus for their discharge from cylinders in the trench-line. In this they worked in close liaison with Lieut.-Colonel C. H. Foulkes, D.S.O., R.E., who had been appointed by Sir John French to command and train the units raised under the title of "Special Brigade, R.E.," for the prosecution of this form of warfare (see Chapter XX). Jackson's Department and the Scientific Advisory Committee also assisted at the production of gas and smoke bombs for the Stokes Mortar, and later of gas and smoke shell for artillery and of Livens projectors and their bombs—a method of discharging gas introduced in 1917. Under General Jackson's direction a large training and experimental ground was established at Porton, Salisbury Plain. This establishment, which is still in existence, became a model of its kind and was of the greatest value. It owed a great deal to the creative and administrative work of Lieut.-Colonel A. W. Crossley, C.M.G., C.B.E., R.E., F.R.S., who was its Commandant from its inception until the end of the war. He was helped by Major (afterwards Brevet Lieut.-Colonel) S. T. Cargill, R.E., and among those who gave valuable assistance in the investigation of the varied problems which arose were Professor Hupkinson of Cambridge University, Dr. Sir Alexander Scott, F.R.S., Sir Richard Threlfall, Sir Beverton Redwood, Professor John Cadman (now Lord Cadman) and Sir Francis Ogilvie. On the production side Jackson had the assistance of Mr. (now Sir Alexander) Roger, Captain Moreland, and others, and in experimental work Captains Vincent, Trelawney, Lister, Richmond, Wicks, Leeming, and Sutton, all temporary R.E. officers. In administrative work he was helped by Mr. R. Enthoven, late I.C.S., and Captain Atkinson, East Surrey Regiment, and in the general administration of the Department by Lieut.-Colonel (later Colonel) J. C. Matheson, R.E., until 1917, when he was sent to the Western Front and almost immediately severely wounded. Major M. St. L. Simon (later Colonel, C.B.E.), and Captain (later Brevet-Major) C. H. Ley, O.B.E., both

of the R.E., were also on Jackson's staff. At the end of 1916, Jackson, who had been promoted to the temporary rank of Major-General, spent two months in Russia having been invited personally by that Government to advise them on munition supplies.

SEPARATION OF RESEARCH FROM PRODUCTION OF GAS EQUIPMENT

By December, 1915, the activities of the Ministry of Munitions had developed and increased to so great a degree that it was considered necessary for those departments dealing with the manufacture and supply of munitions to be independent of the departments responsible for research, design and experiment. Jackson's department was therefore divided into two—the Trench Warfare Research Department, which remained under his direction, and included the Scientific Advisory Committee, henceforward called the Chemical Advisory Committee, and, under other hands, the Trench Warfare Supply Department, which dealt with weapons and appliances that had passed the experimental and design stages and were ready to be manufactured in mass. Whatever advantages this split may have had in the production of guns, shells and normal war-material, it created difficulties in the supply of chemical munitions, the nature of which necessitated prolonged experiment and frequent changes of type. Under these conditions, the difficulties of maintaining constant liaison between the designers of the appliances, the personnel in France who would have to use them, the manufacturers who produced them and the inspection department who had to pass them for service, were much increased by the divided responsibility, and it is very doubtful whether efficiency was advanced by the change.

In the autumn of 1917, when the Germans gained a surprise by the introduction of mustard gas shells, attention became focused upon the drawbacks of a system, under which research and experiment on chemical weapons were conducted by the Ministry of Munitions while similar services with regard to

the means of defence were conducted by the Anti-Gas Branch of the Medical Department of the War Office. Obviously these two matters were merely different aspects of a single problem, and should be studied and developed by a single organization. Sir Douglas Haig strongly urged this view on both the War Office and the Ministry of Munitions, which was then presided over by Mr. Winston Churchill. In consequence it was decided to amalgamate the bodies dealing with research and development of both offensive and defensive gas warfare into a single organization to be placed under the control of the Ministry of Munitions. To effect this reorganization it was considered desirable to appoint a soldier with personal experience of conditions on the Western Front, and in November, 1917, Major-General H. F. Thuillier, C.B., C.M.G. (late R.E.), G.O.C. 15th (Scottish) Division, who had been for a considerable time Director of Gas Services with the B.E.F., was selected and sent home for the purpose. He amalgamated General Jackson's Chemical Advisory Committee and the War Office Anti-Gas Committee into a greatly expanded single body called the Chemical Warfare Department, containing sub-committees representing all the principal branches of science. Major-General Jackson's connexion with trench warfare and chemical warfare research then came to an end, and he received for his services a knighthood and the thanks of the Minister of Munitions (Mr. Winston Churchill).

The further work of the Chemical Warfare Department is described in the next section.

THE CHEMICAL WARFARE DEPARTMENT

This department, as we have just seen, was brought into being in November, 1917, by the amalgamation, under Major-General Sir Henry F. Thuillier, K.C.B., C.M.G. (late R.E.), of the gas warfare portion of Major-General Louis Jackson's Trench Warfare Research Department and the Anti-Gas Branch of the Medical Department, War Office, which had up till then been responsible for the design and manufacture of all anti-gas protective appliances. The conditions and events

which brought about the necessity for this amalgamation have just been described.

The activities of the new department, which was under the Ministry of Munitions, of which Mr. Churchill was at that time Minister in charge, covered all research and experiment with regard to gases for offensive use against the enemy and the methods for using them, but did not include responsibility for their production beyond the stage of field experiment. With regard to defensive appliances, however, the department was entrusted with the entire responsibility for design, experiment, manufacture and inspection, i.e., for production, from the first stage to the last. The Chemical Warfare Department took over from the Trench Warfare Research Department the big chemical experimental ground at Porton, under Lieut.-Colonel A. W. Crossley, C.M.G., R.E., F.R.S., with its complete organization for field tests of all gas appliances, both offensive and defensive. In order to effect a thorough amalgamation of the offensive and defensive sides of the gas problem General Thuillier immediately formed the Chemical Warfare Committee, designed to deal with all aspects of the subject in a comprehensive manner. It was composed of sub-committees dealing with the following subjects:—

Organic Chemistry, directed by Professor W. J. Pope, F.R.S., of the University of Cambridge.

Inorganic Chemistry, directed by Professor H. B. Baker, F.R.S., of the Imperial College of Science, South Kensington.

Physics, directed by Professor J. F. Thorpe, F.R.S., of the Imperial College of Science, South Kensington.

Physiology, directed by Professor Leonard Hill, F.R.S., of University College, London.

Each of these sections organized intense research in all the university laboratories in Great Britain and some of those in Ireland on all compounds that could conceivably be useful in chemical warfare. A systematic investigation was put in hand of every compound described in *Beilstein's Chemical Dictionary*, a well-known compilation containing a description of every

chemical compound then known to science. Every compound that seemed under preliminary consideration to have any chance of being useful for gas warfare was subjected to physiological examination and trial in a laboratory. The few that from these researches gave promise of being of real war-value were then tested by field experiment.

In addition to the above scientific subcommittees the Chemical Warfare Committee included an Anti-Gas Section, consisting of the organization formerly under the War Office, which after its transfer was directed by Lieut.-Colonel E. F. Harrison, C.B.E., and also a Chemical Warfare Designs Section, directed by Professor J. F. Thorpe, F.R.S. The former included the great organization then already existing, and afterwards considerably expanded, for the design, manufacture, and inspection of gas masks for the troops. The Chemical Warfare Designs Section was created at this time to deal with all questions relating to the design of appliances in which gas was used, especially those connected with the chemical contents, bursting charges, etc., of gas-shells for artillery and gas-bombs for mortars.

General Fluillier was president of the Chemical Warfare Committee, the secretary being Dr. C. R. Young, who was later succeeded by Captain J. Davidson Pratt. The secretary had the duty of compiling the records not only of the proceedings of the Committee but also of the scientific research and experiment made in all branches of gas warfare. Besides the wide-spread inquiry, already mentioned, into all chemical substances of possible use in war, the most important tasks which came before the Chemical Warfare Department in connexion with the use of gas in offensive operations were research into the method of manufacture of dichlorethyl sulphide (mustard gas) of which no previous experience was available, and the development of thermo-generators for the formation of poisonous fine smoke clouds by the distillation of diphenyl chlorarsine and diphenylamine chlorarsine, which it was expected would penetrate the German gas-mask. The mustard gas problem was an exceedingly difficult one and many months elapsed before a comparatively simple method

of manufacture was discovered and brought to the pitch of large-scale production. The transition from research, through experimental stages, to this large-scale production was in different hands, so that changes in methods, which from research or experiment seemed likely to save time or labour, could not be brought into effect with the smoothness and speed that would have been possible had all processes been under a single control. The reason for this restriction was that it was the practice in all other departments of the Ministry of Munitions to keep the processes of design, of manufacture in bulk and of inspection under separate and independent controls. The French, who were not tied in this way, followed the logical course of having a unified control, and succeeded in producing supplies of mustard gas shells for use in June, 1918, while ours were not available till September—only six weeks before the armistice.

The manufacture of diphenyl chlorarsine and diphenylamine chlorarsine, and of the thermo-generators (known at the time as the "M. device" for their discharge in the form of fine smoke clouds were problems of considerable difficulty, which was increased by the fact that the responsibility for their manufacture was independent of the Chemical Warfare Department. This difficulty led to delays, and it was not till September, 1918, that simple and effective appliances were produced in sufficient quantity for small-scale field trials to be carried out in the South of France. These trials showed that the device fulfilled all requirements and that the smoke could penetrate the German mask in a few minutes at a range of over 3,000 yds. from the point of discharge. The production of a sufficient number for a major operation, however, was not complete at the time of the Armistice.

The design and manufacture of gas masks were not hampered by the division of responsibility referred to above. In the War Office organization which was taken over, the whole responsibility for gas-masks (the earliest researches, the design, experiment, field trials, manufacture and inspection) were all under the single control of the Director of the Anti-gas Organization. On the transfer to the Ministry of Munitions,

this arrangement—although contrary to the practice of all other branches of the Ministry—was allowed to continue as a special case, because any delay in changes of design and processes of manufacture, to meet new German gases, might have led to great loss of life. The result was that whenever it was necessary to alter the design and bring out a new type of mask the change was effected without interrupting the even flow of production.

The output of gas-masks was greatly increased during the autumn and winter of 1917-18 in order to supply the armies of some of the Allies. The American army authorities decided not only to adopt the British pattern of respirator but also, in view of the great difficulties which they had experienced in its manufacture, to ask the British Government to supply their troops in France until the American authorities had perfected the production of their own. The total number supplied to the American Expeditionary Force was about 400,000. In the beginning of 1918 the Italian Government, finding that their respirators were not proof against the latest forms of German gas, made an urgent request to the British Government for 1,600,000 respirators of the British design. The probability of this demand had been foreseen and the output increased with a view to meeting it. It was therefore possible to dispatch 800,000 to Italy immediately and to provide the remainder at the rate of 300,000 a week, so that the whole demand was met in three weeks without reducing at all the supplies to the British and American troops. Altogether the total number of British box-respirators produced by the Anti-Gas Department of the War Office and the Chemical Warfare Department of the Ministry of Munitions was approximately 13½ million in addition to 4½ million spares. In the spring of 1918 the production of gas respirators was being carried on in forty large factories in and around London and employed 120,000 persons, mostly females.

Early in 1918, when the idea of using poison smoke clouds from the distillation of diphenyl chlorarsine and diphenylamine chlorarsine had been taken up and steps were being taken to produce an appliance to effect this, it became necessary to

design and produce a modification of the canister of the British box respirator, since the one in use would not keep out these clouds. The new type of canister contained folds of cheese-cloth which prevented the passage of even the finest particles of smoke; it also had more active charcoal and chemical granules which gave better protection against all kinds of gas. A full supply of these canisters was manufactured but they were never issued to the troops for fear of disclosing the intention to use the "M. device."

In October, 1918, Major-General Thuillier was appointed to the command of the 23rd Division in Italy. It was then arranged that Brigadier-General Foulkes should be President of the Chemical Warfare Committee, combining this duty with the post he already held of Director of Gas Services at G.H.Q. in France. Lieut.-Colonel E. F. Harrison, who had been Deputy Controller of Chemical Warfare under General Thuillier, was to become Controller in his place. Unfortunately Colonel Harrison fell a victim to the great influenza epidemic and died very shortly after taking over this increased responsibility. His work in the development of the box respirator, and later in the general management of the vast organization for its manufacture in bulk, had been of priceless value, and had he survived he would assuredly have attained a very high position in the profession of chemical technology.

For further information on the development of gas warfare on the Western Front the reader is referred to Chapter XX.

THE R.E. COMMITTEE

The period of the 1914-18 war was a turning point in the history of the R.E. Committee; as constituted and organized in 1914, the committee could not successfully stand the test of war on a large scale, and the end of the war saw its eclipse. It had done well in ensuring that the engineer units sent overseas with the Expeditionary Forces had been provided with excellent equipment of its kind, but the basis on which that equipment had been designed and provided was more appropriate to small forces engaged in colonial operations than

to large-scale continental warfare. In this respect of course engineer equipment was by no means unique, as all arms of the service were similarly affected, but the static conditions and siege operations that developed after the first few weeks in France perhaps bore most heavily on the Engineer arm and demanded most from it.

Large scale war of course produces rapid changes in the needs of an army, and inspires new ideas, new devices and new weapons. Speed in assessing the value and possibilities of these is essential if the army is to reap the full benefit from them. It was owing to its lack of speed and lack of facilities for research and development that the organization of the R.E. Committee was found to be inadequate in the emergency. It had no permanent members free from other duties and had to rely upon the staffs of engineer schools for advice and for trials of new proposals—staffs more than fully occupied with increased instructional and training duties. The unsuitability of the constitution had been pointed out as far back as 1872, when the need for a small number of full-time members had been stressed, and the arguments then used may be quoted, as they were equally applicable to the needs of the 1914-18 period.

"The time of members is so fully occupied by the special (instructional) duties of their appointments that they are quite unable to bestow adequate attention upon the subjects submitted to the Committee. These subjects are very numerous; they embrace nearly every branch of science, and may require laborious and close investigation."

In supporting this representation the I.G.F. commented:—

"I cannot help seeing that, while many subjects are unavoidably postponed, many others have been dealt with in too superficial a manner, and the inevitable result must be that some day the Committee will—from no fault of its own—lead the W.D. into some serious mistake."

The war at any rate endorsed the need for an improved constitution of the R.E. Committee, and that lesson was learned; two others were also appreciated and applied. These

were the need for making greater use of scientific aid, and the need for facilities for experiment, development and design. As a result, in the immediate post-war years the committee was reconstituted as an executive board with permanent members, with its own directly controlled experimental establishments, and with its own scientific and technical staffs. The Royal Engineer Board, as it was named, thus replaced the R.E. Committee. Its activities do not concern this period, but a record of them will be found in a later volume of this History.

The early part of 1914 found the R.E. Committee engaged upon its normal pre-war development work, though there is evidence of a slight speeding up in *tempo*; there are also indications of some foresight in regard to the possibility of war on the Continent and perhaps suggestions of some special needs that such a war might bring with it.

There were at this time two major items under investigation. These were the development of a light bridge and rafting equipment for field squadrons, to replace the air-bag equipment, and the design of a light wireless telegraphy field set, to replace the rather inadequate W/T pack set. The growing importance of radio communications for the army was fully appreciated, and though the Wireless Telegraphy Experimental Section at Aldershot was small, development was making rapid progress.

Of other work in hand the following are worthy of mention and show that the committee was attempting to anticipate the future needs of war supposing it came: -

Modifications were being made to the bi-partite pontoon equipment to increase its load carrying capacity to cater for motor vehicles, although the number and weights of such vehicles that were expected to use these forward bridges were not great. To provide for large-scale demolitions and for mining operations, experiments were being carried out with commercial and service explosives other than gun-cotton and gunpowder; T.N.T., blastine and gelignite were under comparative trials. Trials were in hand in the use of an air-space with mined charges but as a result it was reported that "there did not appear to be anything in the invention as applied to mines."

This is of some interest, as, when the proposal was revived later for mined and bore-hole charges, a definite advantage was proved and the practice was recommended.

The following were also being developed:—an improvised hand grenade invented by Captain R. S. McClintock, flares for illuminating wire entanglements, lights for short-range night defence of positions and light-weight engines and generators for W/T sets, man driven pedal generators having proved a failure.

It should be noted that the responsibilities of the committee in respect of bridging were really confined to field equipment to accompany engineer divisional units and subject to the limitations of horse-drawn transport. Responsibility for the heavier bridges required for rear areas and the materials with which to construct them, lay with the stores branch of the D.F.W. and his Inspector of Iron Structures; such materials were supplied to engineer stores depots overseas and not as equipment of engineer units.

After the outbreak of war the committee continued to operate in its normal way, but it soon became apparent that its procedure could not compete adequately with the speed of events and with the rapid expansion of the demands being made upon the Corps. It was handicapped by the lack of continuity in its membership owing to the calls elsewhere for experienced R.E. officers, and also by added pressure of work on the instructors of the engineer schools. Necessarily the normal procedure had to give way, and gradually the majority of the work of the committee was soon taken over by F.W.4(a), Colonel Dumaresq, F.W.4(b), Major R. A. Lewis, and later by the Inspector of Iron Structures, F.W.4(c), Lieut.-Colonel R. Oakes. The committee as a whole though still advisory became more of a confirming than an initiating body.

With the formation of the Ministry of Munitions the committee was merged—if not completely submerged in that Ministry, and was closely associated with the Munitions Inventions and the Trench Warfare Department, created by Colonel (afterwards Major-General Sir) Louis Jackson (late R.E.). It was, however, still able to have direct access to the

Engineer Advisor—later Engineer-in-Chief—G.H.Q., B.E.F., who arranged for many trials of new ideas, appliances and methods submitted for consideration, and was the source from which information and details of performance of new requirements largely emanated. In France a number of experimental bodies were set up to develop new equipment and test new ideas, but it was the Experimental Section R.E. formed in France at the beginning of 1916, under Lieutenant E. S. R. Adams, which was the main official establishment for such work. The Committee was not directly related to any of these bodies, nor was it concerned with sound ranging, tanks, gas or camouflage, all of which made their initial appearance in 1915/16, though R.E. officers were actively associated with these novelties.

Captain F. J. C. Wyatt, who was in later years a member, and later President, of the R.E. Board which succeeded the committee, formed the Special Works Park for experiment, development and practical use of camouflage and also organized local production of camouflage material.

Similarly in the development of tanks the committee was but slightly concerned, though of course affected in its work by the great increase in bridge loads due to these weapons and also by the apparent need for a special R.E. tank. Most of the experimental work in this connexion was carried out by the Experimental Bridging Company, R.E., established at Christchurch under the command of Major G. le Q. Martel; the Committee was closely associated with this establishment during the war but it was not until later with the post-war reorganization that it could direct its activities.

Another experimental establishment in this country dealing with various appliances, special machinery and heavy bridging material was set up by Lieut.-Colonel Oakes (I.I.S.) at Claygate, and was associated with the depot under Major A. V. T. Robinson (later Wakeley) in France for handling such material. This was no concern of the committee but through their link with I.I.S. in F.W.4, some touch with its work was maintained.

The Inspector of R.E. Stores at Woolwich Dockyard was

also associated with experimental and development work: he took under his wing a number of small groups, either existing before the war like the Wireless Telegraphy Experimental Section at Aldershot, or formed specially to tackle new problems such as sound ranging, sound location and detection of aircraft. The committee was in touch with much of this work and, though it had no actual control, its close association with the Inspector (later Chief Inspector) of R.E. Stores, Colonel Robertson, enabled it to have some say in the direction of development work.

In 1917 a Signals Service Committee was formed controlling the Signals Experimental Establishment on Woolwich Common, which had been set up in 1916, and had absorbed the original Wireless Telegraphy Experimental Section, transferred from Aldershot to Woolwich Dockyard on the outbreak of war. In February, 1918, an Anti-aircraft Searchlight Committee was formed, and to it was added sound location in May of that year: experimental work was carried out at the S.E.E. on Woolwich Common and at the Searchlight Experimental Establishment under the O.C. London Electrical Engineers.

These links with experimental organizations outside the committee's direct control have been mentioned as they were, in fact, preliminaries to the transfer of control of experimental and design work to the committee or its successor at the end of the war. The method of recording the committee's activities by the issue of half-yearly "Extracts of Proceedings" was continued in the new régime, and in the issue for the years 1919 and 1920, a useful summary may be found of some of the subjects dealt with during the war period. Some brief notes on the more important matters covered are given below under the headings of the major subjects concerned.

Bridging.—The activities in this respect were very limited, being confined almost entirely to modifications to existing mobile equipment and to the consideration of a number of proposals for new forms. This was due to the static conditions of trench warfare and to the fact that the heavier semi-permanent bridges in the rear areas did not come within the committee's responsibilities, though it assisted at times in an

advisory capacity. The E.-in-C. in France was energetically pursuing investigations into heavy bridging and kept within his own hands the development of this equipment and the training of units in its use. In retrospect it is, however, surprising to find how very limited was the bridging work of the committee during a period when the development of mechanical transport was producing such a radical change in the bridging problems of the Army.

The modifications and additions to the bi-partite pontoon equipment already referred to, were completed and approved by the end of 1914, and it seems strange that the committee was not brought into the problem of developing floating bridge equipment capable of dealing with the greatly increased loads—tanks, super-heavy guns, etc.—that made their appearance during the war, but that need was provided for by the Special Bridging Company mentioned earlier in this section.

The committee completed work on the new design of light bridging equipment for field squadrons in the summer of 1915. After full trials by O.C. 3rd Field Squadron (Major C. E. P. Sankey) and trials in France under the Cavalry Corps Commander witnessed by the E.-in-C., this design was approved as service equipment, but consideration was given to the possible use of metal to replace the timber and canvas folding boats.

Several novel designs for light transportable bridges were brought to the notice of the committee, but the only one worthy of mention here is that submitted, through the Commandant S.M.E., by Lieutenant C. E. Inglis of the Cambridge University O.T.C. He was of course closely associated with the Corps in post-war years as Professor Inglis of the Cambridge Engineering Laboratories in which most of the younger officers of the Corps did their University training. The primary form of this proposal was a rapidly built girder bridge to carry infantry in single file; it consisted of a series of pyramids with apex upwards, built of light steel tubes all 8 ft. long and connected together with a simple and rapid device. The narrow foot-way was carried on the lower horizontal members so that passage was through the pyramids. The girder weight was about

25 lb. per foot run and no individual member exceeded 40 lb.; its capacity was unrestricted crowded single file for spans up to 72 ft., or men at 1 yd. spacing for spans up to 96 ft.; construction could be effected ready for launching in 15 minutes with almost untrained men. The proposal also envisaged the use of this girder reversed with apex downwards as an over-bridge for heavier loads, and for still heavier by the use of two or three girders combined, or the use of two girders with apex upwards, connected by trussed beams as transoms for the roadway. The committee referred the proposal to G.H.Q. in France to ascertain if such bridges were likely to be required. G.H.Q. indicated that the usefulness of such a bridge would be limited in the then sphere of operations, to the passage of infantry in file and that the type was unlikely to be suitable for heavy bridges in their part of the country. They asked for sample bridges for infantry in file to be produced and submitted to trials at the S.M.E. This was arranged but provision was also made for trials of a "heavy" type bridge. The trials of the "light" bridge were successful, and G.H.Q. accepted the results and asked for the supply of ten sets for 88-ft. spans. Trials in France resulted in a request for additional material of the same type but of dimensions suitable for the passage of troops with their first-line transport. A specification for a 96-ft. girder was supplied and a demand for seventeen such spans, complete with accessories, was made for supply as early as possible. The first sample of the "Heavy" type with 12 ft. tube members was sent to France and accepted in the early part of 1916. Further design work was undertaken by Inglis to produce a really heavy bridge of rectangular type for use in rear areas, but this was not the concern of the R.F. Committee.

Signal Communications.—The army entered the war with its communications based primarily upon permanent line telegraphy in the rear areas and mobile (horsed) field telegraph and cable equipment for the fighting zones, the latter being supplemented by lamp, heliograph and flag signalling. Line telephony was available and increased in its scope rapidly as static conditions developed. Wireless telegraphy equipment

had already made its appearance in a small way and radio telephony was developing ; both W/T and R/T were to make considerable advances under the pressure of war and its increasing demands for extended communications. In view of the great developments in the use of radio by the army in later years it is worth while recalling the inception of this work even though some mention has been made of it earlier.

Experimental work on wireless started at the S.M.E. in 1903, but was transferred in 1907 to Aldershot where the Wireless Telegraphy Experimental Section was formed in charge of Captain C. E. Evans, with Captain H. P. T. Lefroy and Lieutenant R. Chenevix Trench as assistants. In 1908 Lefroy took over from Evans, and Lieutenants Chenevix Trench, E. D. Carden and A. C. Fuller, with two civilians and eight military other ranks, completed the establishment. The Commandant Signal Service Training Centre as a member of the R.E. Committee, kept that body in touch with the work of this section. This experimental section did much original work and helped in the setting up of the Aldershot W/T station. It produced from its own specification the sample of the Light Field W/T set that was adopted as army equipment at the beginning of the war to replace the early pack sets ; it also provided the first two lorry-borne W/T stations (2-kw. spark sets) that went overseas with the 1st Cavalry Division in 1914, commanded by Lieutenants J. L. Tomlin and C. J. Aston.

Another achievement of this small section was the design and complete production of an equipment known as " W.O.S.P., No. 5," which was, in its day, considered to be the only secret method for sending W/T ; this set was on exhibition at the Science Museum for several years before the second world war.

Most of the personnel of the Experimental Section were dispersed to their units on mobilization, but the remainder were moved, early in 1915, to Woolwich Dockyard where they worked under the wing of I.R.E.S. until July, 1916, when the Signals Experimental Establishment was formed on Woolwich Common, and absorbed the expanded remains of the

section. Colonel A. H. Bagnold, C.B., C.M.G. (late R.E.), was appointed Chief Experimental Officer, and was succeeded by Lieut.-Colonel L. F. Blandy early in 1918. The S.E.E. became the home of all research on communications' problems, and was also used for work on acoustics, searchlights and air defence. Throughout the war it provided standard time signals automatically transmitted from the Aldershot station for the forces overseas, and also transmissions for frequency-checking at certain times daily.

In 1917-18 the S.E.E. carried out trials of ground communication by R/T with aircraft from Biggin Hill; these were in continuation of trials carried out in France by Lefroy in 1916 with a 250-watt set, and their immediate object was the direction of night-flying aircraft to intercept enemy Zeppelins. It is of interest to recall that the first trials of communication between aircraft took place in 1912, when Trench and P. G. Grant or sometimes Evans, established quite good communication between two small airships, *Beta* and *Eta*, using sets built by the Experimental Section.

Much work was done by the Establishment on the interception of enemy communications and on the location of enemy stations by direction-finding methods, which proved a valuable aid to the intelligence service; no material attempts were made by either side during the war to jam enemy communications and to start a "jamming war."

During Blandy's régime at S.E.E. the first W/T set transportable by two men was produced. It had an output of 300 watts and a range of from 15 to 20 miles, and was intended for use between battalion and brigade headquarters. Longer range working centred mainly on the Aldershot station, via S.E.E., and worked to G.H.Q. in France, the Middle East and the Sudan, and later formed the main link with Cologne and Constantinople.

Developments in the other forms of communication were many and varied but work was mostly of the same nature as that before the war, though intensified. The outstanding feature of this was its enormous extent rather than technical improvements of novel interest. One item, however, that should be

mentioned was the Fullerphone—a device developed by A. C. Fuller, R.E. (later Major-General), to improve performance and to eliminate the power of the enemy to pick up our messages by induction methods. This device was brought to the notice of the committee late in 1915 by the Commandant, S.T.C., and it was arranged with G.H.Q. for Fuller to go to France to demonstrate his experimental model. The result was an order for the immediate supply of 1,000 sets, with a slight modification found necessary by Fuller. This device known as the "Instrument Telegraph (Fuller)" or more generally as the "Fullerphone" was a definite advance in field communications and remained an item of service equipment for many years.

The R.E. Committee was associated with all these activities, and in 1917 set up a Signals Service Committee which relieved the main R.E. Committee from the detailed work of signals communications.

Explosives, Mining and Demolitions.—Throughout this period trials of trade explosives, available in quantity, were carried out to determine which were suitable for R.E. purposes to supplement the supply of gun-cotton, the standard demolition explosive, and to replace gunpowder for mined charges. These experiments were on a considerable scale, mainly carried out at the S.M.E., and often confirmed by practical trials in France. In general ammonal proved the most suitable for service use, but in the early years at least the demand for it for filling grenades limited the supply for R.E. work. Blasting, gelignite and sabulite were all approved, but T.N.T., permite and amatol were rejected as unsuitable. Other trials with these explosives were carried out, notably those arranged by the Scientific Advisory Council with Professor Cadman at the University at Edgbaston, where the after-effects were specially investigated. In all these tests and trials the Research Department, Woolwich, gave much assistance and technical advice.

Another almost continuous investigation was started early in 1915 to provide a means of boring horizontally for small mined charges. A large variety of appliances—power-driven drills, hand-operated pipe-forming jacks and other devices—were produced for trials. Most of them failed under the con-

ditions required restricted space, difficult soil, silence and rough-handling. Several were given practical trials in France but few were of any use. Linked with these trials were unsuccessful attempts to provide an earth auger suitable for buried charges.

In 1915 a novelty in demolition stores made its appearance in the form of "Cordeau detonant," a detonating fuse used by the French Army. Bickford produced a British type made by filling a thin lead tube with T.N.T., but, as satisfactory results had not been achieved by the end of 1916 the matter was dropped. Samples of the French fuse proved reasonably satisfactory and some supply was made available to our troops.

Another investigation of importance to effective mine-warfare was the development of listening devices to detect enemy mining and to locate the position of his galleries. Many devices were tested at the S.M.E. and in France where in the last half of the war a number of different types were used.

Miscellaneous Matters.—Development of survey appliances was a normal subject for the committee and the pre-war work was continued. There were many new requirements resulting from trench warfare and mining. For these conditions reduction in bulk was often desirable and special periscopic cameras, compasses and inclinometers for underground use, were produced. In addition special theodolites, required for locating enemy artillery by flash-spotting, and survey methods, had to be developed to assist in sound ranging, and for "fixing" our gun positions and enemy targets—the start of artillery survey.

Anti-aircraft defence measures came under the consideration of the committee, and an A.A. Searchlight Committee was formed at the beginning of 1918; this committee also dealt with research on sound detection and the location of aircraft, subjects which became of great importance to the successor of the committee in the post-war reorganization.

The committee was involved to some extent in the special needs of trench warfare—catapults, rocket-operated grapnels for removing obstacles, flares, portable and wheeled shields (abandoned as impracticable), different forms of wire entanglement, wire cutters and a host of other devices most of which

were used as temporary expedients pending proper design and provision. Many such devices were developed locally by formations in the field on their own initiative, and were then taken over by the Experimental Section R.E. in France or the Trench-warfare Department of the Ministry of Munitions.

One of these devices perhaps calls for mention here—the screw picket—a rapid and quiet means of erecting an entanglement even on frozen ground. In the early winter of 1915 the enemy were found to be using these pickets and an immediate demand was received from G.H.Q. for supply to our troops. The R.E. Committee received this demand, accompanied by a drawing, and a small supply for trials was put in hand immediately. After some changes in the shape of the point, the famous corkscrew type was produced, but it was later discovered that an identical picket had been developed by the committee some thirty years earlier, and was recorded in their “Extracts of Proceedings.” Presumably the Germans had read them but we had failed to do so.

With that brief summary of the work of the R.E. Committee in its last years this section must close. The rebirth of the Committee in more executive form with scientific aid and experimental establishments of its own, and with its responsibilities and scope considerably extended, is dealt with in Volume VII of this History. In its new form it became the Royal Engineer Board and later the Royal Engineer and Signals Board, and served the Army in the uneasy period between the two world wars.

CHAPTER V

SURVEY

The Ordnance Survey in 1914—Pre-war policy of the Geographical Section, General Staff—Technical experience and training for war—Survey arrangements for the Expeditionary Force—The Geographical Section during the war—The Ordnance Survey during the war.

THE ORDNANCE SURVEY IN 1914

VOLUME III of this History brings the story of the Ordnance Survey practically up to the outbreak of war in 1914. The recovery from the difficult period of the Boer War, the happy result of the Test Triangulation on the shores of the Moray Firth, and the conclusion of the major portion of the new geodetic levelling—so badly required in Great Britain—are adequately dealt with. Ample opportunity had been given during this period for training the rank and file in the application of survey to war, and our participation during the first thirteen years of the century in colonial topographical surveys and boundary commissions had provided numbers of reliable and experienced non-commissioned officers.

Although valuable domestic survey history was made in the two years immediately preceding the war there is no space in which to record it here.

PRE WAR POLICY OF THE GEOGRAPHICAL SECTION, GENERAL STAFF

Volume III leaves the Geographical Section in 1911, under the direction of Colonel W. C. Hedley. For many years previously, especially in the period during which Generals Ewart and Henry Wilson were Directors of Military Operations, work on an important series of maps, on the scale of 1/100,000, of north-east France and Belgium had been in progress. This

was designed to take the place of the existing Belgian series and of the rather poor 1/80,000 staff map of France. In order to provide for further possible eventualities, large areas of the French 1/80,000 lying to the south of the special 1/100,000 area were printed. Maps suitable for a possible campaign in north-east France and Flanders were packed and stored ready for issue with mobilization equipment. These cartographic preparations for the coming struggle show singular care and forethought on the part of the Directorate of Military Operations.

In addition to these preparations for the major theatre of war, every likely area had been examined as far back as 1907. Where it is possible to employ British surveyors the mapping of such areas presents few difficulties save those of finance. In other places, under foreign rule or influence, rough and hasty measurement may occasionally be possible, but in the main existing surveys have to be used, and the collection of these is an important part of peace-time preparation. Year by year the survey of northern Sinai had been carried out by officers sent each winter from home, assisted by the staff of the Survey of Egypt, and, in 1913, the Sinai survey was extended to cover the Negeb, or southern desert of Palestine. Compilation maps, necessarily somewhat rough, were also prepared of Turkey in Asia and the Balkans, on the scale of 1/250,000. Both Directors of Military Operations above mentioned took a personal interest in all this work, and, in particular, decided upon the area to be prepared in north-east France and Belgium.

TECHNICAL EXPERIENCE AND TRAINING FOR WAR

The four original survey companies were raised for the large-scale chain-survey of the United Kingdom. Their training, exceptionally thorough for that particular work, did not include trigonometrical and topographical surveying. In 1887, therefore, training in field survey was started under the direction of the late General Sir Charles Wilson, though it was not in those days based upon modern topographical methods. In 1890 three survey sections (each of two officers

and twelve rank and file) were formed as training units and in 1912 four such survey sections existed. Each member of a section drew extra duty pay, and each section went through a refresher course every third year. In 1904 a survey section of two officers and twelve men (seven surveyors and three lithographers) was inserted in War Establishments, but was specifically confined to small wars.

The necessity for map printing in the field had been felt during the South African War, and field printing sets had been set up as early as 1900 on the Orange River and elsewhere. In 1911 a small mobile printing section equipped with hand presses was included in War Establishments, and destined for mobilization with the Expeditionary Force.

In 1913 an extensive trigonometrical survey of the Plymouth defences fixed positions of guns, datum points, depression range finders and searchlights. During this work officers and men of the Ordnance Survey, in close touch with the garrison artillery command, became acquainted with those artillery survey problems which were to become so important in the war. The point seems a small one, but is important, since it shows that subsequent happenings were in reality a normal growth of existing co-operation. In fixed defences R.E. officers had long been responsible for surveying gun positions, but their co-operation on survey matters with the siege and field artillery was a war development.

An important feature of this time was the close touch maintained with foreign survey departments and with the leading geodesists of the day, both British and foreign. To conduct precise original surveys is within the competence of many R.E. officers; but to improvise, adapt and adjust from foreign material and maps, so necessary in war, can be possible only to the very few who have the necessary skill, and the equally necessary knowledge of contemporary foreign methods. It may be added that personal experience of computation in all survey processes, including adjustments and projections, is a prerequisite of success.

SURVEY ARRANGEMENTS FOR THE EXPEDITIONARY
FORCE

In 1913, one hundred R.E. officers and ninety other ranks were employed on surveys (including the Survey of India), and on the outbreak of war there were available some 150 serving rank and file, expert in field surveying and capable of work confined only to officers in the French and German armies at the time. It is true that many of these men were abroad, and that others were lost to survey by being posted to field or fortress companies, but the potential was ample to meet the minute provision made in establishments for the map supply and survey needs of the Expeditionary Force. The Intelligence Branch of the General Staff at G.H.Q. included a topographical subsection, consisting of one officer (G.S.O.3) and a clerk; it had no transport, and was purely for map supply. On the L. of C. one officer and one clerk were to supervise the receipt, storage and dispatch of maps printed in England. Divided between G.H.Q. and the L. of C. was a printing company with its headquarters on the L. of C. and with small mobile sections with the corps. The survey sections were not to be mobilized and, in common with the survey companies, were to be used for reinforcing fortress or field companies. Moreover, three-quarters of the R.E. officers of the Ordnance Survey and of the Geographical Section of the General Staff were earmarked for mobilization with field and fortress units.

Thus the preparations made for map supply to the troops, for dealing with any changes in the scene of operations, and for occasional but necessary surveying in the field were far behind those of continental armies. The Expeditionary Force was, in fact, organized for mobile warfare and was equipped in strict accord with that principle, the maps prepared for its use being the normal topographical maps of the country. There were no survey arrangements for siege operations or for long drawn-out battle; no counterparts to the French *Groupes de Canons de Tir* or the German *Vermessungs Abteilungen*; no proper arrangement for the location of hostile guns; nor even for the survey of the ports of disembarkation.

On the other hand the resources of the half-military half-civil organization of the Ordnance Survey, the trained officers and men of the Ordnance Survey and of the Geographical Section General Staff, an important reserve in the civilian staffs of Colonial Surveys, and carefully prepared maps of many theatres of war were available, and were eventually to prove sufficient. We had too, the great advantage of an entire absence of preconceived judgement.

The peace training and experience of officers of the Indian Survey were at least equal to those of the very few on the Home Establishment who had achieved continued survey employment. Losing on mobilization, as it did, all but seventeen of its establishment of fifty-four officers, the Survey of India was yet not only to provide for most eastern and some African geographical tasks, but also to contribute to the European fronts.

Survey work in the field is described in succeeding chapters dealing with the operations on the various fronts.

THE GEOGRAPHICAL SECTION DURING THE WAR

In August, 1914, this section, under the command of Colonel W. C. Hedley, included six officers and forty-three others (clerks, lithographers, draughtsmen and photographers). All five assisting officers and twelve of the other ranks were taken from the section. Lieut.-Colonel P. J. Gordon (late Indian Army and Survey of India) joined, and the staff was filled by engaging new civilian craftsmen.

It is something of a mystery how two officers managed to meet the demands of so many theatres of war. That they did so is due to the facts that the Ordnance Survey was placed wholly at the disposal of the War Office, that the Royal Geographical Society undertook much of the necessary compilation, particularly of map gazeteers, and that the production of suitable maps had been carried out with much foresight before the event.

In 1915 the Section was labelled "Intelligence" (M.I.4) instead of "Operations" (M.O.4) since the mentality of the

time, whilst appreciating the necessity for collecting and issuing maps, failed to envisage actual field work, or the employment of numbers of technical units. Notwithstanding this, M.I.4 had, itself, to intervene in research, organization and the purchase of technical equipment and machinery. Whilst survey personnel in the field rose to a total strength of some 5,000, Colonel Hedley remained the one technical survey adviser and manager at the War Office. His efforts may be gauged from the fact that 8 tons of maps per day was no uncommon amount for dispatch to the Western Front, that innumerable situation maps and diagrams were demanded daily by the Cabinet and the War office, and that expert advice on all aspects of field survey work was called for continually.

THE ORDNANCE SURVEY DURING THE WAR

The outbreak of war found the Ordnance Survey with twenty-two officers (of whom twenty were on the Active List) and about 1,940 other ranks (military and civil), under the command of Colonel C. F. Close (later Colonel Sir Charles Arden-Close, K.B.E., C.B., C.M.G., F.R.S.). Sixteen officers on the Active List were taken for other duties, and of a total of 326 other ranks of the Corps (not including seventy-eight employed on Colonial Surveys) twenty-seven left for overseas survey duties, and 295 for other branches of the Corps. No less than 568 of the civil establishment joined His Majesty's forces, although very few ever reached those survey units in which they would have been so useful.

Colonel Close immediately installed additional printing machinery, recruited fresh staffs, and trained men for duty with the survey units in the field. There were, at the outbreak of war, six Ordnance Survey field divisions. Plan revision was cut down to less than a tenth, three field divisions were closed, and the war deprived the National Survey of nearly four years of revision. On the other hand, map production and printing became very much more important, since every map printed was potentially, a war map. The War Office made increasing demands for training as well as for the dispatch of maps and

stores to the field, the Admiralty required confidential chart printing, and the Cabinet and various Departments of State depended, for secret or confidential matter, upon Ordnance Survey map reproduction.

An interesting feature of the war organization of the Ordnance Survey was the establishment of an Overseas Branch, first at Wardrecques in December, 1917, and afterwards near Wimereux in June, 1918, under the late Colonel W. J. Johnston. "O.B.O.S." was a sub-branch of a civil department. Although given an establishment in the Expeditionary Force it differed essentially from any other survey unit except in so far as it was under the technical orders of "Maps G.H.Q."

Fortunately, to replace some of the officers who left on mobilization, the Ordnance Survey was able to secure the services of the following retired R.E. officers, all of whom had had survey experience: Brigadier-General Penrose, Colonels Macdonnell, Wauchope, Gale, Hill, Jessep, Longe, Creswell, and Laffan; Lieut.-Colonel Harrison; and Colonel W. M. Coldstream, late of the Survey of India, who was available only for 1915 and 1916.

CHAPTER VI

TRANSPORTATION AT THE WAR OFFICE*

Historical background—Pre-war employment of regular officers on railways—Arrangements for mobilization—Raising and training of new units—Assistance rendered by the British railways—Railway material and stores—Inland water transport and docks—The great reorganization in 1916—Richborough cross-Channel service—The Cherbourg-Taranto route—List of transportation units.

HISTORICAL BACKGROUND

THE Transportation Service during the war of 1914-18, including its preparation before the war, affords a good example of the system of using for military purposes the skilled personnel and organizations which exist in peace.

Since regular Royal Engineers of all ranks served in every part of the organization, except the Inland Water Transport, and were largely responsible for pre-war preparation (so far as they were allowed to make any), and since all civilians who joined it in regimental ranks were commissioned or enlisted as Royal Engineers, it is clear that the work of this important branch of the great army of the war is entitled to a prominent place in the history of the Corps.

During the nineteenth century thousands of miles of railway, unheard of in Napoleonic days, had been built in Europe, and in the wars of 1864, 1866 and 1870 Germany, Austria, France and Italy all employed railways on a large scale. On their first attempts to utilize this new and powerful method of moving large quantities of troops and munitions to increase the force and speed of their strategical and tactical operations,

* Acknowledgement is due to the special War Transportation number of the *Railway Gazette* September, 1920, for much of the information in this chapter.

every nation found to its astonishment that the activities of the military staff soon strangled the efforts of the railway technical staff to operate the railways in the service of the army. Learning their lesson in turn, Germany, Austria and France arrived at identical conclusions concerning the principles by which armies could alone make the maximum use of railways without entirely disorganizing them. It was found that military demands for railway transport must only be communicated to the railways by a special army staff established throughout the railway system for that purpose, and also responsible for communicating to the staff of army formations their orders as to the timings and quantities of transport available. No other army officer, whatever his rank, should be allowed to give any order to the railway technical staff.

The British had not taken part in the wars of 1864 to 1870 but in 1896-8 Lord Kitchener, using Major E. P. C. Girouard, R.E., as his Director of Railways and eight R.E. Subalterns, had constructed 585 miles of railway to make the re-conquest of the Sudan possible. In the South African War we utilized some thousands of miles of railway for the operations of an army of $\frac{1}{4}$ -million ranging over a sub-continent. 1,100 miles were captured from the enemy in a demolished condition, denuded of technical railway staff, and had to be repaired and operated by personnel provided by Great Britain and South Africa. Lieut.-Colonel Girouard was also Director of Railways in this campaign, working directly under the Commander-in-Chief. He had carefully studied the operation of railways in war, and followed the principles that had been laid down by the continental armies. He established under his orders throughout the South African railway system a special military staff of Assistant Directors and Deputy Assistant Directors of Railways and Railway Staff Officers (R.S.O's.), who were the sole channel of communication between the army and the railway technical staff, and *vice versa*. He used regular R.E. companies assisted by locally raised units, for the repair of damaged railways, and he organized operating staffs to take over the captured lines denuded of railway personnel.

The Escher Committee of 1902 realized the necessity of establishing at the War Office an organization to plan for the use of railways in future wars, and form a nucleus to expand on mobilization. They appointed a Director of Movements and Quarterings (D.M.Q.), the first holder of this appointment being Brigadier-General H. M. Lawson (late R.E.). He had three branches under him, Q.M.G.1, Q.M.G.2, and a new railway branch Q.M.G.3, with the modest staff of one R.E. captain (graded D.A. and Q.M.G.), and two clerks.

Lawson drafted regulations for the establishment in war of a special staff of R.S.Os. (later R.T.Os.), D.A.D.Rs. and A.D.Rs. under a Director of Railways at Army Headquarters to form the link between the military and the technical staffs of any railways used in war. He had consultations with the managers of the British railways concerning the recruitment and organization on a special army reserve basis, of R.E. units for the survey, construction, repair and operation of railways overseas in future wars. Lawson also concentrated the three regular R.E. railway construction companies (8th, 10th and 53rd), at Longmoor in Hampshire in 1905, and built there a few miles of instructional railway on which to train units in rapid construction and repair—a centre which would be the depot where the special reserve railway units would assemble on mobilization, and would form the connecting link in peace between them and the regular units.

Any new organization inserted into a long-established Ministry of Government has a hard struggle, first for its creation and then for the continuance of its existence. The railway (later Transportation) organization at the War Office was certainly no exception to this rule. For the reasons stated in the preface to this volume much of Brigadier-General Lawson's programme was whittled down, and in particular the creation of the special reserve railway units was never in fact authorized. The 53rd Railway Company, R.E. was disbanded leaving only two regular units, an indication that little railway work was expected in the next war. There were, however, in existence three special reserve (formerly militia) railway companies, one provided by the Anglesey and two by the Monmouthshire

Special Reserve R.E. They carried out their annual training at Longmoor. Thus we eventually mobilized for war in 1914 only two regular and three Special Reserve railway construction companies, whereas, as we shall see, more than 400 military railway units were required before 1918. Moreover, the main sound principles which should govern the use of railways in war, so clearly laid down in the regulations of every army on the Continent, and already followed successfully by ourselves in South Africa, had become obscured in our *Field Service Regulations*, 1913, and even these regulations were not fully put into practice.

PRE-WAR EMPLOYMENT OF REGULAR OFFICERS ON RAILWAYS

In an account of pre-1914 preparations for railway work in war we should not omit to mention the arrangements under which certain R.E. officers were employed on civilian railways in peace. From the very commencement of railway work in India, R.E. officers had played a very important part, in all grades up to the highest appointments, in the creation and maintenance of the Indian railway system, and in 1914 a considerable number were so employed. For many years at least one young officer in each batch, after completion of his courses at Chatham, had been trained for one year at a special course on British railways as a preliminary to work on civilian railways in India and elsewhere.

In Africa, as in India, much of the railway construction and operation had been under the direction of R.E. officers. Thus, in 1914, the Sudan railway system was under the management of Lieut.-Colonel E. Midwinter, with a few R.E. officers under him. In Egypt, Lieut.-Colonel Sir George Macaulay was President of the Egyptian Railways and Harbours, Major R. B. D. Blakeney was General Manager and Major G. C. M. Hall was Traffic Manager. In East Africa, Major (afterwards Major-General Sir James) J. R. L. Macdonald, Colonel Sir Godfrey Rhodes, Colonel G. A. P. Maxwell and other R.E.

officers had built and operated railways. In Nigeria, Brigadier-General H. O. Mance, Colonel F. D. Hammond and other R.E. officers, N.C.Os. and men, had done much railway construction. Strong detachments of the 8th and 10th Railway Companies, R.E. had been employed in various parts of Africa where they had left their mark on thousands of miles of line. We have already referred to experience in South Africa.

Thus there were sufficient R.E. officers and other ranks available with their knowledge of military organization and of railway work in war and peace, to leaven that great body of railway personnel which was destined to be drawn from the civilian railway systems and organized into military units. We shall meet the names of many of these officers in subsequent chapters dealing with the transportation work carried out in the various theatres of war.

ARRANGEMENTS FOR MOBILIZATION

In December, 1912, the Movements Section of the War Office was reorganized under an Assistant Director, Colonel E. M. Perceval, succeeded later by Colonel Hon. A. R. Stuart-Wortley, with a Staff Captain (Captain H. O. Mance, R.E.) under him for railway work. The purely railway section, Q.M.G.3, was thus reduced from D.A. & Q.M.G. to Staff Captain status, with little realization that in war a Director-General would be required, with a seat on the Army Council and even direct access to the Prime Minister. Captain Mance was assisted by a retired officer-clerk. His duties were defined as: "General railway questions, traffic arrangements with railway companies in peace. Railway questions in connexion with mobilization and war. Study of the use of railways in war and utilization of intelligence regarding railways in all possible theatres of war. Training of officers for railway duties in war. Technical training of railway troops and preparation of training manuals on railway duties. Supply of railway stores. Issue of headquarter warrants."

A scheme was prepared to form on mobilization a Railway

Transport Section of six D.A.Ds. Railways and twenty-four R.T.Os. by earmarking officers, who were to receive a minimum of training on manoeuvres. Railway stores were to be provided by a branch of D.F.W's. office. Any organization for railway intelligence was still in abeyance. For the British Expeditionary Force the mobilization scheme provided only one Assistant Director (Colonel A. M. Henniker, R.E.) to supervise the work of the Railway Transport Establishment and of the 8th Railway Company, R.E., which was to be the only construction unit to be sent. The modesty of these arrangements was due to the definite assurance by the French that they would provide all railway services for the B.E.F. (see Introduction). A Staff Captain (Captain Redman, R.E.) was to join Captain Mance as his assistant on mobilization.

With regard to plans for the movement of the B.E.F. to France, it was not until 1911 that it was permissible to take the management of the British railway companies into the confidence of the War Office for the necessary preparation of this extremely secret scheme, but by the end of 1912 co-operation had been organized as is explained below.

A *Railway Executive Committee* consisting of nine General Managers (subsequently increased to twelve) was appointed in November, 1912, as a consultative body with a view to its undertaking executive functions and co-ordinating the working of the railways in war. The President of the Board of Trade was titular chairman, but the work was done by the acting chairman (Sir Herbert Walker, General Manager of the L.S.W. Railway) from April, 1914, till the end of the war.

It was decided that in the event of general mobilization all essential railways would be taken over by the government under Section 16, Regulation of Forces Act, 1871.

A Communications Board was formed under the presidency of the Quartermaster-General, consisting of the members of the Railway Executive Committee and senior representatives of interested Government Departments. The military secretary of the Board was Captain H. O. Mance, R.E., and the railway secretary was Mr. Gilbert Szlumper, later General Manager of the Southern Railway.

The railway programme for the movement of the Expeditionary Force was arranged by the War Office directly with the London and South Western Railway, which acted as "Secretary Railway," and also co-ordinated the main programme with the command programmes where necessary. The officials of this railway actually in charge of the work were the only people outside the War Office entrusted with the complete scheme for the mobilization movements.

Captain Mance at the War Office kept in close and continuous touch with these officials, and where necessary with the officials dealing with Command H.Qs. Periodical conferences were held at the War Office at which the mobilization programmes were reviewed and difficulties and suggested improvements discussed. Among the secret plans were those for the rapid construction of additional sidings and other facilities that would be required on mobilization.

At the same time the complicated arrangements for the shipment of the Expeditionary Force across the Channel were being worked out between the Movements Section of the War Office and the Admiralty.

On the bringing into force of the mobilization programmes the whole of the energies of the Movements Section, under Colonel Hon. R. Stuart Wortley, were concentrated on carrying them out. The moves by rail and ship took place without a hitch, and were followed by those for the concentration of the Home Defence Forces. These were arranged between the War Office and the Railway Executive Committee, and completed as planned in spite of the difficulty of bringing back Territorial units from their numerous and scattered summer training camps.

RAISING AND TRAINING OF NEW UNITS

As it was felt from the outset that sooner or later the Expeditionary Force would be called upon to provide its own railway services, Colonel Twiss (late R.E.), who had been earmarked as Director of Railways for the Expeditionary Force but not sent out (for reasons stated in the Introduction),

was instructed immediately on the outbreak of war to reopen negotiations with the British railways for raising four railway companies; Colonel Waghorn (late R.E.), who had been earmarked as Deputy Director of Railways, was instructed to organize an intensive study of the possible requirements for repairing the railways up to and across the Rhine and to make preliminary arrangements for acquiring the necessary stores and plant.

At this time the A.A.G., R.E. at the War Office was overwhelmed with the expansion of other R.E. units, and as it was thought that any additional railway units could be obtained through the agency of British railways, it was arranged that railway personnel should be dealt with by the Railway Section of the Movements Directorate—an arrangement which continued throughout the war. The old files at the War Office containing Brigadier-General Lawson's discussions with the railway companies were consulted and some of his detailed war establishments were used. Thus began the large expansion in the number of R.E. transportation troops for operations overseas, numbering eventually more than 100,000. At the end of this chapter the reader will find tables showing the large number and the varied types of the units actually raised.

The peace-time R.E. railway training centre at Longmoor was found to be invaluable as a war depot for transportation units. On the departure of Colonel Twiss to France as Director of Railways in October, 1914, Colonel H. M. Sinclair became Commandant. The depot grew rapidly soon filling the whole of Longmoor and then of Borden and two battalion lines at Aldershot. By 1917 the strength had reached 10,000. Units were raised and trained for railways, light-railways, roads and I.W.T., but inland waterway training was later transferred to Richborough. From the outbreak of the war until the end of November, 1918, nearly 1,700 officers and 66,000 other ranks were sent overseas, including thirty officers and 3,000 other ranks from Canadian, Australian and South African units.

ASSISTANCE RENDERED BY THE BRITISH RAILWAYS

On the outbreak of war 130 out of the 176 railway companies of Great Britain were taken over by the Government under the *Regulation of Forces Act, 1871* (railways in Ireland were included later), and their control was handed over to the Railway Executive Committee. It was not intended to supersede in any way the existing management of the railways, but that the State should be thus empowered to make the many separate railways co-operate as parts of a single system.

It was soon found that the British railways were able to assist in more ways than by the movement of troops and stores, and the provision of personnel for military railway units. Through various subcommittees, the railway organization was used for the supply of many types of tools and small stores, and for the manufacture of war material such as stretchers, general-service wagons, fuses and shells. They built nearly a hundred ambulance trains for British and American forces. Much railway work was required at the ports to meet increased military requirements, numerous depots were provided with railway connexions and internal rail communications, and special connexions and marshalling yards were constructed to handle the extra traffic.

Valuable service was performed by members of the Engineer and Railway Staff Corps in different capacities. This was a unit created in 1865, formed of distinguished senior members of the railway and engineering professions. It was intended that they should be consulted from time to time by the War Office. In practice during peace they were usually consulted in their individual capacities as members of civilian railway companies, which, as we have seen, were in close touch with the War Office. Non-railway members were consulted from time to time on their own speciality.

Among special missions were those carried out by Mr. (later Sir Guy) Calthrop (General Manager of the London and North Western Railway) to Italy, Sir Francis Dent (General Manager of the South Eastern Railway) to Salonika, Colonel Stewart (Commanding Canadian Railway Troops) to Egypt and

Palestine, and Major-General Freeland (late R.E.) to Mesopotamia. In March, 1917, Brigadier-General R. de Candolle (formerly General Manager of the Buenos Aires and Great Southern Railway) was sent to Roumania in view of the great difficulties confronting the Roumanian railways owing to the military situation.

RAILWAY MATERIAL AND STORES

At first all purchases of railway material and stores were effected through the Inspector of Iron Structures (Lieut.-Colonel R. Oakes), under the D.F.W., but by the end of 1915 it was found that railway requirements covered such a wide field outside the needs of the engineer services that it was agreed that the Railway Section of the Movements Directorate should be responsible for future provision. Acting on the principle of using existing organizations as far as possible, the services of Messrs. Rendel, Palmer and Tritton were engaged at a nominal fee over and above out-of-pocket expenses, for all design and inspection work required in connexion with railway and light railway requirements except those articles provided through the Stores Sub-committee of the Railway Executive Committee. By 1916 the formation of a Ministry of Munitions and the priority given to shells made it increasingly difficult for the War Office to obtain rails and other supplies for railway services, at a time when a vast increase in transport requirements was impending. From the end of 1916, under arrangements made by Sir Eric Geddes, most purchases other than through the British railways, were effected through the Ministry of Munitions, a special railway section of which was housed in the office of the Director of Railways, Light Railways and Roads, situated in temporary buildings on the Victoria Embankment. Messrs. Rendel, Palmer and Tritton continued to act as consulting engineers.

INLAND WATER TRANSPORT AND DOCKS

In view of the extensive canal system in France, it was found desirable, before the end of 1914, to organize barge

services for the requirements of the British army. An Inland Waterways Section, staffed by temporary R.E. officers, was therefore included in the Railway Section of the War Office, and charged with the purchase of barges and the stores necessary for their upkeep and with the recruiting of the first inland water transport units. A base for this purpose was established at Dover and a temporary store depot at Ashford. The personnel was at first trained at Longmoor.

All technical questions in connexion with docks in France were left in the hands of the French, until growing British requirements demanded better regulation of the ports and the provision of additional facilities. This need led to the creation of a Royal Engineer Docks Organization which was associated with the Inland Water Transport Section.

In the spring of 1916, owing to the growing diversity of transport requirements, the Railway Section at the War Office, which had become an Assistant Directorate on 23rd April, 1915, was subdivided into two separate Assistant Directorates for Railways and Inland Waterways. An Inland Waterways Stores and Personnel Depot was set up at Richborough, expanding greatly later to include the cross-Channel barge and ferry services.

THE GREAT REORGANIZATION IN 1916

In August, 1916, Sir Eric Geddes was sent out to France to study the transport situation in the B.E.F. which, as explained in a later chapter, had completely overtaxed the French Railway system. The Assistant Director of Railway Transport from the War Office (Brigadier-General H. O. Mance) and a senior R.E. officer from France (Brigadier-General H. F. Freeland) were attached to his staff for this purpose. On his return in September, Sir Eric Geddes was appointed Director-General of Transportation in France and Director-General of Military Railways at the War Office. These posts were separated in April, 1917, when Sir Guy Granet (General Manager of the Midland Railway and member of the Railway Executive Committee), became Director General of Movements

and Railways, with a seat on the Army Council. He was succeeded in March, 1918, by Sir Sam Fay (General Manager of the Great Central Railway and Member of the Railway Executive Committee). The Railway Section was expanded into a Directorate of Railways, Light Railways and Roads under Brigadier-General Manoe, and was organized in three Sections: Policy and Intelligence (Lieut.-Colonel E. Woodhouse), Stores (Colonel H. A. Micklem) and Personnel (Lieut.-Colonel R. H. Cunningham). The Inland Water Section was expanded into a Directorate of Inland Waterways and Docks under Brigadier-General A. S. Collard (formerly employed on the construction of the Bano-Mano Railway, Nigeria), and subsequently under Brigadier-General A. S. Cooper (formerly General Manager, Nigerian Railways). This was organized into numerous sections dealing with the diverse activities of this directorate. In January, 1917, the Movements Directorate, under Sir Sam Fay and later Brigadier-General Delano Osborne, was also placed under the D.G.M.R. The Railway Section of the Movements Directorate (Colonel A. S. Redman) dealt with all home movements, including co-ordination of government requirements for railway transport where they were likely to clash with each other or with civilian needs. A sub-section dealt with the numerous military camp railways. The D.G.M.R. had a most effective civilian statistical service and a link in Paris with the French authorities, under Major-General Thornton (General Manager of the Great Eastern Railway and Member of the Railway Executive Committee). This organization continued until the end of the War.

RICHBOROUGH CROSS-CHANNEL SERVICE

In view of the congestion at the original Barge Depot at Dover and also at Longwood Camp, it was decided in January, 1916, to develop Richborough as a depot and base for inland water transport. At this time Richborough consisted of a short length of quay suitable for barges, and one dwelling house.

By 1918, it had become a large and well equipped seaport, of 2,000 acres, complete with all services and capable of handling

30,000 tons of traffic per week. Building yards and workshops were constructed to increase the supply of barges and other small vessels needed in all theatres of war. The River Stour was diverted by cutting a new channel to render possible the construction of 2,300 ft. of new wharf for the cross-Channel barge service, in which, at the end of the war, 242 barges were employed, including ten of 1,000-ton capacity. On 10th February, 1918, a cross-Channel ferry service, approved early in 1917, was brought into operation between Richborough and Calais with a supplementary service from Southampton to Dieppe. These ferries were invaluable for the transport of locomotives, rolling stock, heavy guns and tanks. In all, some sixty miles of broad gauge railway were laid at Richborough.

CHERBOURG—TARANTO ROUTE

Owing to the heavy losses of shipping through submarine activity, it was decided early in 1917 to organize under the War Office an overland line of communication from Cherbourg to Taranto, some 1,460 miles, thereby considerably reducing the sea journey for personnel and supplies to the near east theatres. For this purpose a terminal depot with rest camp was constructed near Cherbourg; intermediate rest camps were established at St. Germain and Faenza, with other facilities en route; and a completely new lighter port with rest camp accommodating 15,000 men, together with a hospital of 250 beds, was constructed at Taranto under the supervision of Lieut.-Colonel C. Morgan (later Sir Charles) of the Engineer and Railway Staff Corps, Chief Engineer of the London, Brighton and South Coast Railway. The very difficult task of organizing and co-ordinating this work in record time was carried out by Major-General W. H. Grey, G.O.C. Mediterranean L. of C., previously head of a large commercial firm in West Africa, and later Director of Inland Water Transport in Mesopotamia where he had done wonders in reorganizing and increasing the river transport. He subsequently organized the lines of communication of the British Forces sent to assist

the Italians after their reverse in 1917. Up to February, 1919, 386,000 passengers and 184,000 tons of goods had been conveyed by the Cherbourg-Taranto route, which was also heavily used for demobilization.

TRANSPORTATION UNITS, 11TH NOVEMBER, 1918

United Kingdom

Longmoor and Bordon	Railways and Roads Training Centre, Railway Construction Troops Depot, Railway Operating Troops Depot, Instructional Military Railway.
Buxton	Road and Quarry Troops Depot.
Richborough	I.W.T. Depot, Workshop and Shipyard Companies, Nos. 11 to 17, 19 to 27, 37 to 40 and 43 to 48, Construction Companies, Nos. 96, 97, 117, 118, 132, 136, 141 and 142, Marine Companies, H.Q. and Nos. 70 to 75, Traffic Companies, H.Q. and Nos. 36 to 61, Train Ferry Companies, H.Q. and Nos. 85 and 86, Stores Companies, H.Q. and 90 and 91, Accounts Company, No. 95, Tugmasters.
Southampton	I.W.T. Headquarter Depot, Construction Company, No. 99, Train Ferry Companies, Nos. 62 (shore) and 88.
Poplar	I.W.T. Headquarter Depot, Craft Repair Company, No. 77.
Glasgow	Mesopotamia I.W.T. Reserve Unit, Marine Company, No. 44 (Scottish Canal).
Other stations	I.W.T. Construction Companies, Nos. 98, 100 to 103, 105, 106 to 109, 119, 120 and 122.
Purfleet	Transportation Stores Company.

Western Front

Railway Construction Companies	Nos. 8, 10, 109 to 114, 118 to 120, 259 to 264, 268, 271, 275, 277 to 282, 295 to 298, 3rd R. Anglesey and 2nd and 3rd R. Monmouth.
Broad Gauge Operating Companies	Nos. 1 to 7, 9, 11 to 15, 20 to 31, 34, 40 to 53, 64 and 65.
Signal and Interlocking Company	No. 200.
Broad Gauge Workshop Companies	61 to 63 and 78 to 80.
Broad Gauge Miscellaneous Trades Companies	37 to 39, 82 and 83.
Wagon Erecting Companies	Nos. 16 to 18, 66, 67 and 70.
Steam Boiler Repair Company	One.
Electrical Sections	Nos. 1, 2 and 3.
Railway Traffic Sections	Nos. 1 to 13 and two on Mediterranean L. of C.
A.D.L.R. Headquarter Sections	Nos. 1 to 5.
L.R. Operating Companies	Nos. 1, 2, 4, 6, 10, 11 and 29 to 34.
L.R. Train Crew Companies	Nos. 18 to 22.
L.R. Foreway Companies	Nos. 231, 232 and 234 to 240.
L.R. Misc. Trade Companies	Nos. 23 and 24.
L.R. Workshop Companies	Nos. 25 and 26.
L.R. Tractor Repair Company	No. 28.
Road Construction Companies	Nos. 301 to 319, 330 to 347 and 349.
Quarry Companies	Nos. 198, 199, 320 to 329 and 348.
Quarry Maintenance Section	No. 1.
Transportation Stores Companies	Nos. 1 to 13.
L.W.T. Headquarter Sections	Nos. 1 to 16 and 24 to 27.

Docks Headquarters	Nos. 1 (Boulogne), 2 (Havre), 4 (Calais), 5 (Dunkirk), 6 (Dieppe) and one at Cherbourg.
Port Construction Companies	Headquarters (G.H.Q.), Nos. 1 (Lery), 2 (Quévilly-Rouen), 3 (Oissel-Rouen), 4 (Rang-de-Fliers), 5 (Les Forts-Bergues), 6 (Dunkirk), 7 (Ostend), 8 (Boulogne) and 11 (Havre).

Egypt

Railway Construction Companies	Nos. 115, 116, 265, 266 and 272.
Railway Survey and Reconnaissance Sections	No. 106.
Broad Gauge Operating Companies	Nos. 71 to 77, 94, 95, 99 to 105, 201 and 202.
Railway Traffic Sections	Five Sections.
L.R. Operating Companies	Nos. 96 and 203.
L.R. Train Crew Companies	No. 98.

Salonika

Base Depot	
Railway Construction Companies	Nos. 117, 267 and 273.
Railway Survey and Reconnaissance Sections	No. 108.
Broad Gauge Operating Companies	Nos. 19, 32 and 204.
Railway Traffic Sections	No. 1.
L.R. Operating Companies	Nos. 33 and 107.
Transportation Stores Park	
Railway Labour Company	No. 270.

Italy

Railway Traffic Sections	Three.
Wagon Erecting Company	One section.
L.R. Operating Company	No. 109 (one platoon).
Transportation Stores Section	One.

East Africa

I.W.T. Detachments	Port Amelia, Mozambique, Lindi, Dar-es-Salaam and Kilindini.
--------------------	--

Mesopotamia

I.W.T. Headquarters at Basra, with the headquarters of the following departments: Construction, Marine Engineering, Dockyards and Shipbuilding, Vessels, Native Craft, Conservancy and Reclamation, Barge Depot, Coal Depot, Buoyage and Pilotage, I.W.T. Stores and I.W.T. Accounts.

Camps at Ma'qil, Khorra Creek and Abadan (Tanuma).

Detachments at about sixty-four places in the Baghdad Section, Narrow Section, Persian L. of C. and Upper, Middle and Lower Euphrates.

Russia

I.W.T. Detachment at Murmansk.

CHAPTER VII

TRAINING AT HOME

Chatham in the early days of the war—R.E. Training Depot, Aldershot, in the early days—New Training Centres at Newark and Deganwy—The formation and training of a New-Army field company—Some remarks on pre-war training.

CHATHAM IN THE EARLY DAYS OF THE WAR

ON 4th August, 1914, Major-General R. Maxwell (late R.E. and afterwards Lieut.-General Sir Ronald, K.C.B., K.C.M.G.) was G.O.C., Eastern Defences with his Headquarters at Chatham. He went to the War Office at once to be Deputy C.I.G.S. and soon crossed to France.* He was succeeded at Chatham by Major-General H. Mullaly who remained till the end of the war.

Brigadier-General J. E. Capper (afterwards Lieut.-General Sir John, K.C.B., K.C.V.O.) was Commandant S.M.E. and Commander of the R.E. Depot. He left in 1914 to proceed to France.†

On 5th October, 1914, Brigadier-General F. Rainsford-Hannay took up the appointment at Chatham vacated by Brigadier-General Capper and remained to the end of the war. Other appointments at Chatham and their occupants on 4th August, 1914, were:—

Brigade Major—Major H. W. Weekes; O.C. Training Battalion R.E.—Lieut.-Colonel T. A. H. Bigge until August, 1915, when he went to France and later became A.G. 7 at the War Office. He was succeeded by Lieut.-Colonel T. H.

* As Inspector-General of Communications in France, 1914. He was later Quartermaster-General in France, 1915-17.

† As Deputy Inspector-General L. of C., 1914; later he was Chief Engineer, Third Army, 1915; G.O.C. 24th Division, 1915-17; and Director-General of the Tank Corps, 1917.

Cochrane; O.C. Depot Battalion R.E.—Major, later Lieut.-Colonel, R. H. Macdonald. The officer in charge of R.E. Records was Colonel B. R. Ward; Captain H. G. Lyons (later Colonel Sir Henry, Kt., D.Sc., F.R.S.) was recalled from the Reserve of Officers and took charge of a very busy recruiting office. His distinguished service in many spheres is recorded elsewhere.

Mobilization of the R.E. of the Regular Army proceeded with clockwork precision and absence of fuss as in all other arms of the service, thanks to the well-prepared mobilization schemes and arrangements. As soon as Lord Kitchener's call for recruits for the New Army had been issued, however, things began to hum, and the great improvisation began at Chatham as at every military station.

The peace-time intake of recruits had been about four per day. This rose at once to a hundred and then by leaps and bounds to a peak of 800. The "catch" of a single night stretched from end to end of St. Mary's Barracks in a solid mass. The provisional companies could not cope with them, nor could the barracks accommodate them, so they were planted out in billets all over Gillingham and Old Brompton. For this purpose they were organized in billeting companies, each sometimes numbering up to 1,200. N.C.Os. were, of course, very scarce, so sappers and bandsmen were made into acting N.C.Os., each in charge of a hundred men, to be their drill instructor, sergeant-major, friend and marker. The men were kept occupied by drilling but they had arrived without great-coats and in their old clothes. It was not long before hundreds could be seen sitting on "The Lines" unable to march because their toes were poking out of their boots. Plates, cups, knives, forks and particularly razors were not to be had, so Major H. Biddulph became a commercial traveller buying up all he could in the Midlands. The Brigade major signed bills for clothing alone up to £60,000 which were passed without a query.

A special branch of the R.E. Records Office was formed under Colonel Sim to deal with attestations, but could not keep up with the work. Large numbers joined who should have

gone to Caterham and *vice versa*. Trade tests could not, of course, be carried out and had to be dispensed with. There was no such charge as "Absent without Leave" because anyone who wanted to could disappear for a time without being discovered. Food never failed. Billeting saved trouble over this and helped with the plate shortage, but the payment of the men and for their billets was a heavy task. All the young officers under instruction at Chatham, not already drafted away, were appointed as company subalterns.

The situation would have been hopeless if it had not been for the wonderful spirit of the men, who never grumbled, and the fact that the weather was perfect. On one occasion at 5 p.m. the Brigade Major came upon about a hundred men sitting on the curb near the Memorial Arch and, on his inquiring what they were doing, a six-foot smart public schoolboy jumped up, stood at attention and said: "We're waiting for *breakfast*, Sir, but it's quite all right!" The number of splendid and well-qualified men who came voluntarily from abroad was very striking and most of them had to pass through the ranks.

The Records Officer sorted the men, formed them into companies almost daily and sent them off to various stations to relieve the congestion at Chatham. Each company consisted of 200 men, one officer, one acting C.S.M., one acting Pay N.C.O. and one bugler. The various rapid changes in organization and administration were published in "Circulars." The number of men at Chatham rose to 17,000, and after the first confusion was over and some order and training had been established, a parade of six R.E. battalions, numbering 10,000, was held on The Great Lines. *The Sapper* published a photograph of this historic occasion.

The way that order, organization and training were established can perhaps best be explained by giving a description of the work of the Training Battalion, R.E., which was renamed the 1st Reserve Battalion, R.E. Four other almost similar battalions were formed from time to time as the war went on.

The battalion was organized in war, as in peace, into a headquarters and six companies. Most of the six companies were commanded by officers of the Royal Anglesey or Royal

Monmouthshire R.E., Special Reserve, who remained in their appointments for nearly the whole of the war. There was thus a considerable continuity in command, which was very valuable.

The functions of the battalion were to receive young regular R.E. officers on first commission from the R.M.A., Woolwich, temporary officers on first commission or on transfer from other arms and, later, cadets on probation for temporary commission, and recruits on enlistment. All these had to be trained in drill, field engineering and musketry, and dispatched, as required, overseas or elsewhere.

The company commanders were so fully occupied with the administration of the large numbers of men with whom they had to deal, that they were relieved of nearly all responsibility for training. This was undertaken by the H.Q. staff of the battalion, assisted by the very able regular N.C.Os. who had performed this duty before the outbreak of war. To these N.C.Os. (and to those who resisted the considerable pressure from them and from others to send them overseas) is due any credit there may be for the high and uniform standard of training of those officers and men who passed through.

Young regular R.E. officers arrived from the R.M.A. every three months in batches of about thirty and ordinarily underwent about five months' training. Of this, three months were devoted to drill, musketry and field engineering and the remainder to other subjects. Officers with temporary commissions and, later, cadets on probation arrived in batches of about the same number at irregular intervals. They received the same training as the regular officers for three months and were then considered ready for drafting. There were thus always from 100 to 150 officers being administered and trained. Outside messes had to be hired, but all officers spent part of their time in the headquarter mess.

Recruits arrived weekly in parties of 100 to 110. Each party on arrival was posted to a company for administration and divided into four sections for training. This consisted of five weeks drill on the square, one week of musketry at Shornmead Fort and six weeks of field engineering. Selected men received further training in special subjects, but were

transferred elsewhere for the purpose. The number of recruits in the battalion at any one time was usually between 2,500 and 3,500.

Accommodation was provided in Brompton and St. Mary's Barracks, in billets and under canvas. The floor space allotted per man in barracks was reduced from the 60 sq. ft. of peacetime to 40 sq. ft., and all accommodation including that in the basements was fully used. An outbreak of spotted fever which occurred in 1916 showed that the wisdom of thus crowding the men was perhaps questionable.

The organization under which responsibility for training was allotted to a cadre of experienced regular N.C.Os. under the battalion staff or the Chief Instructor in Field Works was, in the circumstances, probably the best that could be adopted. Time was very short and it was essential that a definite standard should unfailingly be reached in that time, both by officers and men. The company commanders were not young men, nor had they received a regular training; they were, moreover, fully occupied with the administration of their very large companies. Even if they had had the experience, they certainly had not the time to undertake much training. As time went on it was found possible to accede to the requests of some of the instructors to be sent overseas and to replace them with war-enlisted men who showed special aptitude, but it was never possible to spare the old militia officers who commanded and administered the companies. They loyally remained at their dull and laborious duty throughout the war.

A small mounted section containing about thirty horses was maintained to give elementary instruction in riding and horsemanship to regular and temporary officers. It was commanded by a prominent member of the local hunt, commissioned temporarily into the R.E. This section performed a very valuable service, and the instruction given in it was all that many officers received in this branch of training—so important in those days.

R.E. TRAINING DEPOT, ALDERSHOT IN THE EARLY DAYS

The R.E. Training Depot at Aldershot was an establishment for training "Drivers (horse) R.E.," who enlisted for twelve years, of which two were with the colours and ten in the reserve. In peace they went through a course of about fourteen weeks, in which they were trained in foot-drill, riding and driving, and were then posted to units. The Aldershot Depot also taught certain recruit sappers to ride after they had completed their training at Chatham in drill and field works. The peace strength of the Depot in August, 1914, was three officers and about 400 other ranks. Reservists began to arrive on the first day of mobilization, and the frequently practised mobilization scheme worked smoothly and with complete success. By 10th August the numbers had increased to 1,800 as there was a surplus of unallotted reservist drivers and of unfit men returned from units. The posting of N.C.Os. from the depot to units caused a shortage in the depot, intensified by the swollen numbers to be handled. The accommodation in barrack rooms was doubled by placing mattresses on the floors between beds, and tents were pitched on the grass plots. The dining-rooms were also used for sleeping and meals were served in barrack rooms, the men using the service canteen, knife and fork, in their personal kit.

Reservists were clothed and then dispatched to their units where they received their arms and equipment. The regimental tailor had an arduous time, since the sizes of men's clothes, recorded when they had left the colours, did not conform to the altered figures now returning after an interval of sometimes many years. The weekly paying of 1,800 men required special organization and occupied six or seven hours.

After the orderly mobilization and departure of the field units, improvisation began. Recruits for the regular army began to arrive to be trained at the depot, and at the same time the flood of recruits for the New Army passed through, before being posted to the new units which now began to form at Aldershot to take over responsibility for their training.

Large numbers of horses came in from the remount depots, and picket lines had to be laid down on every open space. Only the actual cricket pitch was spared for use when the war was over. The Officers' Mess carried on as usual under the imperturbable and skilful Mr. Trodd, so well known to two generations of R.E. officers during his fifty years as mess butler. Subaltern officers slept two or three in a room and field officers gave up one of their two rooms. Officers' married quarters were evacuated and used for temporary officers' messes. Classes of instruction for young officers in riding, driving and horse mastership were started.

The numbers in the depot fluctuated considerably from day to day, owing to constant orders to send off drafts. Moves were usually ordered by telephone or telegram direct from the War Office, and generally the draft had to be at Southampton the same evening. Clerical and administrative work was very heavy. The Army Ordnance Department was now struggling with demands from an army in the process of expansion to a size many times greater than anything ever contemplated, so that the work of equipping drafts was a matter of considerable difficulty.

The peace-time staff of warrant officers and N.C.Os. was invaluable and accomplished wonders. It was hard to refuse their earnest wish to go to the front, but at Aldershot, as at Chatham, and at the training centres opened at other places, experienced W.Os. and N.C.Os. were essential for training, and it would have been a wrong policy to send this nucleus training staff to the front in the first year of war.

Throughout the difficult period of improvisation all ranks at the R.E. Depot, as elsewhere, whether in the old, new, or Territorial Army, remained keen and cheerful under the most trying conditions.

NEW TRAINING CENTRES AT NEWARK AND DEGANWY

In the spring of 1915 it became obvious that Chatham would be unable to compete with the training of all R.E. officers and other ranks prior to their posting to service units.

A new training centre was, therefore, established at Newark, under Brigadier-General A. L. Schreiber, temporarily recalled from France, with Colonel Jerome as his Assistant Commandant, to whom he handed over after a few months and returned as Chief Engineer of a Corps. Captain R. L. Bond was temporarily recalled from France to be Adjutant. Offices were established in the Militia Barracks, and all ranks were billeted in houses, schools, breweries and other buildings, until huts were built in 1916.

The organization and system of training for temporary officers and other ranks was much the same as at Chatham. The training was carried out under a Chief Instructor in Field Works (Major Rotherham) by assistant instructors and N.C.Os. There was also a Chief Drill Instructor (Lientenant and Quartermaster Bright) with N.C.O. assistants, and also musketry instructors. Pontoon training was carried out on the Ouse, and, later, training in riding and horsemanship was arranged. Officers wounded overseas and discharged from hospital were available very temporarily as company officers to carry on the very heavy administrative work of the large companies.

By August, 1915, the numbers at Newark were nearly 3,000, but of these about 1,000 were permanently unfit for general service, either because they had been badly wounded or seriously ill, or because they never had been fit. It was some time before medical boards removed these non-effectives.

About September, 1915, Colonel Kenney, having visited Newark to see how the centre was run, proceeded to Deganwy to open another training centre there. This was organized on almost the same system.

THE FORMATION AND TRAINING OF A NEW-ARMY UNIT (82nd Field Company, 19th Division, B.E.F. October, 1914 to July, 1915)

This item of minor history is inserted as a typical example of the experiences of so many who were engaged at this time in raising units for the New Army *ab initio*. The reader will

note that nine months were required before this field company was ready to take its place in battle as part of a trained and organized division.

On the outbreak of war the narrator, at the age of 38, was Staff Officer R.E., Malta, and had had no previous field company or war experience. He had, however, served for four years as adjutant of a Territorial R.E. unit, thus gaining some insight into the method of teaching field works and bridging, and experience in the handling of non-regular soldiers.

The Narrative

I arrived at the S.M.E. on the afternoon of 3rd October, 1914, reported to the Brigade Major (Major H. W. Weekes), and was posted to No. 2 Billeting Company. The Mess was crowded with regular officers (many like myself, from overseas), Special Reserve, Territorial and temporary officers. I could get no accommodation in barracks, nor indeed in Old Brompton, and was found a room in an hotel in Chatham High Street. No. 2 Billeting Company was one of three "super" Depot companies formed for the reception of the mass of recruits arriving for R.E. and signal units. The headquarters of No. 2 were in the Model School, Chatham Lines, and our men were billeted in New Brompton. The company was 1,200 strong, when I joined, and was commanded by Major W. J. O'Meara (R. of O.). The only other officer was 2nd Lieutenant B. C. Denning. We had a regular pay corporal, and three corporal instructors. With this small staff we could do little but see that our men were fed and paid, and keep them employed with squad drill, physical training, and a little elementary field works instruction. Meanwhile the S.M.E. and Depot staff were working overtime in forming field, fortress and signal companies, preparing documents, and dispatching embryo units to their destinations.

The Formation of the Unit.—My new company, the 82nd Field Company, R.E. was in orders on the 16th October, I was furnished with a nominal roll of 200 men and instructed to have them ready to march to the station *en route* for Bulford Camp, at 9 a.m. on the 18th. The men were warned on the

afternoon parade of No. 2 Billeting Company, next day, and then sent to their billets to pack. No uniform or equipment of any sort had been issued, so that the men had only to put together their small possessions, which were collected by lorry and taken direct to the station. Two soldier-like men in civilian clothes were handed over to me on the marching-off parade—both of them time-expired, R.E. N.C.Os.—one, ex-Sergeant Deyermund, to be my C.S.M., and the other, ex-Sergeant Johnson, to be my C.Q.M.S. Both proved to be of pure gold, and both ended up with D.S.Ms. and commissions. On our departure, I was the only officer and was the only individual in uniform, but I marched off proudly at the head of this gallant, ill-clad, almost ragged, ten score of young men who were to become, in due course and after many tribulations, a field company R.E. trained and equipped for war. I only knew one of them, an ex-sapper called Collins, who had been cook's mate in the 21st Company with me a few years before, and had volunteered to come with me. I accepted him and made him company cook—my first appointment and, as it turned out, a very lucky one.

Move to Bulford.—The steadiness and good behaviour of this oddly assorted 200 men on the journey from Chatham to Bulford was remarkable. There was no difficulty in lining them up along the platform, and there was no noise or confusion when they entrained. I was a little anxious, on arrival at Waterloo Junction, when I was told that we had to change into a train at the main terminus. As I saw no possibility of marching the men across the footbridge and through that long narrow passage connecting the two stations, I asked my C.S.M.'s advice. He said "Tell them to follow you, and then march straight ahead." I did so, and the men followed and entrained without any further advice or instructions. On arrival at Bulford we found that we were to be accommodated in tents, but we were allotted two barrack huts as dining rooms, and I was given half a hut as my company office. The tents were already pitched, for which I was very thankful. My C.Q.M.S. was invaluable. He knew his job from the start, and had a wonderful way of getting hold of any stores or

equipment available. It was not long before rations were drawn and the first dinner cooked by Collins and two volunteer cook's mates. That same afternoon the C.Q.M.S. and myself borrowed two mounts from a signal unit, and rode over to the Ordnance Depot at Tidworth to find out the situation regarding uniform and equipment. We were disappointed to discover that no uniform whatever was available, but we got fifty rifles and belts and some small kit in the way of clasp-knives, cutlery and cleaning gear. That was all.

Early training days.—As a start, I had all the men on parade, and asked anyone to fall out who had had any previous military training. Two responded—both smartish ex-R.E. Territorials. I then asked for any man who had been a foreman in civil life. About four stood out. I picked the likeliest looking pair and made them and the two Territorials acting lance-corporals. The next step was to organize the unit into sections, allotting to each so many tradesmen and making up with pioneers. Nearly all the men came from the North Country, and were either miners or in the heavy industries (I lost all the former on the formation of the mining companies). We had very few carpenters or bricklayers, which was a little unfortunate. Many of the pioneers had no trades at all, but had joined "t'Engineers" to be with their pals from the shops. The drivers were all put in a mounted section for training purposes, and their instruction in the very early stages was carried out by the C.Q.M.S. who had been a mounted sergeant in a field company and was well up to the job. At an early opportunity I paraded all the men in a hut and gave them a talk on the organization and duties of a field company, and an outline of the training they would be going through to fit them for their special work in the field. Incidentally I found these talks very helpful and valuable, and in the first weeks I set apart half an hour of each day for a talk to the company on training, the progress of the war and any matters requiring explanation or elucidation. Until we got some uniform and boots, especially the latter, it was difficult to do much outdoor drill or field work. We started with physical training, squad-drill and elementary indoor instruction in knots and lashings. For this

we had plenty of rope and spars, and enough barrels and superstructure to make a barrel-pier. We had to go easy with the physical drill, as the pathetically thin working clothes of the men wouldn't stand the strain, and the sight of safety pins holding together ripped garments was all too common. The spirit of the men was splendid, and even the many small hardships and inconveniences of the early days never affected their keenness. Football was started, and one of our huts was converted into a reading and recreation room. We soon had our first sing-song. Luckily I was soon given an imprest account, and I was able to draw on this for an adequate supply of crockery. The rations from the first were adequate and good, and Collins with his two assistants turned out excellent meals three times daily. This kept people happy.

At the start we were rather hampered by want of transport, but my C.Q.M.S. always seemed to be able to borrow a mount for a daily visit to the Ordnance, and he managed somehow to get a G.S. wagon to fetch stores as they became available. There was at this time no chance of giving any proper instruction in riding or mounted duties to the drivers, so they were trained in field-works with the sections. As my only qualified instructors were the C.S.M. and C.Q.M.S. and the latter had to spend a lot of time at Ordnance, the drill was taken by the C.S.M. (who did it very well), and the field-works by myself. We were assisted later by a very useful old soldier, Corporal Scholes, ex-R.E., who had been a Field Works Instructor, and was loaned to us by the S.M.E.

Arrival of Subaltern Officers.—Luckily the situation was much improved by the arrival of two subalterns, who had just completed a short course at the S.M.E. They were two keen young temporary officers, who had had one or two years' experience with engineering firms—S. N. Barron and H. C. Bates. They knew their drill and were well qualified to give preliminary instruction. Barron, who was a structural engineer, undertook the training in field-works and the use of the pick and shovel, while Bates, who had been building bridges for the Midland Railway, took over instruction in bridging, light railways and demolitions. As regards equipment we were able

to draw fifty picks and shovels and some cutting tools in addition to the bridging stores already referred to.

Early Organization.—On the arrival of the first two subalterns I was able to develop further the section organization. Barron was posted to No. 1 Section, and Bates to No. 2. By this time, too, it was possible to estimate the qualifications of the four acting lance-corporals for permanent rank. I promoted the two best to sergeant, and the other two to corporal and 2nd-corporal respectively. Four more sappers were promoted lance-corporals with a view to further advancement at an early date. At the same time I put a bank-clerk from the Midland Bank in the company office with the rank of corporal, and his brother, on the recommendation of the C.Q.M.S., was promoted 2nd-corporal (mounted). Both of these brothers did exceedingly well. We had enough N.C.Os. now for company duties. An orderly corporal was instituted and a guard mounted by day and night. The Company began to take shape.

A month later two more subalterns arrived for duty—A. F. Hewett and J. Strachan—very young and very keen, having just finished their education at engineering schools. Strachan survived to command the company for the last six months of the war. The posting of these officers to Nos. 3 and 4 Sections completed the company organization, except for the Captain, second-in-command, who did not turn up till some weeks later.

Meanwhile the rest of the 19th Division was being rapidly formed and trained. The 81st Field Company (Major C. A. Elliott) was with us at Bulford, and the 94th (Major F. G. Guggisberg) was in training at Basingstoke. The headquarters of the division and the divisional R.A. were also at Bulford, with the infantry brigades at Tidworth, Blackdown and Winchester. Luckily the 57th Brigade, to which the 82nd Company was affiliated, was at Tidworth, and it was possible to keep in touch with the Brigadier and his staff from the first.

Training of the Company (dismounted).—It was now possible to draw up a programme of training for the unit. My instructions were to have the company ready to take the field in three months' time, i.e., by New Year, 1915. I arranged a

programme accordingly, allotting so many days or hours to each sub-head of technical training, leaving time for tactical and physical training and equitation. A complete copy of this programme was issued to section officers and sergeants, and on every Saturday morning the part of the programme (with any amendments) for the following week was posted on the notice board. Each section was trained under its own officer and N.C.Os. and, to ensure uniformity of instruction, I instituted a lecture for officers and N.C.Os. every evening (except Saturdays and Sundays) after tea, when I explained the work for the next day and the method of carrying it out. We had weekly route marches, usually on Friday, and these were carried out in conjunction with a tactical scheme illustrating the role and work of a field company in attack or defence. In this period, too, we did a lot of night work, such as finding the way by compass bearing, carrying and using tools noiselessly in the dark, tracing out a trench-line, putting up wire etc. The facilities for technical training at Bulford were very good. We had a variety of ground for the tactical siting and digging of defence lines, chalk strata for instruction in mining, and plantations for instruction in clearing the foreground and the making of fascines, bivouac shelters and rough huts.

Training in Mounted Duties.—This was not so easy. It was not until a month had passed that we were able to procure eight horses and saddles for the teaching of riding and horse management. We then began classes in an open-air *ménage*. It was found that few of the men enlisted as drivers had ever sat on a horse before, though several were carters or teamsters. Two of the worst were brought to my notice as never having had any horse experience. They explained to me that they were *engine* drivers. I gave them the option of being remustered, but they preferred to stay with the horses and did quite well. We could not make a start at driving until my C.S.M. solved the difficulty by obtaining a G.S. wagon and harness from an Australian unit going overseas from Larkhill. He told me that it cost him half-a-crown—a cheap buy. I was not so lucky. We found a derelict dog-cart in a ditch at Sling, with a smashed wheel and shaft. It looked ideal for a mess-cart, so I put on

our wheelwright to repair and paint it. He had just finished this most efficiently when the owner then turned up to claim it. Riding instruction progressed rather slowly till the arrival of Captain C. G. Lewis, when a new era started. He was a most able and keen instructor, and the standard of riding, driving and horse management rapidly improved. Soon after his arrival more horses became available and we received one or two technical vehicles. The high standard we eventually attained was a striking testimony to Lewis's work.

Company and Section Rolls.—From the very start I kept a company roll, for my own use, in a handy pocket-book made by Gale & Polden. In this was entered up the name of every officer and man as he arrived, with the address of his next of kin and subsequently his rate of pay, promotions, casualties, transfers, etc. It was very little trouble to keep it up, and I found it of the greatest value during my two years in command of the company.

Arrival of Reserve.—In March the company received a reinforcement of one officer (J. Haw) and fifty other ranks. These were posted to sections to complete the quota of trades as far as possible, and nearly all were in time absorbed into the establishment. When we finally marched off with our "first reinforcement" to be left at the base, there were only ten to leave behind.

Discipline.—From the beginning I realized that there was going to be little crime. The men were all so keen and earnest that they seldom tried to rebel against authority or break the rules. Unpunctuality was never a trouble, and there was no drunkenness or misbehaviour in camp or quarters. Our only real difficulties arose from the periodical week-end leave. All the men were from the North of England, and a week-end from Friday night to Sunday night was largely spent in the train. There were thus nearly always absentees on Monday morning, and at times men did not return till Wednesday. Used as they were to civil life, where if a man stays away he merely forfeits the day's pay, it was difficult to make them realize that this was not the way of the army. Practically all the men, youths as they were, were married, and I have no

doubt that gentle pressure was brought to bear at home to keep them over time at the risk of my displeasure. Inoculation was another stumbling block. It was an innovation, and all the men disliked it, though the majority submitted after a little persuasion. A few steadfastly resisted, and, and it had to be a case of "no inoculation, no going overseas," and in the end all, but three or four, came into line. Later on, of course, the "inoculation clause" became part of the conditions of enlistment.

Issue of Uniform and Equipment.—As already explained, we were somewhat handicapped at the start by want of uniform and boots. We were soon able, however, to get a partial issue of boots for those most in need, and some socks, underwear and flannel shirts. After two months at Bulford we received our first issue of blue uniform. It was rather ugly and of inferior serge. It consisted of a jacket, plain blue trousers and a fatigue cap. We were glad to get it, however, as many of the men were definitely in rags by this time, and it *was* uniform. It was February, 1915, before we began to get service dress, but the unit was completely equipped by the middle of March. By this time, too, we had exchanged our first issue of D.P. rifles, for service rifles with bayonets and web equipment.

As regards technical equipment, we got our first tool-cart and limber, G.S., in December, and we were then able to horse and equip one section complete. This was excellent for instructional purposes, and each section had the use of it in turn. More vehicles and sets of harness arrived early in the year, and by the end of February we had everything except our pontoon wagons and a few items required to fill the tool-carts. On the 22nd March we were able to parade as a complete and fully equipped field company. This was the great day.

Entrenching.—In November we worked, in conjunction with the 81st Field Company, in laying out and excavating a small complete trench system at Shipton Bellinger for the use and instruction of the 57th Infantry Brigade. While we were doing it, we were inspected by Field-Marshal Earl Kitchener, then Secretary of State for War. This exercise was exceedingly

good instruction for both officers and men, as we camped near the site and did a lot of the work at night. Incidentally we got out a very good drill for night-wiring, which we found invaluable in our early days in Flanders when the sappers were being largely used for this work. During this exercise we also got some useful experience in designing and constructing dug-outs, machine-gun emplacements, etc.

Wire-Cutting.—As a sequel to the Shipton Bellinger training, we were told to practise wire-cutting and the destruction of wire entanglements, for the passage of infantry. For this we made and experimented with Bangalore torpedoes, constructed of iron pipe filled with gun-cotton primers. We also practised at night, with wire-cutters and with strong hooks like boat-hooks made of round iron bar. 2nd-Lieutenant Bates designed a grapnel, with a flexible wire cable attached, to be fired from a home-made mortar into the enemy entanglement. The cable was then to be hauled in from the front-line trench. While practising with this near Sling Plantation, the charge of powder was rather overdone, with the result that the grapnel parted from the cable, soared over the plantation like a rocket and landed among some new huts on the other side. Bates went after it, and found a party of workmen eyeing the half-embedded object and discussing the situation.

Trench Mortars.—We had been told to try our hands at improvising trench mortars. Experiments were made with a length of iron water pipe firing a jam-tin that exactly fitted the bore. Here again our keenness to get results led to overloading the gun. During an inspection by the Divisional Commander, a mortar made of 4-in. pipe completely disintegrated, the charge and bomb exploding together inside. Luckily everyone was under cover. We did, however, evolve a 3-in. trench mortar with a jam-tin bomb and time fuse, which we used later with some effect near Festubert. In addition we made several kinds of hand-grenade, such as "stick" and "hair-brush" bombs, and even a rifle grenade. All this experimental work was good instruction in handling explosives even if the results attained were a bit amateurish.

Bridging.—We spent a very useful fortnight during March

on the Thames at Pangbourne, carrying out instruction in pontoon bridging, both light and heavy. There was plenty of equipment, easily sufficient to bridge the river, as well as three or four Weldon trestles. We kept a flying bridge going all the time which was good instruction and useful training for ferry work. The march to and from Bulford, with nights in billets at Marlborough and Newbury, gave us useful practice in march discipline and billeting. By this time we had an efficient fife and drum band, organized by the C.S.M., and a great asset on the march.

There were few facilities for heavy bridging at Bulford, but we had the use of the weir-pool at Amesbury, where we made single- and double-lock bridges lashed and bound with wire, and a pier for barges. This was partly on cribs and partly on piles. Bates designed a girder bridge which he and his section constructed out of hutting material, requisitioned from the contractor. Another bridge, made by Barron, was a suspension foot-bridge constructed of telegraph wire and light planking.

Tactical Training.—Before we got our horses we did weekly route marches, combined with a simple tactical scheme. As soon as we had our full equipment we made a tactical march through Savernake Forest, sleeping in bivouacs, and doing day and night schemes. Subsequently sections were sent out in turns to carry out an engineer night reconnaissance, and the rest of the company would march out next day to complete the exercise, the whole unit returning to camp together. We also had some very instructive days with the 81st Field Company under the C.R.E. (Lieut.-Colonel P. G. Grant). During May we did some combined training with the 57th Brigade and then with the Division, ending with divisional manoeuvres from 24th till 26th May, when we bivouacked and worked as divisional engineers.

Final Touches.—The month of June was spent on section and company training and on recapitulation of technical instruction, which had been somewhat hurried in the early days. During this final month we practised turning out on an alarm by day or night. A subaltern would also be given orders to march with his section to some destination and to carry

out a scheme when he got there. We did this occasionally as a company with captain or a subaltern in command. Casualties were also practised giving section sergeants the command of their sections. A big effort, too, was made in horse management and stable discipline, with a view to getting the horses as fit as possible and under the best possible control of their drivers for the move overseas.

The company paraded at full strength, with the 19th Division for inspection by H.M. The King on 23rd June.

We received orders to mobilize for overseas on the 10th July, and embarked at Southampton on the 18th. If the company that landed in France on the morning of the 19th July was not the best trained of the new field companies, it was certainly one of the keenest and happiest.

SOME REMARKS ON PRE-WAR TRAINING

A conspicuous feature of the Russo-Japanese War of 1903-4 had been the famous siege of Port Arthur which demonstrated the power of the 11-in. howitzer. The close of this war found the opponents in a stalemate situation in trench lines throwing bombs at each other. The war of 1912 between Turkey and the Balkan nations also finished in a stalemate in the Chatalja Lines.

Royal Engineers, therefore, found it difficult to believe the doctrine that the next war would be so mobile that siege or trench conditions would not arise. At all events, the records of the training of engineer units before the war indicate that much attention was being paid to field defences and to the construction and demolition of barbed wire obstacles—particularly the demolition, for which all sorts of expedients were tried, including the Bangalore torpedo copied from Captain McClintock's original experiments with his Sapper and Miner company. His experiments with improvised hand-made bombs also received great attention at home. Experiments with various types of trench shelter, including the use of reinforced concrete, if sometimes rather crude, at least showed a realization that such structures would probably be required. There were many experiments and demonstrations by field

companies of the penetrating power of rifle fire against various materials likely to be available for parapets and for revetment. Though at Chatham after the South African War there had been large-scale siege exercises against the old Chatham fortifications, it is fair to say that instruction and experiment in mining and counter mining was not taken really seriously.

It was realized that motor vehicles were about to increase considerably the loads that would be imposed on military bridges. It was, therefore, a biennial feature of field company training to construct what were known as "heavy bridges," i.e., bridges to carry 3-ton lorries, and many types of these were tried. Special experiments were carried out by field companies in 1912, 1913 and 1914 to find a way of using the standard service pontoon equipment to carry mechanical transport. Captain C. E. P. Sankey produced probably the best solution of the problem, but in 1914 the sound conclusion was reached that our entire pontoon equipment must be scrapped and a stronger type designed. Mobilization thus caught us with this task still undone, thereby imposing severe restrictions on the loads that could be carried by our floating bridges throughout the war, the effects of which will be seen in later chapters. It was not till after the war that the redesign of our pontoon equipment was eventually carried out.

Mention should be made of the valuable training for war which had been received by Royal Engineers of all ranks when carrying out the works services of the army in peace—the construction and maintenance of all types of buildings and their provision with water, electric light and power, drainage, roads etc. This work in an improvised form is the first thing demanded by an army from its engineers in war and the 1914-18 war was no exception.

The construction and maintenance of the fortifications of defended ports at home and overseas gave valuable war training to all ranks. Searchlight personnel trained in these coast defences provided detachments for mobile field searchlights and became the nucleus of the A.A. searchlight units.

In other chapters the reader will find notes on the pre-war training in railways, survey and signals.

**ROYAL ENGINEERS IN OPERATIONS ON THE
WESTERN FRONT, 1914-18**

CHAPTER VIII

ENGINEER-IN-CHIEF AND CHIEF ENGINEERS IN FRANCE

Lack of higher engineer posts in 1914—The Brigadier-General, R.E. at G.H.Q.—Appointment of Chief Engineer, B.E.F.—Appointment of E.-in-C. and C.Es. of armies and corps—Development of duties of E.-in-C. and C.Es.—Final distribution of duties in the E.-in-C's. office—List of Es.-in-C. and C.Es.

LACK OF HIGHER ENGINEER POSTS IN 1914

THE reader is reminded that in the Introduction he will find a general explanation of the reasons why army regulations in 1914 contained no provision for Chief Engineers of armies or of corps in theatres of war.

We find that our *Field Service Regulations, Part I*, (reprint 1914) in Section 5, described the characteristics and functions of divisional R.E. units, bridging trains (pontoons and trestles only) and field companies, but mentioned no other units. In Section 17 we find reference to the duties and functions of signal units which were elaborated in Appendix I. Otherwise there were no references in *F.S.R., Part I*, to engineer organization, duties and functions.

Turning to *F.S.R., Part II* (reprint 1913), we find in Section 23 a definition of the functions of a Director of Army Signals, and also in Section 23 the duties and responsibility of a Director of Works on the Lines of Communication. Section 59 referred to the general organization of the military railway services and the responsibilities of the Director of Railway Transport ; while Appendix I made the M.G.O. responsible for the provision of technical stores of engineer units and of their vehicles. These were the only references in the regulations for army organization, extant in 1914, which concerned the functions of engineers and their organization in an Expeditionary Force.

The regulations of August, 1914, are completely silent about an Engineer-in-Chief and his staff and about Chief Engineers and their organization at headquarters of armies and of corps.

In those days the "Division" loomed in the eyes of the British army as a very large formation. The R.E. certainly did not think of war in terms of armies and corps, any more than did the bulk of the army. We devoted much thought to the functions of a divisional C.R.E., but little to those of a corps or army C.E. and still less to those of an E.-in-C. In fact, there seemed to be little necessity for higher engineer control.

Moreover, the officials referred to in the regulations quoted were provided with totally inadequate establishments to enable them to carry out their duties. Their startling inadequacy can be fully appreciated by comparing them with the War Establishments of November, 1918, and the long list of many types of engineer units then in the field. The reader's attention is directed to the one Brigadier-General, R.E., at G.H.Q. to act as technical adviser, with his two horses and one clerk, and the Director of Railway Transport must have smiled when he found himself provided with a riding horse. It was from these slender War Establishments that an engineer organization in every theatre of war had to be created and expanded as rapidly as possible to cope with the imperative demands of the then biggest war in history.

It is essential that the reader who did not take part in these events should at this point get a clear outline picture of the engineer organization that existed in France at the time of the Armistice and (subject to adaptation) in other theatres of war.

Starting from the front there were the units of the divisions, each with its C.R.E. Divisional areas were grouped into and backed by a corps area with a Chief Engineer on the staff of the Corps Commander, to whom he was responsible for all engineer work in corps and divisional areas. The corps engineer units were each under a C.R.E., Corps Troops, responsible to the C.E. Corps areas were grouped into and backed by army areas, each with a Chief Engineer Army, on the staff of the

Army Commander and responsible to him for all engineer work in the area of the army and its corps. Army engineer units were under a C.R.E., Army Troops. The Signal organization was similar. Behind the areas of the armies was the zone of the Lines of Communication where the engineer work was executed by the Director of Works, whose organization is not dealt with in this article.

The Engineer-in-Chief was technically responsible to the C.-in-C. for all engineer work, not only in army areas but also in the Lines of Communication zone. In this zone he delegated full responsibility to the Director of Works but retained control over the allotment of personnel and engineering resources to all parts of the theatre of war, until, in April, 1918, personnel distribution was transferred to the Adjutant-General. The Director-General of Signals, the Director of Railways (later Director-General of Transportation, i.e., roads, railways and inland water transport), were also at G.H.Q. The number and types of engineer and transportation units created to execute the work are summarized at the ends of Chapters II and VI. This very rough outline of the Engineer-in-Chief's organization and functions will perhaps help the reader to follow the ensuing story of how it grew from such small beginnings into a big organization, so humorously summarized in the Engineer-in-Chief's Christmas card of 1917 (reproduced after p. 174).

THE BRIGADIER-GENERAL, R.E. AT G.H.Q., 1914

After the foregoing introduction to this subject the reader will not be surprised that on the way to France the Artillery Adviser, Major-General Lindsay, remarked to his opposite number—Brigadier-General G. H. Fowke—"I don't suppose that you will have much to do in this war!" It should also be recorded that on arrival (in France) a single motor-car was provided for the use of the two advisers, and that their two clerks were thoughtfully allotted pedal bicycles to increase their mobility!

Actually, during the rapid retreat of the British army from Mons to the Aisne, there was little that General Fowke could

accomplish single-handed, though he undertook reconnaissance of successive defensive positions, and managed by personal exertions to effect the destruction of one or two bridges, notably one at Soissons.

After the move of the B.E.F. in October, 1914, from the Aisne to the section covering the Channel ports, at Fowke's urgent representation Sir John French consented to the attachment of two officers* (Lieut.-Colonel J. E. Edmonds and Major R. N. Harvey) to the E.-in-C. for general duties, including collection of engineer intelligence, liaison with the French and later for work on defensive positions. Shortly afterwards, the first battle of Ypres resulted in the stabilization of the front, with G.H.Q. at St. Omer.† This inaugurated the period of stationary warfare which lasted for nearly four years.

For warfare of this character no provision had been made, either in personnel or equipment. However, Fowke and his two officers were exceptionally well qualified by their experience‡ to deal with the new problems as they arose, and to give authoritative advice regarding field works and siege operations. This was communicated to formations through the General Staff in a series of field-work notes and designs. The improvisation of hand grenades, trench mortars, periscopes, hyperscopic fittings for rifles and other material was taken in hand and an experimental section was formed, in charge of an officer

* The staff of the E. in C., exclusive of attached officers, numbered :-

In August, 1915, 5 officers.

In August, 1916, 9 officers.

In August, 1917, 14 officers.

In August, 1918, 25 officers.

The subordinate staff increased to about sixty clerks and draftsmen.

† Here Generals Lindsay and Fowke (known to the General Staff at G.H.Q. as "The Bing Boys") and their assistants were allotted one room as an office; the assistants shared one table.

‡ Both Fowke and Harvey had been Instructors in Field Works at the S.M.E. Fowke had been a member of the British Military Mission in the Russo-Japanese War of 1905-6. Edmonds had for many years served on the Staff, and in the Intelligence branch of the War Office.

(Lieutenant Adams, 2nd Bridging Train, R.E.) expert in mechanics, for the design, testing and manufacture on a small scale, of the various weapons, appliances, projectiles, etc., which were hastily improvised to counter the German attacks. In conjunction with the French, rear lines of defence were sited and marked: notably the "B.C.D. Line" (Boulogne-Calais-Dunkirk) to cover a re-embarkation.

In addition to railways, the French had undertaken also to construct and maintain all road communications in France, for our army—by the agency of the *Sous-Commission du Service Routier*. It soon became obvious, however, that they could not fulfil their obligations, and in November, 1914, two officers (Lieut.-Colonel W. A. Liddell and Major C. C. H. Hogg) were appointed to General Fowke's office to co-ordinate and supervise work on roads and bridges in army areas. It was realized moreover, that new types of bridges would be needed during an advance to cope with the rapidly increasing transport, and the great weights to be carried. Other pressing demands reached G.H.Q. for accommodation, works and stores of all kinds in the army area, and it was necessary that provision should be made locally for these, since there was no agency for labour, stores or works administration between the Director of Works, I. of C., and the C.S.R.E. divisions.

APPOINTMENT OF CHIEF ENGINEER, B.E.F.

The formation of the Second Army in the last days of 1914 clarified the situation. It was evident that the senior R.E. officer at G.H.Q. could no longer be restricted to advisory functions, and imperative that he should assume administrative and, in certain matters, executive powers to cope with his growing duties and responsibilities. This, in fact, Fowke did without hesitation.

Although formal recognition of status was delayed, in January, 1915, General Fowke became Chief Engineer, B.E.F., and Lieut. Colonel Liddell was appointed Deputy Director of Works, G.H.Q., to administer under his orders works and works-personnel in army areas.

APPOINTMENT OF E.-IN-C. AND CHIEF ENGINEERS OF ARMIES AND CORPS

Two months later an official representation was made to the War Office by G.H.Q., regarding the changes in the position and duties of artillery and engineer advisers, but it was not until July, 1915, that an establishment was approved for the E.-in-C. and for Chief Engineers of army and corps. These officers were formally given the powers of a Director of Works in respect of expenditure, purchases, etc., and, in addition to acting in an advisory capacity, powers to plan and execute works under the orders of their commanders. In September, 1915, the E.-in-C. was authorized to correspond direct with armies and corps on matters connected with the design and pattern of engineer stores and general questions affecting R.E. equipment and issues.

The winter of 1914-15 found the opposing forces on the British front in a position of stalemate. On both sides there was a great shortage of ammunition and of aeroplanes. A considerable proportion of the front was waterlogged, and not only was the construction of satisfactory defences difficult but any considerable movement by either side was impossible. There was an acute shortage of R.E. officers, caused by heavy casualties in field companies and an increase in the number of these companies in the establishment of divisions. Consequently the staffs of the E.-in-C. and C.Es. were kept to a minimum.

During this period the staff of the E.-in-C. worked in two sections. One section continued to give its attention to the provision of rear lines and the instruction in field works of the new field companies, infantry battalions and, later on, divisions as they arrived in France; and to keep the General staff informed of the methods of trench warfare devised at the front.

Experimental work was continued, but the armies were now manufacturing at Béthune and Hazebrouck their own improvised stores, and it became the principal duty of the Experimental Section to test and report upon the various

types of trench stores, particularly hand and rifle grenades, trench mortars, rockets, flares, land torpedoes, smoke bombs, catapults, trench diggers, etc., submitted by inventors at home and in the theatre of war. Many of these inventions were ludicrously unpractical, but much development took place, particularly in mining. At the end of 1914 it had become known that the Germans were mining on a definite system, and in view of the shortage of engineers in the front line, a demand for special mining units was raised. The creation and work of the large mining organization is not dealt with here, but we may record the arrival at G.H.Q. in February, 1915, of Major Sir J. Norton Griffiths, M.P., of King Edward's Horse. He was a civil engineer and contractor of wide experience, very influential in the political and mining world, and with a forceful and dynamic personality. From the first he was associated with Major Harvey, who by this time had become Assistant to the Chief Engineer.

The use of gas by the Germans at Ypres, in May, 1915, raised entirely new problems, which in the first instance were referred to the E.-in-C., on whose recommendation the Special Brigade was organized under command of Lieut.-Colonel C. H. Foulkes, R.E., with the rank of Brigadier-General.

Following some sporadic bombing of G.H.Q., an anti-aircraft searchlight service was organized and remained directly under the E.-in-C. throughout the war. The first three projectors arrived in July, 1915. By the end of 1916 there were twenty-two anti-aircraft searchlight sections, and when the war ended there were eighty, under an Inspector—Lieut.-Colonel W. C. H. Prichard.

The other section of the office of the E.-in-C., under D. D. W. G.H.Q., became engaged in a multiplicity of duties similarly involving engineering problems of a type and on a scale unprecedented in the British army. Road communications were administered in conjunction with the French, and to supplement local resources a number of R.E. units, practically untrained, were sent to France for road work early in 1915, but demands for additional front-line units caused their diversion to formations. The training of these units to fit

them for front-line work devolved on the D.D.W. They were subsequently replaced in the summer by eleven R.E. labour battalions.

Depots of bridging material on canal barges were formed by fortress companies. Orders were also given for a considerable number of steel girder bridges, and designs for special types of canal bridge and equipment were prepared locally by an experienced bridge engineer attached to D.D.W. Memoranda of instructions for bridge work were compiled and issued to armies. Later, Major C. E. Inglis, Professor of Engineering at Cambridge University, advised the E.-in-C. on bridging. His valuable work is well known to the Corps.

It was clear from the outset, that the future requirements of the army for roadwork, bridges and water supply could not be gauged accurately until a considerable amount of definite information regarding engineering and physical conditions in the area of operations had been collected. This intelligence was practically non-existent both in the French army* and in the departments of the French civil administration. Two officers (Captain G. J. V. Shepherd, R.E. and Lieutenant W. B. R. King, R.W. Fus., Geological Survey of Great Britain) were attached to the E.-in-C. in May, 1915, and with the help of two engineers of the Belgian *Ponts et Chaussées* attached to the D.D.W., the compilation progressed satisfactorily for about a year. Investigation was also made into existing and possible inundations,† sources of water-supply, road metal and other engineer information. It was by use of this information and by close liaison with all branches at G.H.Q., formations and the L. of C., that the E.-in-C. was enabled to estimate future requirements of stores and equipment, much of which took

* For example, French intelligence maps did not show the Canal du Nord under construction at the outbreak of war, nor the causeway, road and railway across the Somme near St. Valéry.

† Thereby, in the summer of 1915, the Belgian army was enabled to maintain a large inundation of the river Yser to neutralize a considerable length of front. Pumps supplied from England and installed on two barges pumped over 37 million gallons of sea water daily into the river channel. In winter these barges were used to lower the water level around defences near Béthune.

months to manufacture and supply. The forecast of stores became one of the most important functions of the E.-in-C. When his duties and responsibilities were expanded, a portion of the E.-in-C's. Intelligence Branch was transferred to the Intelligence Branch of the General Staff.

For the next few months both sections of the E.-in-C's Staff were continuously engaged in initiating and elaborating proposals for R.E. Staff, and for the organization and equipment of new types of units for work additional to that carried out by divisional engineers. For example, following the Indian system, Field Engineers (civil engineers of wide experience, with temporary commissions) were appointed to corps early in 1915, for miscellaneous duties on roads, water supply, accommodation, etc. In the summer, the four fortress companies in France were converted into army troops companies—serviceable units, equipped with motor transport and made capable of a wide range of duties. Eventually the number of these companies was increased to fifty-two. There were many other new units formed for stores and parks, and for the operation of workshops, forestry, survey, mining, etc.

In February, 1916, General Fowke was appointed Adjutant-General to the Forces. His successor was Major-General Spring R. Rice, who had been Chief Engineer at Salonika. In September, 1917, he was succeeded by Major-General G. M. Heath.

DEVELOPMENT OF DUTIES OF E.-IN-C. AND CHIEF ENGINEERS

Except for the creation of the Third Army and an extension to the south as far as the Somme, there was not much change in the position of the B.E.F. in 1915; but with the advent in 1916 of large reinforcements, increase of ammunition and development of air strength, the E.-in-C's. responsibilities were increased correspondingly.

A memorandum on the Administration of Works in the Field, prepared by the E.-in-C., was issued by the Q.M.G. in January, 1916, to regulate the transactions of engineer officers in army areas. C.Es. of armies under the technical

control of the E.-in-C. were charged with the administration of all works, labour, etc., required in army and corps areas: the administration and supervision of advanced parks, and other administrative and financial measures were prescribed. In respect of works, Cs.R.E., field engineers and unit commanders were stated to be the representatives of C.Es.

Further steps were taken to regularize the position of the E.-in-C. at G.H.Q. and to organize his staff. In a letter of April, 1916, it was laid down that the E.-in-C. should be under the C.G.S. in respect of operations and defence, and for works, under the Q.M.G.; that he should be responsible for the provision of engineer plant and stores, that he was authorized to communicate direct with C.Es. of armies regarding works and their relations with the French authorities. His financial responsibilities were defined. Also in April, 1916, the establishment of the E.-in-C. at G.H.Q. was enlarged and reorganized. The post of Deputy Engineer-in-Chief was created and Colonel W. A. Liddell was appointed thereto. This distribution of duties, and the status of the E.-in-C., were subsequently confirmed and placed on record by an Army Order issued on 1st January, 1917. In March, 1917, another Army Order defined the status and duties of Chief Engineers of armies and corps.

As the British Army grew in size, and especially when offensives on a large scale began, armies and corps became the only more or less permanent institutions in given areas. Through them flowed a constant stream of divisions attacking or recuperating after heavy losses. So it became increasingly necessary for the larger formations to take control of many matters formerly left to divisions, in order to secure continuity of policy. This applied particularly to engineering. As a result, the functions of the C.Es. expanded. They were expected to take a firm grip on the engineering work of their areas, and to mould it into one connected whole. They were expected to exercise some measure of control over the engineering of lower formations and to undertake themselves work of all kinds extending far forward into the battle zone as well as far in rear of it.

At this period of the war the staff of a Corps C.E. normally consisted of one staff officer and three field engineers, and he probably had permanently under his orders :—

- 3 army troops companies, R.E.,
- 2 or 3 tunnelling companies, R.E.,
- 1 company of a labour battalion, R.E.,
- $\frac{1}{2}$ M.T. pontoon park,
- 1 infantry labour battalion,

supplemented by a varying number of field squadrons and companies, R.E. and working parties drawn from miscellaneous units, such as the Special Brigade, R.E., the corps cavalry, corps cyclists, squadrons of cavalry, etc., and as much horsed and lorry transport as he could persuade the D.A. and Q.M.G. of his corps to place at his disposal.

Engineer control within the limits above defined was achieved by a combination of the following: engineer circulars and instructions, standard specifications and designs, inspections, reports, conferences and correspondence.

By the latter part of 1915 it had become evident that the mining operations ought to be more closely co-ordinated, and accordingly in January, 1916, it was decided to create the appointment under the E.-in-C. of Inspector of Mines with the rank of Brigadier-General, with a Controller of Mines for each of the four armies. Norton Griffiths remained Technical Adviser at G.H.Q. A notable addition to the E.-in-C's. office in 1916 was the appointment of Major David, attached to the Australian Mining Corps, a professor of Sydney University and a member of Shackleton's South Polar Expedition, as adviser upon geological conditions in mining operations. David had a world-wide reputation as a scientist, and his services were invaluable.

In the autumn of 1915 another new service had been born to the R.E. as a result of the French having established at Amiens a workshop for camouflage equipment, mainly connected with trench warfare. The establishments of each army and corps were now to include camouflage officers, while a Controller of

Camouflage was added to the E.-in-C's. staff—Lieut.-Colonel F. J. C. Wyatt, R.E.

The conditions in 1915 did not produce any large demand for accommodation of troops, who generally found billets in villages at that time undamaged by shell-fire and bombing. When, in 1916, a large concentration of troops on the Somme was contemplated it became necessary to provide certain hatted encampments and other shelters. The question became more acute after the close of the Somme battle, and led to the designing at G.H.Q. in the spring of 1917, of the Nissen hut. The first order from G.H.Q. was for 47,600 huts of this pattern. The type was utilized in every European theatre of war and involved an expenditure of over £7 million. Major Nissen, who possessed great mechanical ingenuity and workshop ability, was chiefly responsible for this design, and for other types of shelters and many of the items of camp equipment and accessories which were issued to the troops in large numbers during the war.*

Not very much actual bridging was undertaken in 1916 but steady progress was made with the supply of steel bridges and equipment. At first classes were formed at Havre Depot for the instruction of officers and men in the erection of steel bridges, but these proved inadequate to deal with the personnel required. A bridging school was therefore established at Aire in 1916-17 and subsequently moved to Monchy Cayeux. In all, some 400 officers and 2,000 men were trained in France.

A new type of bridge, designed by Professor Inglis, was tried and adopted. The original pattern, designed for infantry only, allowed of bridging spans up to 100 ft. in a very few minutes, but modifications for heavier loads were taken in hand, with the result that the Inglis heavy bridge, permitting the passage of all but the heaviest type of artillery and tanks,

* The Nissen Hut, with a semi-circular corrugated iron roof, was designed to provide a stable, warm and weatherproof shelter for men in devastated areas. It was readily transportable, one to a lorry, and erected with great rapidity by unskilled labour. Each hut housed at least twenty men. Nissen type hospital huts and steel tents were also supplied in large quantities.

was made in a fraction of the time which it would take to erect similar bridges of normal pattern. This type of bridge proved invaluable for hasty work during the final advance of 1918.

Early in 1917, in anticipation of an eventual general advance by the B.E.F., the bridging requirements for an advance of 50 miles were worked out in the E.-in-C's. office and orders placed for the material and stores. A special type of bridge was designed by Captain Hopkins (a specialist in bridge design) and adopted in spans from 60 ft. to 120 ft. Designs were also prepared for floating bridges for heavy loads, using service equipment. These bridges were frequently constructed at a later date. A floating bridge with piers of 60-70-ton Thames lighters was assembled at Dunkirk in readiness for the passage of the Yser at Nieupoort.

The concentration of large bodies of troops and horses on the Somme in the spring of 1916 caused a revision of the equipment provided for water supply, and the collection of a large amount of material for use by the R.E. In this area, which closely resembles Salisbury Plain, there was practically no surface water except in widely separated streams, and it was necessary to sink wells or bore holes through the chalk sub-soil. Prior to the commencement of fighting, more than a hundred power pumps were installed, and 120 miles of water mains were laid. As the battle progressed, these figures were largely increased. The single Mechanical and Electrical Company then existing could cope with the maintenance of only a fraction of the plant, and by the end of the year it was found necessary to form five such companies, with enlarged establishments. Boring plant had also been procured, and successful use of air-lift pumps on the bore-holes, a novelty in military practice, greatly increased the supplies of water available. It was by these means only that the troops could be maintained in the area they occupied during and after the Battle of the Somme.

The organization for the supply of stores and equipment is not within the scope of this section. Here we will only note that the E.-in-C. and the D.W. each made forecasts of requirements. The D.W. was responsible for provision, storage and

distribution of stores. Allotments of stores were made monthly to C.E.s. of armies.

In 1915-16 a small R.E. unit was formed under Lieutenant Mallinson to exploit the timber in the forest of Nieppe adjoining the River Lys. This unit worked directly under the Deputy E.-in-C. until merged into the Directorate of Forestry, formed early in 1917 under Lord Lovat, for extensive operations both in army and L. of C. areas. Eventually there were eleven forestry and two artisan works companies, R.E. controlled by the directorate.

In addition to the mining and the bridging schools, established in 1916, a school for training in Field Engineering was organized by the E. in-C. at Rouen early in 1917, to which junior officers and other ranks were sent for short courses of instruction in the latest methods. In the winter of 1916-17 a school for senior field and army troops company officers was formed at Le Parc, and lasted for about a year. It was re-established at Blendagues for the same period in December, 1917. These schools were under the direct supervision of the E.-in-C.

The demand for tramways originated in divisional areas. They then became co-ordinated by corps headquarters, then by headquarters of armies and eventually by G.H.Q., who made E.-in-C. responsible. The line of demarcation, or rather the merging of tramways into the organization of light railways and standard-gauge railways, was necessarily rather indefinite. The Director-General of Transportation was responsible for light railways as well as normal gauge, and at the time of the Armistice his assumption of responsibility for forward tramways was under discussion.

The battle of the Somme had thrown an excessive strain on the French railway and road systems, and this caused a big transfer of responsibility from the French to the British behind the British front. A Director-General of Transportation (Railways and Roads) was therefore appointed. He took over roads in rear areas, but in forward areas they remained the responsibility of the engineers in formations, who obtained material, stores and plant from the E.-in-C. The R.E. also continued to be responsible for the construction of all new bridges.

FINAL DISTRIBUTION OF DUTIES IN THE E.-IN-C'S. OFFICE

On the 27th October, 1918 (at which date the imminent collapse of Germany could not yet be guaranteed) the E.-in-C. approved the following reorganization of his office :—

DEPUTY ENGINEER-IN-CHIEF (1)

Brigadier-General H. Biddulph, D.S.O. and eleven officers

1. Operations. 2. Bridging. 3. Water Supply Operations.
4. Defence in Army Areas. 5. Inundations. 6. Tunnelling and Explosives. 7. Allocation R.E. Units. 8. Publications connected with above.

DEPUTY ENGINEER-IN-CHIEF (2)

Brigadier-General J. E. Edmonds, C.B., C.M.G. and twelve officers

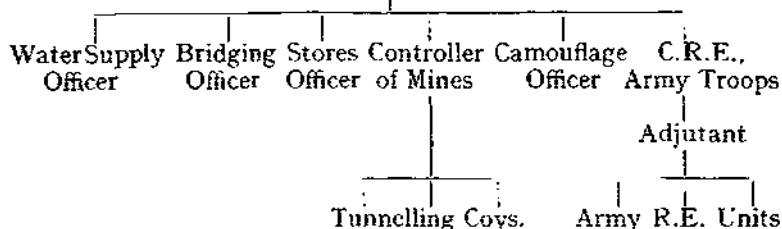
1. Training and Schools. 2. Camouflage. 3. Searchlights.
4. Electrical Power and Plant. 5. Publications, other than D.E.-in-C. (1). 6. Draughtsmen and Maps. 7. Experimental Workshops. 8. Stores (including Mining, Water Supply, Electrical and the output of Base Workshops). 9. Engineer Equipment. 10. Engineer Intelligence of the Country, etc. (including Geology). 11. Engineer Information from enemy and allied sources. 12. Records of Operations. 13. Rear Defences outside Army Areas.

ARMY AND CORPS ENGINEER STAFFS, 1918

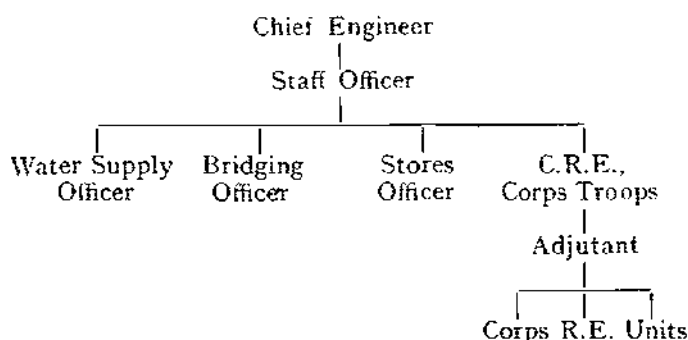
ARMY HEADQUARTERS

Chief Engineer

Staff Officer



CORPS HEADQUARTERS



ENGINEERS-IN-CHIEF AND CHIEF ENGINEERS IN FRANCE

ENGINEERS-IN-CHIEF

*Year of
Appointment*

Brigadier-General (later Major-General) G. H. Fowke ...	1914
Major-General Spring R. Rice	1916
Major-General G. M. Heath	1917

DEPUTY ENGINEERS-IN-CHIEF

Brigadier-General W. A. Liddell	1916
Brigadier-General D. S. McInnes	1918
Brigadier-General E. P. Brooker	1918
Brigadier-General J. E. Edmonds	1918
Brigadier-General H. Biddulph	1918

CHIEF ENGINEERS OF ARMIES

First Army

Major-General S. R. Rice	1915
Major-General G. M. Heath	1915
Major-General H. de V. Atkinson	1917

Second Army

Major-General A. E. Sandbach...	...	...	...	1915
Major-General F. M. Glubb	...	...	...	1915
(also E.-in-C. Italy 14.11.17 to 17.3.18)				

Third Army

Major-General J. E. Capper	...	...	...	1915
Major-General W. Huskisson	...	...	...	1915
Major-General E. R. Kenyon	...	...	...	1916
Major-General W. A. Liddell	...	...	...	1918

Fourth Army

Major-General R. U. H. Buckland	1916
---------------------------------	-----	-----	-----	------

Fifth Army

Major-General R. P. Lee	...	...	...	1916
Major-General P. G. Grant	...	...	...	1917

CHIEF ENGINEERS OF CORPS

I Corps

Brigadier-General S. R. Rice	...	...	...	1914
Brigadier-General C. Godby	...	...	...	1915
Brigadier-General R. P. Lee	...	...	...	1915
Brigadier-General E. H. de V. Atkinson	...	...	...	1916
Brigadier-General H. W. Gordon	...	...	...	1917

II Corps

Brigadier-General A. E. Sandbach	...	...	...	1914
Brigadier-General G. M. Heath	...	...	...	1915
Brigadier-General C. Godby	...	...	...	1915
Brigadier-General G. H. Boileau (Temporary)	...	...	...	1918
Brigadier-General C. Godby	...	...	...	1918

III Corps

Brigadier-General F. M. Glubb...	...	...	...	1914
Brigadier-General J. E. Capper	...	...	...	1915
Brigadier-General A. L. Schreiber	...	...	...	1915
Brigadier-General A. Rolland	...	...	...	1917

IV Corps

Brigadier-General R. V. H. Buckland	...	...	1914
Brigadier-General E. R. Kenyon	...	...	1916
Brigadier-General S. F. Williams	...	...	1916
Brigadier-General C. M. Carpenter	...	...	1918

V Corps

Brigadier-General R. D. Petrie...	...	...	1915
Brigadier-General A. J. Craven	...	...	1917
Brigadier-General A. G. Stevenson	...	...	1918

VI Corps

Brigadier-General C. Hill	...	...	1915
Brigadier-General R. N. Harvey	...	...	1918

VII Corps

Brigadier-General W. Huskisson	...	...	1915
Brigadier-General J. A. Tanner	...	...	1915
Brigadier-General R. D. Petrie...	...	...	1917
Brigadier-General R. A. Gillam	...	...	1918
Brigadier-General C. J. Armstrong	...	...	1918

VIII Corps

Brigadier-General E. A. Tudor	...	...	1915
Brigadier-General J. A. Gibbon	...	...	1915
Brigadier-General G. S. Cartwright	...	...	1916
Brigadier-General H. W. Rushton	...	...	1917
Brigadier-General R. A. Gillam	...	...	1917
Brigadier-General H. G. Joly de Lotbinière	...	...	1918
Brigadier-General H. Biddulph	...	...	1918
Brigadier-General A. B. Carey	...	...	1918

IX Corps

Brigadier-General A. C. Painter	...	...	1915
Brigadier-General E. H. Bland...	...	...	1915
Brigadier-General G. P. Scholfield	...	...	1916
Brigadier-General G. S. Cartwright	...	...	1918
Brigadier-General R. A. Gillam	...	...	1918

X Corps

Brigadier-General J. A. S. Tulloch	...	...	...	1915
Brigadier-General G. H. Boileau	...	...	...	1917

XI Corps

Brigadier-General L. Jones	...	...	...	1915
Brigadier-General H. J. M. Marshall	...	...	...	1917

XII Corps

Brigadier-General G. Godby	...	...	...	1915
Brigadier-General F. K. Fair	...	...	...	1916
Brigadier-General G. Walker	...	...	...	1916
Brigadier-General C. G. W. Hunter	...	...	...	1917

XIII Corps

Brigadier-General S. H. Powell	...	...	...	1915
Brigadier-General E. P. Brooker	...	...	...	1916
Brigadier-General H. R. S. Christie	...	...	...	1917
Brigadier-General C. A. Elliott...	...	...	...	1918

XIV Corps

Brigadier-General H. R. Gale	...	...	...	1916
Brigadier-General C. S. Wilson...	...	...	...	1916

XV Corps

Brigadier-General P. G. Grant	...	...	...	1916
Brigadier-General S. D'A. Crookshank	...	(Jan.)	...	1917
Brigadier-General H. J. M. Marshall	...	(Feb.)	...	1917
Brigadier-General C. W. Singer	...	(April)	...	1917

XVI Corps

Brigadier-General H. L. Pritchard	...	...	...	1916
Brigadier-General G. Walker (Temporary)	...	(July)	...	1916
Brigadier-General H. L. Pritchard	...	(Aug.)	...	1916

XVII Corps

Brigadier-General H. C. Nanton	...	...	...	1916
Brigadier-General W. D. Waghorn	...	...	...	1917

XVIII Corps

Brigadier-General H. G. Joly de Lotbinière	1917
--	-----	-----	-----	------

XIX Corps

Brigadier-General A. G. Bremner	...	...	...	1917
Brigadier-General H. Biddulph	...	...	...	1918
Brigadier-General E. N. Stockley	...	...	...	1918

XX Corps

Brigadier-General R. L. Waller	1917
--------------------------------	-----	-----	-----	------

XXI Corps

Brigadier-General R. P. T. Hawksley	1917
-------------------------------------	-----	-----	-----	------

XXII Corps

Brigadier-General A. E. Panet	1917
-------------------------------	-----	-----	-----	------

XXIII Corps

Brigadier-General G. D. Close	1918
-------------------------------	-----	-----	-----	------

Canadian Corps

Brigadier-General W. B. Lindsay	1917
---------------------------------	-----	-----	-----	------

I Anzac Corps

Brigadier-General A. C. Joly de Lotbinière	1916
--	-----	-----	-----	------

II Anzac Corps (see XXII Corps above)

Brigadier-General A. E. Panet	...	...	(Dec.)	1917
(Transferred from H.Q. II Anzac Corps to H.Q. XXII Corps, 31.12.17. The II Anzac Corps became XXII at midnight 31.12.17.)				

I Indian Corps

Brigadier-General H. C. Nanton	1914
--------------------------------	-----	-----	-----	------

Canalry Corps

Lieut.-Colonel W. H. Evans (C.R.E.)	1916
-------------------------------------	-----	-----	-----	------

OTHER ENGINEER APPOINTMENTS IN FRANCE

Director of Works

Major-General Sir Andrew M. Stuart	1914
------------------------------------	-----	-----	-----	------

Deputy Director of Works (Stores)

Colonel W. Baker Brown	1916
------------------------	-----	-----	-----	------

Director of Engineer Stores and Materials

Brigadier-General J. S. Sewell	1918
--------------------------------	-----	-----	-----	-----	------

Director of Army Signals

Major-General J. S. Fowler (later Sir John)	1914
---	-----	-----	-----	-----	------

Director of Survey

Brigadier-General E. M. Jack	1916
------------------------------	-----	-----	-----	-----	------

Director of Railways (Director of Rail Transport till 1915)

Brigadier-General J. H. Twiss	1914
-------------------------------	-----	-----	-----	-----	------

Colonel W. D. Waghorn (later Sir W.)	1916
--------------------------------------	-----	-----	-----	-----	------

Director-General of Transportation

Major-General* Sir Eric Geddes	1916
--------------------------------	-----	-----	-----	-----	------

Director of Transportation

Brigadier-General H. F. E. Freeland	1916
-------------------------------------	-----	-----	-----	-----	------

Brigadier-General V. Murray	1917
-----------------------------	-----	-----	-----	-----	------

Director of Light Railways

Brigadier-General* G. H. Harrison	1917
-----------------------------------	-----	-----	-----	-----	------

Director of Docks

Brigadier-General* R. L. Wedgewood (later Sir Ralph)	1917
--	-----	-----	-----	-----	------

Chief Engineer, Port Construction

Colonel* Sir Alexander Gibb	1917
-----------------------------	-----	-----	-----	-----	------

Director of Inland Water Transport

Brigadier-General* G. E. Holland	1917
----------------------------------	-----	-----	-----	-----	------

Director of Roads

Brigadier-General H. Maybury (later Sir Henry)	1917
--	-----	-----	-----	-----	------

Inspector of Mines

Brigadier-General R. N. Harvey	1916
--------------------------------	-----	-----	-----	-----	------

Director of Gas Services

Brigadier-General H. F. Thuillier	1916
-----------------------------------	-----	-----	-----	-----	------

Brigadier-General C. H. Foulkes	1917
---------------------------------	-----	-----	-----	-----	------

* Temporary Commission.

Director of Forestry

Brigadier-General* Lord Lovat	1917
-------------------------------	-----	-----	-----	------

Inspector of Searchlights

Lieut.-Colonel W. C. H. Prichard	1917
----------------------------------	-----	-----	-----	------

Controller of Camouflage

Lieut.-Colonel F. J. C. Wyatt	1917
-------------------------------	-----	-----	-----	------

* Temporary Commission.



War Babies

THE 1917 CHRISTMAS CARD

The "Babies" represented are: Searchlights, R. E. Park, Base Park Company, Tunnelling Company, Artisan Works Company, Workshops Company, E. & M. Company, Railway Company, Corps Troops R.E., Boring Section, Forestry Company, Land Drainage Company, Sound Ranging Company, Pontoon Park, Road Construction Company, Port Construction Company, Inland Water Transport, Special Companies Gas, Sigs Company, Army Troops Company, Special Works Park, Camouflage, Signals.

CHAPTER IX

BATTLES OF 1914 IN FRANCE AND FLANDERS

Mons and the Retreat—Passage of the Marne—Passage of the Aisne—First battle of Ypres—Winter of 1914/15 R.E. Units of the initial B.E.F.

MONS AND THE RETREAT

THE British Expeditionary Force landed in France in August, 1914, with one cavalry division of four brigades, an independent fifth cavalry brigade, and four infantry divisions (the 1st, 2nd, 3rd and 5th). The 4th and 6th Divisions were temporarily retained in England in case of a German invasion, but followed in a few weeks. A list of the R.E. units in the Expeditionary Force is given at the end of this chapter.

The Royal Engineers were represented in the Force by a "Brigadier-General, Royal Engineers" (Brigadier-General G. H. Howke) attached to General Headquarters with a roving commission and no staff except a single clerk; by a "Colonel, Royal Engineers" on the staff of each of the two Corps Headquarters (Colonel S. R. Rice and Colonel A. E. Sandbach); by a C.R.E. (Lieut.-Colonel) with an adjutant and a clerk in each infantry division; by two field companies to each division and a field squadron with the Cavalry Division; and by two fortress companies on the Lines of Communication.

The field units had been well trained within the narrow limits imposed by rigid peace economy, and all of them had passed through the South African war. Although the lapse of time had changed the personnel, the traditions and experience of fairly recent active service had permeated the units, and many of the reservists who joined on mobilization had been through that campaign. So far as was possible, the units were ready for the new adventure.

Their organization and equipment underwent no change

throughout the whole war, and although this might be interpreted as only another indication of the lack of a spirit of progress, it is an undoubted fact that the field units with their elastic organization in sections remained unaltered, and nobody wanted to change them from the beginning to the end. The only shortcoming was that there were never enough of them. It was quickly realized that a third field company in a division was wanted, and the deficiency was made up by taking Territorial units from the divisions assembling in England. There were as yet no pioneer battalions.

It was in the higher organization and in the general lack of knowledge of what was coming that the Royal Engineers of 1914 were inadequately prepared. The Boer War had not been an engineers' war. The make-believe position of the Engineer Adviser at G.H.Q. was in itself a symptom of the lack of appreciation of the engineering problems of continental fighting, which, whether it turned out to be a mobile campaign or static trench war, called for preparation of engineer resources on the largest scale.

Neglect of the theory and practice of field defences had been encouraged by the *en avant* principles of the French School. The British General Staff and the teaching of the Staff College had been affected by the doctrine that the Crimean War was too far back for it to be expected that anyone should trouble about its lessons. The impracticability of carrying out engineer works on peace manoeuvres had prevented the Staff from gaining any visual experience, and it had been left to individual officers of the Royal Engineers to do what they could in their annual training and at the School of Military Engineering to assimilate the lessons that were to be drawn by those who looked for them.

But if the Crimean War was too far removed from modern probabilities, the Russo-Japanese War provided a sufficiently up-to-date field of study, and it was fortunate that the officer selected for the post of Engineer Adviser to the Commander-in-Chief was one who had the widest experience of engineer duties, and had been one of the *attachés* sent out to the Far East to study the war of 1904-5. As we have seen in the

previous chapter he lost no time in obtaining an expansion of the higher engineer representation.

The British Expeditionary Force had scarcely reached its first positions on the Mons canal when the oncoming German columns and the reports of the withdrawal of the French Fifth Army made it clear that a retreat was imperative. Steps had been taken on the 23rd August to select a main position in rear of the line of outposts, and troops, aided by gangs of Belgian civilians, had already begun to dig trenches; but the principal work of the R.E. units was that of preparing bridges for demolition. Most of the subalterns of the companies were detailed to take charge of these preparations, while the company commanders and the Cs.R.E. reconnoitred a second line in rear. The limited amount of explosives carried and the absence of any doctrine for a wholesale demolition belt prevented the destruction of roads, railways or buildings.

The fog of war immediately descended upon the B.E.F., and with every hour there came news of increasing gravity. The situation developed so rapidly that the issue of orders was scanty, and none of the units knew what was happening. A cheerful optimism, however, pervaded all ranks. Most of the bridges along the canal were in the outpost line and east of Mons they were far beyond it.

The brunt of the first day's fighting fell on the II Corps (3rd and 5th Divisions). The front of the I Corps (1st and 2nd Divisions) had been drawn back to link up with the French, and there were no bridge demolitions in their area.

In the small hours of the morning of the 23rd August, the G.O.C., II Corps had sent orders to his divisions to prepare the bridges over the canal for demolition, but they were not to be destroyed without orders from the divisional staffs. In the 3rd Division (C.R.E.—Lieut.-Colonel C. S. Wilson; 56th and 57th Field Companies) the field companies were scattered on various works, and many of the bridges on the divisional front were rushed by the Germans before the preparations were completed. The 56th Company (Major N. J. Hopkins) had reconnoitred their bridges on the evening of the 22nd, and had asked permission to prepare them at once,

but were told to do nothing that night. When the sections reached the canal next morning the enemy was already sniping at the bridges. One section of the company was rushed while fixing its charges, and Lieutenant H. W. Holt, R.E. (S.R.) was killed and the rest of his section captured.*

Owing to untoward circumstances connected with store-changing before mobilization, the companies had no instantaneous fuse with them and only one exploder per section. The demolition parties had therefore to rely on their electric firing-apparatus and safety fuse—all too scanty.

The 57th Field Company (Major F. G. Howard) had eight bridges to prepare, but in spite of the gallant work done under heavy fire, only one was blown up. There were more bridges than officers to take charge of them, and many junior N.C.Os. were detailed to carry out the work. Lieutenant A. B. Day with Corporal A. Payne and twelve sappers on bicycles with half a tool-cart went to the road bridge over the railway and canal north-west of Mons to blow up the portion over the canal. Corporal Payne was sent along the canal to reconnoitre the railway bridge near Nimy. On Payne's return Lieutenant Day decided to go on with six sappers to demolish the Nimy bridges, leaving Corporal Payne and the rest of the party to deal with the bridges at Mons. The lack of safety fuse and the paucity of explosives forced Corporal Payne to resort to the risky alternative of using equal lengths of safety fuse, and trust to their being lighted more or less simultaneously. The bridge was blown up, but the full extent of the damage could not be ascertained. Meanwhile, Lieutenant Day arrived at the Nimy bridges and decided that, as he had insufficient explosives for both, he would prepare the railway bridge, but unfortunately before he could get his charges fixed the Germans attacked and captured the bridge, and he was wounded and taken prisoner.

The bridges from Jemappes station to Mariette were allotted to Lieutenant P. K. Boulnois (57th Company) who took with him four N.C.Os. and four sappers on bicycles, and his forage cart loaded with explosives and a drum of cable. He divided

* *Demolitions at Mons, R.E. Journal*, March, 1932, p. 26.

up his small party and stores, and arranged to return with the exploder and blow up each bridge in turn. The bridge at Mariette was prepared by Sergeant Smith and Sapper Dabell. About 2 p.m. Lieutenant Boulnois, accompanied by Sergeant Smith, went off on their bicycles to visit the other bridges. On their way they met Captain T. Wright (Adjutant, 3rd Divisional R.E.) coming from Lock 2 where he had been wounded in the head by shrapnel while trying to cross the twenty yards between the barricade and Lance-Corporal Jarvis's boat. No orders had yet been received for the destruction of the bridges, but they stopped a dispatch-rider (searching for the Scots Fusiliers) and learned that he was carrying orders for a general retirement. They at once realized that they were faced with the problem of instantly blowing up five bridges on a front of 3 miles with one exploder.

Wright started off in a car to order the destruction of Day's bridges, and told Boulnois to get on with his as best he could. Boulnois bicycled with Sergeant Smith to his farthest bridge, close to Jemappes station, and successfully destroyed it at about 3 p.m. He then decided that, as there was no time to lose, he would omit the bridges at Lock 2 and the two next to it (Lance-Corporal Halewood's) and make for the Mariette bridge which carried a main road. On their way, they again met Wright and, after a short consultation, it was decided that he should take the exploder and drum in his car and, accompanied by Sergeant Smith, go to Mariette while Boulnois went to Lance-Corporal Halewood's bridges. Here he succeeded in joining up his leads with the local electric supply in an adjoining house, hoping that the current which was still running the lights would set off the detonator if he switched it on suddenly. By this time, however, the village had been deserted, and at this very moment the current failed.

Captain Wright and Sergeant Smith on reaching Mariette made most gallant attempts to get at the free ends of the leads, which only just reached the towpath. B Company of the 1st Northumberland Fusiliers was still holding out at the barricade on the south side of the canal, but the towpath was separated from the barricade by the subsidiary canal, here

spanned by a girder bridge fifteen to twenty feet wide. Captain Wright 'bridge-laddered' under this subsidiary canal bridge with extra leads tied on to him, and time and again tried to get at the ends of the leads on the towpath. Each time his hands or head appeared above the level of the towpath he was fired at from about thirty yards off, so eventually he gave up the attempt. In swinging himself back under the girder across the subsidiary canal, he lost his grip owing to exhaustion, and was pulled out of the water by Sergeant Smith.

"The result was that of eight bridges allotted to the 57th Company only the one close to Jemappes station was blown up. Captain Wright and Lance-Corporal C. A. Jarvis were awarded the V.C. for their gallant work at the Mariette bridge and at Lock 2 respectively."*

Lance-Corporal Jarvis and Sapper Neary of the 57th Field Company had been left to prepare the charges at Lock 2, and "working in a small boat underneath the bridge, managed to fix their charges, whilst heavy firing went on over their heads, but they had to make occasional dashes back across the twenty yards between the canal and the barricade to fetch explosives and run out their leads."* The bridge was successfully blown up.

On the 5th Divisional front (C.R.E.—Lieut.-Colonel J. A. S. Tulloch; 17th and 59th Field Companies) the 17th Company (Major C. W. Singer) prepared bridges in Ghislain. The charges on the railway bridge had been fixed, when enemy shell-fire blew off the gun-cotton without detonating it. Corporal Marsden attempted to refix it, but was killed before he was successful. The main road bridge, together with a footbridge alongside was prepared by the same section (2nd Lieutenant K. B. Godsell), but heavy shelling drove the party off until the evening, when the work was finished. All these bridges were successfully blown in the small hours of 24th August. At Lock 4, Lieutenant C. E. R. Pottinger, of the same company, had trouble with his exploder and the bridge had to be left standing, although he had endeavoured to set the charges off by firing at the detonators with his revolver. Several barges along the

* *Demolitions at Mons, R.E. Journal*, March, 1932, pp. 27-28.

canal were sunk by exploding a 1-lb. slab of gun-cotton close to the keel of each.

The other field company of the 5th Division, the 59th (Major G. Walker), had the bridges west of Lock 4 to prepare, including a plate-girder railway bridge at Les Herbières. Lieutenant Pennycuik and No. 1 Section prepared the railway bridge and successfully blew it. Lieutenant Flint and No. 3 section at the bridge over the Hain on the Ville Pommereul Thulin road fired their charges under fire from a field gun which the Germans had posted a mile away in full view on the dead-straight road. Their bridge was successfully blown up. Meanwhile the mounted section of this company, under Captain W. H. Johnston, had begun the construction of a pontoon bridge over the Haine to enable the infantry to retire. Lieutenant Pennycuik took his section to assist in this about 3 p.m. In the evening, after the East Surreys had retired, this bridge had to be destroyed, as there was no time for dismantling.

The field squadron with the cavalry blew up the drop-bridge over the canal, north of Lieutenant Flint's bridge, at 5.15 p.m. The bridge at Lock 5 and a wooden bridge near it were also destroyed by the squadron. Early on the morning of the 24th two more bridges at St. Aybert were blown up by the same unit. They sent back all their wheeled transport during the night of the 23rd on the orders of the Cavalry Division, so they were without tools or explosives until 30th August, when they picked up their transport at Compiègne. They were employed as mounted infantry in the meantime.

The situation at nightfall on the 23rd August was that most of the bridges prepared for demolition had been successfully destroyed, but several were left untouched for want of time and explosives to destroy them. The canal was narrow and the Germans could not be delayed for long. Nevertheless, all that could be done under the circumstances had been done, and the moderate amount of available explosives had been utilized to the full. Many gallant deeds had been performed, and the casualties among the field companies were among the first incurred in the war. The sudden conversion of the advance

of the B.E.F. into an enforced retreat had prevented the preparation of any scheme of demolitions, and the absence of orders was perhaps inevitable in the confusion which followed, but the traditional training of the field companies had prepared them to act wherever they saw their opportunities.

Next day, the 24th August, the whole force retired to a line running east and west through Bavai. No bridge demolitions were carried out, but some of the field companies were engaged in the preparation of farm buildings for defence and in the construction of strong points, which, of course, were never occupied. Long marches and very little rest now became the order of the day.

On the 25th August, the retreat brought the I Corps across the Sambre, but there was still no policy for demolishing bridges. There was a general expectancy that the advance might soon be resumed, and therefore the bridges were not to be destroyed. Orders given to the 5th and 11th Field Companies of the 2nd Division (C.R.E.—Lieut.-Colonel R. H. H. Boys) to prepare demolitions were cancelled almost as soon as issued.*

Meanwhile the retreat of the II Corps was becoming jammed by traffic congestion, and its position seriously endangered. General Smith-Dorrien's decision to stand on the Le Cateau position and strike back at the enemy so as to gain time for a subsequent retirement, was taken during the small hours of the 26th. There had been no time to prepare a scheme of defence.

At Le Cateau, the 50th Field Company had its first experience of infantry fighting. At 7.15 a.m. on the 26th, the company paraded outside its billets at Remumont, and was about to move off when Major Walker received orders to report to the G.O.C. 14th Brigade, whose headquarters were said to be in Le Cateau, with a view to strengthening a position about that place. Captain W. H. Johnston was sent ahead with the cyclists to reconnoitre the town for materials for head cover. He was unable to find the 14th Brigade headquarters, but he soon met German cavalry. An ammunition column, apparently stampeded by the Germans, dashed up the road from Le

* *Demolitions at Mons, R.E. Journal*, March, 1933, p. 32.

Cateau at full gallop and went through the 59th Company which was descending the hill. This caused considerable confusion and one man and two horses were injured. Efforts to find the brigade headquarters were unsuccessful, and as the battle was now developing, the company was employed in assisting the 19th Brigade to strengthen its position on the right flank of the 5th Division. There was very little time for work, but fire trenches were dug and communications improved. These trenches were manned by the retreating infantry and by the sappers who dug them. When the trenches became overcrowded, the sappers got out and lay in the open. They came under heavy shrapnel fire in the afternoon, but they took an effective part in stemming the German infantry. At 4.30 p.m. they joined in the general retirement ordered.*

The 17th Field Company (Major C. W. Singer) put the village of Troisvilles into a state of defence, digging trenches, loopholing walls, and constructing observation posts until 2 p.m., when the enemy's attack made further work impossible. The company was then moved across to the right of the division and ordered to prepare a position to cover that flank. There was no time for work, however, and the company joined in the general retirement, bringing up the rear in such excellent order as to gain the congratulations of Sir Horace Smith-Dorrien himself. The 56th and 57th Field Companies of the 3rd Division on the left, were not heavily involved in the fighting and carried out no R.E. work.

From now onwards, until the B.E.F. arrived on the Aisne, the work of the divisional engineers consisted of the demolition of bridges and the construction of others. During the night of 26th/27th August a section of the 59th Company under Lieutenant Flint blew up the bridge over the St. Quentin Canal at Jussy, and others in the neighbourhood were prepared for demolition. Several prepared bridges were left for the field squadron to blow up, but as the squadron followed another route, the demolitions were not carried out.

* War diary of 59th Field Company. Diary of Lieutenant J. A. C. Pennycuik, R.E. *From the Curragh to the Aisne, R.E. Journal*, April, 1919. *Official History*, 1914, Vol. I, p. 106.

There was at this time much confusion about blowing up bridges. The French were generally averse to their demolition, and there was a shortage of explosives, but it seems that there was a reluctance to destroy bridges which might presently be required for an advance. This doctrine ignored the fact that the enemy was certain to blow them up himself if forced to retire, and our failure to destroy them merely assisted his advance. There were practically no orders for bridge demolition until the Marne was reached. The military importance of demolitions had not been fully realized throughout the British Army, and the supply of the necessary explosives was far too scanty for the large amount of work to be done.

The I Corps had fewer bridges to deal with, but being nearer to the French army, met with more opposition to their destruction. On the 27th August, the 23rd Field Company (Major C. Russell-Brown) prepared a bridge at Petit Cambrésis on the Sambre Canal, and also built a footbridge alongside it for the withdrawal of the rear-guard, but "at 3 p.m. orders came to withdraw the charges and leave the bridge standing. Arrangements had also been made to destroy the permanent bridge over the canal at Oisy and the temporary trestle bridge which had been built alongside by the 23rd Company but at the last moment urgent orders were sent by the 1st Division cancelling their destruction."* The 26th Company had orders to prepare five bridges over the Oise at Etreux, but these also were not destroyed.

The II Corps, continuing its retreat from Le Cateau, ordered the preparation for destruction of the bridges near Ham. The 17th Company was sent there, and Lieutenant G. F. B. Smyth and 2nd Lieutenant K. B. Godsell prepared the bridges, but again the orders for demolition were postponed or withheld until the opportunity had passed.

On the 28th August, it was again only in the II Corps that any steps were taken to prepare bridges. In the I Corps, the 11th Field Company (Major P. T. Denis de Vitré) reconnoitred the bridges over the Oise at Beautor and Condren, but the charges were not fixed until the following day, when the

* *Demolitions at Mons, R.E. Journal*, March, 1932, p. 33.

5th (Major C. N. North) and 11th Companies dealt with them. The 57th Company prepared the bridges at Ham, but only one was destroyed. The other was prepared by Lieutenant Boulnois, but at the last minute the charges were withdrawn, and the bridge left for a French cavalry brigade to cross.

On the 29th August, the bridges prepared at Beautor and Condren were allotted to the 11th and 5th Companies respectively. A medley of orders and counter-orders reached the unfortunate company commanders, but the two bridges at Condren were eventually blown up.

Meanwhile, the 4th Field Troop (Captain L. Chenevix-Trench) had been detailed to prepare the bridges at Chauny. Some French sappers were found to be preparing the main railway bridge there, so the field troop undertook the road bridge and a metre-gauge railway bridge. Lieutenant T. A. S. Swinburne took charge of the road bridge, and a corporal was posted to the light railway bridge. Orders and counter-orders succeeded each other owing to anxiety on the part of the Cavalry Division to see its brigades safely across, and on the part of the I Corps to get the demolitions completed. The N.C.O. on the railway bridge had orders to blow it up as soon as he heard the explosions at the neighbouring bridges, and when the French blew theirs at 3 a.m. on the 30th he followed suit successfully. Lieutenant Swinburne, on the other hand, received a written order from the I Corps to remove his charges and drop them in the river!

In the uncertainties of the retreat, there was some confusion concerning the respective responsibilities of the infantry divisions and the cavalry. The O.C. 5th Field Company went to Chauny at 8.30 p.m. on the 29th to ascertain what had been done, and found, as he thought, that the field troop had left four bridges unprepared. On his return to his company he reported this to the G.O.C., 6th Infantry Brigade, and was ordered to do the preparation with his own men. Accordingly, he sent two sections back to Chauny, but there received a series of orders and counter-orders, and finally only succeeded in partially destroying the two railway bridges. The 5th Company had a disturbed night in bivouac at Amigny. Twice

during the small hours, Major North received orders to blow the Condren bridges, and twice he received counter-orders. Both bridges were finally destroyed on an order received at 5 a.m. on the 30th, which was quickly translated into action before any further changes could intervene. One of the two bridges had in fact been blown at 3 a.m. on a previous order.

Meanwhile, the II Corps had crossed the Oise, and had issued orders to its divisions to prepare the bridges over the river and the canal. The 5th Division was made responsible for the bridges at Varèsnes and Pontoise, and the 4th Division (which had now arrived in the field; C.R.E.—Lieut.-Colonel H. B. Jones; 7th and 9th Field Companies) for those at Pont L'Évêque and Ourcamp. The 7th Company (Major S. G. Faber) was ordered to prepare the bridges between Pont L'Évêque and Sempigny, working all through the night of the 29th/30th, while the 4th Division was crossing. Lieutenants R. G. Wright, G. N. Macready and K. I. Gourlay each blew up their bridges successfully. Gourlay's first attempt on his bridge, an old stone one of massive construction, was only partially successful. He had attacked the haunches of two arches, but the charges were insufficient, and he had to make a second attempt. While he was placing this, the cavalry picquet covering the bridge "was attacked by dismounted Uhlans, who had crossed the river in a boat only a few hundred yards from the village, bringing a machine-gun with them. When they opened fire down a small street through the village parallel to the canal, the horses of the cavalry picquet were enfiladed and stampeded, and the R.E. horses took fright and disappeared up a side road into the forest, never to be seen again. The bridge, was held until Gourlay had fired the second charge, and he got away, mounted behind a cavalry officer."* Two sappers were severely wounded.

The 17th Company was responsible for the two bridges on the Noyon-Pontoise road, and four bridges at Varèsnes were allotted to the 59th Company. Lieutenant Smyth (17th Company) successfully blew up the girder bridge over the canal, but the wire-cable suspension bridge over the Oise proved a

* *Demolitions at Mons, R.E. Journal*, June, 1932, p. 222.

failure owing to shortage of gun cotton, and had to be left, damaged but still passable.

On the 30th August, the I Corps marched on and reached the Aisne near Soissons. The troops bivouacked for the night on the north bank, but the bridges were to be blown up at 3 a.m. next morning, or immediately if there was any danger of a rush. As before, the chief activities of the field companies occurred in the II Corps, which crossed the Aisne at Vic and Attichy. Captain H. M. Henderson and Lieutenant R. C. Wells (57th Company) with a few sappers successfully blew the bridge over the Oise at Bretigny. On arrival at the bridge they found two or three Uhlans on it. Henderson with one of the sappers drove them off, rescuing a man of the 59th Company previously captured by them.*

The 59th Company left the neighbourhood of Vaires very early on the morning of the 30th to follow the rest of the 5th Division in the direction of Attichy. At about 8 a.m. when the company had rejoined the main column, and during a brief halt for breakfast, Lieutenant West, R.E., an officer dispatch-rider, rode up on his motor-bicycle with a note for Major Walker from Major Buckle, Royal West Kent Regiment, to say that the suspension bridge at Pontoise was not completely demolished and was still passable. Lieutenant Pennycuik came up whilst Major Walker was reading the note, and immediately volunteered to go back with Lieutenant West to see if anything could be done. The distance was about eight miles. The motor-bicycle was loaded up with a box of fourteen gun cotton slabs, on the top of which mounted Pennycuik with his pockets full of primers and detonators. Major Walker suggested that if he could get to the bridge, the best place at which to attack the suspension cables was on the top of the piers. The two officers rode off, and passing first through the infantry rear-guard, and then the cavalry, reached the bridge, much relieved to find that the enemy had not yet arrived. They climbed one of the piers to investigate, and Pennycuik decided that with the small quantity of gun-cotton they had with them it was better to make sure of the job on one side than attempt a demolition on both piers. There were

* *Ibid.*, p. 224.

twin cables on both sides of the bridge, each cable being of round steel, some two inches in diameter. The whole charge of thirteen slabs (one had fallen into the river) was fitted in between the two cables on the top of the left hand pier, but the first attempt to set it off was a failure. The detonator fired, but the only result was that the primer broke up. A fresh primer and detonator having been inserted, the second effort was successful and, considering the small size of the charge, the demolition was a good one. The top of the masonry pier was blown off, and both the cables were cut. This dropped the roadway into the water and left it suspended on the right-hand cable only. In addition, three or four of the ties on the right side of the bridge were broken, probably by flying fragments of masonry. It was a bold feat and both officers were awarded the D.S.O.*

The bridge over the Oise at Bailly, which had been prepared by Captain F. C. Westland (9th Field Company) on the 29th was not destroyed, on orders received by Brigadier-General Hakland (10th Brigade) from the II Corps. The charges were withdrawn and Captain Westland rejoined his unit on the 31st; but at 3 p.m. on the 30th the C.R.E., 4th Division received orders to send an R.E. officer to II Corps for instructions. Four bridges over the Oise were to be destroyed from Bailly to Compiègne. Motor lorries were available to carry working parties and explosives. None of these bridges were blown, as the order had arrived too late. A party of the 9th Field Company under Lieutenant C. E. Fishbourne started off for Bailly in a lorry at 9 p.m. "to find their way in the dark by unknown roads, to a village they had never seen, to blow up a bridge which had not been reconnoitred by any of the party. As the infantry escort, which had been ordered by the division, did not arrive Major J. B. Baislow (O.C. 9th Field Company) accompanied the party, taking an escort of two sappers. They left the lorry 2 miles outside Bailly, and proceeded on foot, but were fired on by a picket at about fifteen yards range, with the result that Major Baislow was killed, and 2nd Corporal Stone so severely wounded that he could not be moved. The

* *Ibid.*, p. 224.

remainder of the party returned to camp (three of them wounded) at 5 a.m. having been unable to blow up the bridge, which could have been destroyed earlier in the day by Captain Westland without any trouble.**

The destruction of the bridge at Compiègne forms one of the classics of those days. The Commander-in-Chief, whose headquarters were still in the town on the 30th August, gave orders that the bridge was to be blown up next morning on the request of the French. It was a magnificent stone bridge of three arches supported by two massive piers. The 11 Corps was instructed to send a party to prepare it, and Lieutenant B. K. Young, 9th Field Company, was detailed. He arrived on the site at about 5 p.m. on the 30th with his section sergeant, eight sappers on bicycles and his tool-cart. He calculated the charge required for the haunches of one arch at 2½ tons of gun-cotton!

Meanwhile, Brigadier General Fowke had been to see the bridge, taking with him Captain S. F. Newcombe, whom he placed in charge. Captain W. G. S. Dobbie, adjutant of the 4th Divisional R.E., also appeared on the scene, and the two officers set about finding explosives and any information that could be obtained from the French. Captain Dobbie found a French Territorial officer who produced plans of the bridge disclosing the position of the demolition chambers with which all French bridges in that region had been provided, and about a ton of melinite. A wire had already been sent by General Fowke for 2 tons of gun cotton from another depot, and at about 6 p.m. a ton of it reached the railway station.

With these fortunate developments, the sappers set to work to remove the *paré setts* and expose the demolition chambers. There were three of these chambers in each pier, each 18 in. in diameter and 30 ft deep, going down well below the water line. They were so narrow that there was no room for a man inside to bend his body, and the bags of gun-cotton had to be lowered and trampled into position with the feet. Captain Newcombe himself undertook this difficult task, while Young prepared the electrical circuits and fuses. 400 lb. of gun-cotton

* *Ibid.*, p. 228.

tied up in sandbags with three slabs prepared with primers and detonators to each bag were lowered into each shaft. About a hundred pounds of the French melinite was added as a sort of tamping to each charge, and finally a layer of three sandbags filled with gravel finished them off. Fuse and leads, in duplicate, were brought up and laid across the *pavé* in grooves filled in with gravel and sand. During all this preparation, which took until nearly daybreak on the 31st, the roadway had to be kept open for two lines of traffic, and all through the night a stream of vehicles of every kind continued.

By dawn, all was ready. The sergeant and the sappers were sent back to find their company, taking with them the surplus gun-cotton, while Newcombe and Young remained to blow the bridge. The orders were that the demolition was to be made as soon as all the cavalry had crossed. General Fowke, who had remained on the spot, received a message from General Allenby at 11 a.m. saying that his division was clear, and he gave the order to fire the charges. Just as Lieutenant Young pressed down the handle of the exploder, a car full of refugees dashed on to the bridge. There was no explosion! The exploder had failed. There remained the alternative fuse. This did its work—rather too suddenly, for the 6 ft. of safety fuse burnt in 30 seconds.

The result was one of the cleanest demolitions of the war. There was almost no noise, and no damage to the neighbouring houses; but two of the three arches with their pier simply vanished, and no debris remained above the water line.

The moment of the failure of the exploder (it was afterwards found to have been defective) was an unenviable one for the R.E. subaltern. Under the eyes of his Engineer-in-Chief his first alternative had failed, but he has himself borne witness to the composure of the general. The happy escape of the refugee car, followed by the complete success of the demolition, was a sufficiently satisfying climax to a very hard night's work.

On the 31st August, the I Corps crossed the Aisne in two columns, at Soissons and to the west of it, and halted for the night between the river and the forest of Villers Cotterets.

The II Corps bivouacked south-west of Villers Cotterets, and the newly-formed III Corps (4th Division and 19th Brigade, Chief Engineer, Brigadier-General F. M. Glubb) marched through the forest of Compiègne to its south-west corner near Verberie. The retreating columns were unmolested by the enemy, and the bridges over the Aisne between Fontenoy and Soissons were destroyed. Lieutenant G. C. Gowlland (5th Company) blew up the girder bridge at Pommiers and Lieutenant J. H. Stafford (23rd Company) that at Bois Roger, both in the early evening of the 31st August.

The Field Squadron, working with the Cavalry Division on the left, prepared the suspension bridge at Port de la Croix St. Ouen, but received no orders for its destruction, and on being relieved at nightfall, the squadron withdrew its charges. At 8.30 p.m. the bridge was rushed by Uhlans.

The retreat was continued throughout 1st September, but only in the I Corps area were any demolitions carried out. The 23rd Company destroyed a girder bridge at Marolles at 11 p.m. and two bridges over the Ourcq at La Ferté Milon at 11.30 p.m. On 2nd September the 26th Company prepared two solid bridges over the Marne at Meaux, but had to leave them for the 57th Company to destroy the next day.

By this time, the B.E.F. had reached the outskirts of the Paris entrenched camp, and found that most of the bridges had been prepared by the French, and that French officers had been told off to them, with strict orders that demolition was only to be carried out by order from the Governor of Paris. In some cases this difficulty was overcome by verbal arrangement on the spot, backed by the obvious necessities of the moment, but in others much delay ensued while the various channels of communication operated. Some more definite allocation of responsibility for the bridges was included in British G.H.Q. orders for 2nd September, which apportioned to the three corps the responsibility for destroying the bridges over the Marne.

On 3rd September, the whole Force crossed the Marne; the 1st Division at Trilport; the 2nd and 3rd at Meaux; the 5th at Isles les Villenoy; the 4th at Lagny; and the Cavalry

Division at Gournay. They blew up all the bridges behind them as they moved south-east."* That night, the army lay south of the river, from Jouarre to Nogent.

The 1st Division was ordered to prepare the bridges at St. Jean les Deux Jumeaux and La Ferté sous Jouarre. The 23rd Company was given St. Jean and Sommeron; the 26th Company (Major H. L. Pritchard) La Ferté. There were four bridges in all, two falling to each company. Those at St. Jean and Sommeron presented no difficulty, and were successfully destroyed at 6.30 p.m. The 26th Company's bridges were ready by 7 p.m. but orders for their destruction were withheld until 4 a.m. next morning, when the O.C. conveyed them to his section officers, Lieutenants E. E. Calthrop and A. G. Smith, whom he had left by themselves on the bridges, covered by a company of Coldstream Guards. He found that Lieutenant Calthrop had already received orders to blow his bridge and had done so, but that the steel girders, although cut through had not fallen and still supported enough of the bridge to afford a passage for infantry. A second attempt was made, but this was further hampered by the bursting into flame of a broken gas main, ignited by a spark struck by a sapper picking at the *pavé*. Six charges were used this time, but again the result was not entirely satisfactory. The C.R.E. then arrived on the scene, and as the Germans had already reached the farther bank, he ordered the sappers to withdraw.

The 2nd Division had the two bridges at Trilport to deal with. The 5th Field Company (Major C. N. North) was ordered there, the road bridge being allotted to Lieutenant A. Q. Perkins and the railway bridge to Lieutenant G. C. Gowlland. The road bridge had already been prepared by the 4th Field Troop. Both were successfully destroyed. The 3rd Division dealt with the bridges at Meaux, the 57th Company (Major F. G. Howard) carrying out the work and completing destruction at 5 p.m. The 5th Division found the bridges in their area under the charge of French officers. There was some difficulty at first in persuading these officers to accept instructions from the British, as they had their own definite orders,

* *Official History 1914*, Vol. I, p. 253.

but eventually the trouble was cleared up, and the demolitions were all successfully carried out.

On 4th September the retirement slowed down; the III Corps remained at Lagny, while the right wing of the B.E.F. swung back to Coulommiers. On 5th September the great retreat came to an end, and in a few hours was converted into the victorious advance which forced the Germans back to the Aisne.

PASSAGE OF THE MARNE

It might have been expected that the Germans would have made certain of the demolition of the bridges over the Marne, but they had prepared none of those on the front of the British army. Only the largest bridges at La Ferté sous Jouarre were destroyed, and this had been done by the British in their retreat.

The heads of the British Corps had reached the southern bank of the Marne by the evening of 8th September and on the 9th the I and II Corps crossed the river. The III Corps was waiting for the completion of a bridge at La Ferté. This bridge, the first to be built by the field companies, was sited just below the old broken masonry bridge at the south end of the town. Its length was 220 ft. and it was made up of two trestles, the four pontoons of the 7th and 9th Field Companies, four barrel piers, one barge and two boats. The site was reconnoitred by the C.R.E., 4th Division (Lieut.-Colonel H. B. Jones) and his adjutant (Captain W. G. S. Dobbie). The field companies were well behind. The 9th Company had been digging all night and putting Jouarre into a state of defence, and it was not until 4 p.m. that it arrived on the spot. The 7th Company was even later. Considering the extreme probability that bridges would be required on the Marne, it is remarkable that the pontoons had not been pushed farther forward. The 1st and 2nd Bridging Trains, extremely cumbrous horsed units, after many adventures during the retreat, had been sent back to Le Mans, and were only entrained on this day for the front. There was no reason why they should not

have been sent forward two or three days earlier, to follow up the advancing army.

The work at La Ferté was divided: the 7th Company made the approaches and the 9th Company built the bridge. The covering troops were ferried across by boat. Extra decking and road-bearers had to be found locally, and barrels were collected from the neighbouring cellars, their contents being run to waste. Several Germans, dead drunk, were found during this process.* Work on the bridge continued all through the night of 9th/10th September and was finished at 6.30 a.m. "The last link was dramatic. All we possessed had been put into the bridge and it would not meet, when Lieutenant R. G. Wright (7th Company) suddenly appeared up stream in a row-boat which just filled the gap and saved the situation."† The division started crossing at once, and traffic continued up to 8.30 p.m. At 4 a.m. next morning, the 11th, the bridge was dismantled, the companies collecting their pontoons and hurrying off to overtake their divisions.

The two bridging trains had meanwhile been sent up by rail from Le Mans, and on the 11th, after detraining at Chaumes, were moving up at a good speed; but they were still two days' march behind. They each carried forty-two pontoons and sixteen trestles, and had about 350 horses.

PASSAGE OF THE AISNE

On the march from the Marne to the Aisne, nearly all the field companies found themselves too far back in the columns, and when required to push forward their bridge equipment they had great difficulty in getting past the traffic.

The I and II Corps and the Cavalry all had to overcome the resistance of the German rearguards in their advance to the Aisne, but the prisoners taken were from so many mixed units that it appeared that the Germans might retreat farther than the river. The British pursuit was therefore pressed, and the orders issued on the night of the 12th prescribed an advance

* Lt. B. K. Young, *Diary of a Subaltern, R.E. Journal*, Dec. 1933.

† *Ibid.*

across the Aisne up to a line about five miles beyond. Crossing places were allotted as follows :—

Cavalry Division and I Corps :—Bourg, Pont Arcy and Chavonne.

Gough's Cavalry and II Corps : Vailly, Condé and Missy.

III Corps :—Venizel and Soissons.

The bridges at all these places, except Condé, had been blown up by the Germans, but at Venizel and Pont Arcy the demolitions had been only partially successful.

The 4th Division had orders to push across the river on the night of the 12th if possible, and the Divisional Commander sent for the O.C., 9th Company (Major D. M. F. Hoysted) at 8 p.m. and instructed him to have a reconnaissance made. Captain F. C. Westland was sent to investigate, and came back with the report that on the Venizel bridge only two charges had gone off, and that men could get over the bridge in single file : that was all that he could be sure of in the dark. Acting immediately on this news, the 11th Brigade (Brigadier-General Hunter-Weston, late R.E.) began to cross. By 3 a.m., the whole brigade was over, and even some batteries of artillery were unlimbered and passed over by hand. This established a bridgehead and provided cover for the subsequent bridging operations. The pontoons were brought up and the 9th Company built a bridge alongside the damaged one. By midday on the 13th, the 4th Division thus had two crossing places over the Aisne, and these were soon to be supplemented by another pontoon bridge on the night of the 14th, built by the 9th Company with pontoons brought up by the 2nd Bridging Train, and by a number of footbridges put across on the gunwales of some barges found in the river.

Meanwhile, on the right of the British army, the Cavalry Division crossed at Bourg, and the I Corps at Bourg, Pont Arcy and Chavonne. At Bourg, the C.R.E., 1st Division (Lieut.-Colonel A. L. Schreiber), and his adjutant reconnoitred the crossings and found the 2nd Cavalry Brigade trying to force a passage. The two road-bridges over the canal were intact, but the main bridge over the river had been blown up. A crossing was possible, however, by the bridge which carried

the canal over the Aisne. This aquaduct had been damaged but needed only a little repair to make it passable even for heavy artillery and mechanical transport.* After crossing the river, transport could follow the canal towpath on the north bank until it reached the Bourg-Soupire road. After a little fighting, the cavalry got across at 9.50 a.m. The 23rd and 26th Field Companies were brought up and were employed for the greater part of the day in keeping the towpath in repair and widening and lowering it under the bridge. By the evening (13th) most of the 1st Division had crossed, but the transport continued its passage all night. Some barges were also placed across the canal to provide a second crossing for infantry if required. Meanwhile, at Pont Arcey, the 11th Field Company repaired the road bridge which had only been partially demolished; and by 5 p.m. the 5th Company had put a pontoon bridge across about half a mile west of Bourg.

Next on the left came the 3rd Division, of which the 8th and 9th Brigades got across by means of a single plank footway left by the Germans over a gap in the road-bridge at Vailly, supplemented later by a pontoon bridge built by the 56th and 57th Companies, and a footbridge improvised over the damaged light railway bridge.

Farther to the west, the 5th Division crossed at Missy and at the Moulin des Roches. At Missy, the enemy were driven from the damaged bridge at about 5 p.m., and the 59th Field Company was able to begin the preparation of rafts for the 13th Brigade. One small boat, one timber raft and two hay-bag rafts were used. The crossing of the brigade continued all night. The 17th Field Company arrived at Moulin des Roches at 11 a.m. and started work on ferrying the 14th Brigade. A two-pontoon raft working on a cable, two rafts of tarpaulins stuffed with hay, and a small boat were quickly got together and the ferrying began at 12.15 p.m. Sixty men, or four horses and thirty men, at a time were taken by the pontoon ferry, and twenty-nine men by the hay-rafts and boat. By 6 p.m. the whole of the 14th Brigade was across, except its S.A.A. carts. After a short interval for rest, work was resumed at

* War diary of C.R.E., 1st Division.

8.30 p.m., and then the 15th Brigade crossed during the night. By 6 a.m. on 14th September both brigades were over.

The passage of the 4th Division, which had been begun by the 11th Brigade during the night of the 12th, was continued on the 13th. Captain V. P. Smith (7th Company) was sent at 4 a.m. to reconnoitre the road-bridge at Soissons. The 7th and 9th Companies (Majors S. G. Faber and D. M. F. Hoysted) were brought up to Venizel and started work together on a pontoon bridge at a site selected by the Chief Engineer III Corps (Brigadier-General F. M. Glubb). Work began at 10.30 a.m., but almost at once the village was shelled, and bridging was interrupted until noon. The span was 195 ft., and three trestles, four pontoons and five barrel piers were used. By 6 p.m. the bridge was complete, and crossing continued throughout the night. At 3.30 p.m. the 7th Company was taken off and sent to Soissons, 4 miles westwards, with a view to joining the 2nd Bridging Train (Major C. M. Carpenter), which had arrived that afternoon, in the construction of a heavy bridge close to the broken road bridge.

By daybreak on 14th September, most of the fighting units of the B.E.F. were over the river Aisne, and were driving back the German rearguards and endeavouring to secure a foothold on the higher ground on the north bank. The I Corps had orders to resume the advance and capture the Chemin des Dames ridge; the II and III Corps had similar orders to continue the pursuit. But so far from continuing his retreat the enemy was strongly entrenching himself. The ensuing day's fighting was extremely fierce and confused. "It was the first day of that stabilization of the battle line that was to last so many weary months."*

The field companies, for the most part, continued their work on the bridges, repairing the damaged ones, and adding new ones. The 23rd and 26th Companies advanced with their division, and prepared a defensive line astride the Bourg-Vendresse road. The 5th Company went forward with the 6th Brigade.

The 3rd Division met with strong opposition, and their

* *Official Hist.*, 1914, Vol. I, p. 341.

bridge at Vailly came under very heavy artillery fire. In assisting the 5th Cavalry Brigade over the pontoon bridge, Captain T. Wright, V.C., the adjutant of the divisional engineers, was fatally wounded himself while helping wounded men to shelter.

The ferrying of the 5th Division at the Moulin des Roches continued all day, ammunition being passed over one way and wounded brought back the other. Captain W. H. Johnston and Lieutenant R. B. Flint, of the 59th Company were indefatigable; the former himself working the rafts under heavy fire. Captain Johnston received the Victoria Cross, and Lieutenant Flint the D.S.O.

In the 4th Division the 7th Company under Captain V. P. Smith, which had been sent to Soissons the previous evening, attempted to put a heavy pontoon bridge across the river in daylight, but the site was now in full view of the enemy, and no sooner had the first pontoon been put into the water from a convenient covered lane when heavy shells descended with great accuracy on the spot, accompanied by lighter artillery fire directed along the half-mile of road through the town on which the loaded pontoon wagons were standing, lending colour to the rumour that spies in the town were signalling to the German gunners. It was decided to postpone building the bridge until darkness, but in the afternoon, as the French had taken over the area, the operation was cancelled. The 7th Company returned to its division, and the pontoons were diverted to form another medium bridge at Venizel, which was put across that night by the 9th Field Company.

From this date onwards, the work of the field companies, besides the maintenance and repair of the bridges, included a steadily increasing amount of trench-work and wiring. The long period of trench warfare had begun. The infantry had not yet been trained to strengthen their own positions, or even to improve the slight shelter trenches dug with their small entrenching tools. Anything deeper than three feet, or anything in the nature of a wire entanglement was considered to be the business of the sappers, and as there were as yet only two field companies to a division, the tasks thrown upon them

immediately became overwhelming. Brigades called for assistance in improving the precarious foothold which they had just won upon the high ground on the north bank of the Aisne, and the utmost that could be done was to allot to them one or two sections each, leaving the remainder to keep up the all-important bridges. There was no reserve of engineers in hand, and the only relief the sections obtained was the alternation of work on the bridges, which were frequently shelled, with nights in the trenches, which were often attacked. Work on the bridges was at times very tiring, as the combination of heavy rain and German shelling had produced a swollen river full of debris, including very large trees. The floating bridges were thus in constant danger and had to be dismantled frequently to clear the stream.

The first requirements in the front line were overhead cover from shrapnel, revetment in the trenches and barbed wire entanglements for the frontal obstacle. There were no steel helmets. Tools and materials were scarce. The local French shovel—a heavy long-handled implement—was requisitioned wherever found, and wire was collected from the farms, but it was unfortunately not a closely fenced country. The undercutting of the parapet to obtain resting-places—learned from the Boers—produced the first “dug-outs.” The supply of revetting materials, wire “gooseberries,” *chevaux de frise* and fascines became the task of the field companies by day in order to carry the work forward by night. The strain fell particularly heavily upon the officers, for they had to make their reconnaissances in the morning, prepare their programmes and see to the collection of materials in the afternoon, and take their sections out at night.

During this period, a fine example of field company work was achieved by a section of the 9th Company, under Lieutenant G. le G. Martel. The old roadbridge at Soissons, consisting of several stone arches, had had a whole span demolished, leaving a gap of 76 ft. Lieutenant Martel prepared a design for a wooden lattice girder bridge to carry a concentrated load of 10 tons, and using local materials only. Work began on 30th September and the first girder was completed and tested

on the afternoon of 1st October. The other three girders were ready by the 5th. Launching was done on the 6th, and the bridge completed on the 7th. In all, the work took 61 hours. The construction of the girders under cover of the neighbouring houses caused intense interest among the French troops in whose area the bridge was being built. Many helping hands assisted the sappers in the launching: at one period the Chief Engineer of the III Corps (Brigadier-General F. M. Glubb) and his chauffeur were to be seen among those holding on to guy-ropes. The heaviest timber used was 9 in. by 3 in. The lattice bracing was of 1½-in. floor-boarding from neighbouring houses. The work was a great success, and the bridge became known thereafter to the French as the *Pont des Anglais*. A detailed account of it was officially circulated in the French Armies.*

During September, the 6th Division arrived on the Aisne. The C.R.E. was Lieut.-Colonel G. C. Kemp and it had the 12th Field Company (Major A. F. Sargeant) and 38th Field Company (Major F. M. Browne).† In order that they might gain instruction, the 12th Company was attached to the 3rd Division and the 38th to the 2nd Division. They were employed in building and maintaining bridges across the Aisne and on work in the front line.

The 1st and 2nd Bridging Trains, under Majors G. P. Scholfield and C. M. Carpenter respectively, had been sent to overtake the army soon after the general retreat was converted into the advance, and they arrived on the Aisne on 15th and 13th September respectively. The 1st Bridging Train was attached to the I Corps and the 2nd to the III Corps. Their pontoons being variously distributed amongst the divisions, but remaining under their own officers.

Work was also done in the preparation of defensive positions on the south bank of the Aisne. Battalions taken out of the line for rest provided the working parties, and R.E. officers borrowed from the field companies and bridging trains supervised them under the directions of the divisional Cs.R.E.

* An account, with plates, is given in the *R.E. Journal*, Dec., 1914.

† Killed in the Hohenzollern redoubt at Loos in 1915.

The 20th Fortress Company (Major A. G. Stevenson) and 42nd Fortress Company (Major T. E. Kelsall) took part in the operations, acting in the capacity of what were later known as Army Troops Companies. They were allotted to divisions and worked under C.S.R.E. on roads, battery positions and semi-permanent bridges over the Aisne.

FIRST BATTLE OF YPRES

Early in October, the B.E.F. began its transfer to the left flank of the line, its place on the Aisne being taken over by French troops. The II Corps drew out first, and the gap was closed by extending the flanks of the I and III Corps until they joined. The III Corps followed between 8th and 10th October; and the I Corps between the 14th and 19th.

Of the R.E. units, the 56th and 57th Field Companies (3rd Division) arrived first, detraining at Abbeville on 8th October, followed immediately by the 17th and 59th Companies (5th Division). The troops marched forward until they made contact with enemy advanced guards in the neighbourhood of Hazebrouck, Bailleul and Armentières.

At about the same time, the 7th Division (C.R.E. Lieut.-Colonel A. T. Moore) landed on the Belgian coast at Zeebrugge, and, with the 3rd Cavalry Division forming the new IV Corps, covered the withdrawal of the Belgian Army across the Yser. The field companies of the 7th Division—the 54th (Captain J. A. McEnery) and 55th (Captain L. St. V. Rose)—were thus approaching Ypres from the north-east as the 3rd and 5th Divisions were coming up from the south-west.

The country in which the British troops found themselves was very different from the hills and valleys of the Aisne. The Flanders plain was low-lying, closely intersected by hedgerows, wet ditches and canalized streams. The sub-surface water, never very low, rose rapidly in wet weather, and filled all excavations. It was an area in which the troops were to toil with relentless labour for the next four years.

As the divisions arrived, they engaged with the enemy on a front which continually extended northwards until the allied

left flank rested on the sea. The II Corps (3rd and 5th Divisions) was the first to come into the new line, and pressed back the German Cavalry about Givenchy and Neuve Chapelle. All field companies, which had formed parts of the advanced guards during the approach marches, now assisted the infantry brigades to entrench and to consolidate the long front. Billeted close behind the support lines, the companies spent their days in collecting materials and their nights in carrying them forward and putting up wire entanglements. Many foot-bridges were required over the numerous wet ditches; these had to be portable for handiness and of simple pattern for lack of materials.

As the line closed on the sea, the fierce struggle for Ypres began. The German right flank, consisting at first of two cavalry corps, was reinforced by infantry drawn from other sectors, and during the latter half of October by four new reserve corps, which were flung against our lines in a desperate attempt to break through to the Channel ports. The brunt fell upon the British I and IV Corps. The fighting from 19th October to 22nd November, known as the First Battle of Ypres, was as critical as any in the war. It was fought with the heaviest odds against the small British force and against a line which in some places was held even by cooks and batmen. The field companies bore their share in this famous defence; among them the 5th and 11th Field Companies specially distinguished themselves.

Even at this point in the war, the company commanders found that brigadiers had no very definite ideas about the employment of engineers in operations. Companies were attached to brigades, but the company officers had to press for orders in more cases than not. Many a time the sections trudged out to wait for hours, expecting orders which never came; the error of exhausting the sappers before they were really needed for work prevailed for a long period during the war. Much, however, depended upon the energies and capacities of the field company commanders. If the brigadiers were uncertain how to employ them, the commanders themselves could tactfully guide them. At a later stage of the war, the

field company commander would be detailed to attach himself to brigade headquarters for operations, but during the first battle of Ypres there was no such liaison.

A good account of the work of a field company during the first battle of Ypres is contained in the war diary of the 5th Company commanded by Major C. N. North. "On 24th October, after a night spent bivouacking in a field east of Hooze, we moved out at 7 a.m. for work with the H.L.I. and Worcesters, but as usual during fighting nobody appeared to want us, and one had to make oneself a nuisance to get orders or information." It was eventually found that the company had been placed under the 4th Brigade, who were due to attack at 3 p.m. The company was ordered to assemble near Polygon Wood and await instructions, but these never came, and in spite of many efforts on the part of Major North to find useful employment for his unit the day was wasted.

The attack continued next day, but the 5th Company remained in reserve until about 2 p.m. Then it went forward to the trenches of the Irish Guards and worked until 8 p.m. A bridge and a corduroy road were made over a swamp; paths were cut and communication trenches were started. In addition, some wire was put out in front of the 2nd Coldstream Guards. During the next four nights, similar work was done, costing the company the loss of Captain J. K. Dawson-Scott, who was killed while reconnoitring the line, and of Lieutenant A. Q. Perkins, who was wounded while leaving the trenches.

On the night of 31st October, Major C. N. North was himself killed while reconnoitring, and the command of the company devolved on Lieutenant A. E. Collins.

For the first ten days of November, the 5th Company worked every night on improving the scanty defences. Two small redoubts were made at the corners of Polygon Wood. On 11th November, at about 9.30 a.m., while the 5th Company was still bivouacking in the north-west corner of Polygon Wood, not far from 5th Brigade Headquarters, the new O.C. (Major A. H. Tyler) was informed that the Germans had broken through the 1st Black Watch and 2nd Connaught Rangers. Sergeant Lethbridge, R.E., and some twenty sappers were

sent to man the trenches on the south side of Polygon Wood, while Major Tyler took the rest of the company southwards into the open, occupying a disused trench and a short length of hedge on the left rear. This trench was enfiladed by enemy fire from the Nonne Bosschen on the right, and Lieutenant A. L. Collins was killed. The Germans had set fire to a cottage on the edge of the Nonne Bosschen, and the smoke from this obscured the view of the sappers in the trench. Also the right flank was in danger, as the Germans in the wood were well behind it. This caused Major Tyler to fall back to a second position, which had a similar right flank trench thrown back, from which Lieutenant Gowlland's section, aided by some twenty or thirty infantrymen, was able in their turn to enfilade the Germans.

At about 2.30 p.m., the Prussian Guards' attack having been stopped, the 2nd Oxford Light Infantry made a vigorous counter-attack with two companies, and drove the Guards through the Nonne Bosschen. Seeing this success on his right, Major Tyler ordered his men forward. The company split up into parties: one under Lieutenant Gowlland crossed over towards the left and followed a trench down the edge of Polygon Wood; another under Lieutenant H. F. Renny-Tailyour moved across the open, and a third with Major Tyler and 2nd Lieutenant N. M. Vibart moved along a communication trench towards the old British front trench. Fire from these parties accounted for about a hundred of the enemy running back outside the Nonne Bosschen. Soon afterwards, Major Tyler and Lieutenant Renny-Tailyour were killed, and several other casualties were caused by heavy machine-gun fire from a building on the right front. At about 4.30 p.m. the remains of the 5th Company were withdrawn under orders from Brigade Headquarters. About a quarter of the company had become casualties.

When the company had moved out in the morning it left its section cooks behind at the bivouac. These men attached themselves to a neighbouring French battery. Later, when enemy fire from a building outside the Nonne Bosschen was annoying the guns, these five men, led by Sapper Vye, advanced

in skirmishing order on the house, drove out five Germans and captured two of them. These they handed over to the French battery, and then joined their own company and took part in the final counter attack described above. The 5th Company gained seven D.C.Ms. for its exploits this day; a record for so small a unit.*

On 31st October, the 1st and 2nd Divisional Headquarters at Hooge chateau were shelled, and very serious losses occurred among the divisional staffs. Among those killed was Captain R. Ommanney, R.E., the G.S.O.₃ of the 2nd Division; Lieut.-Colonel R. H. H. Boys, the C.R.E. of the division was wounded. He was succeeded on 12th November by Lieut. Colonel G. P. Scholfield.

On 26th October, a section of the 11th Field Company (Major Denis de Vitré) assisted a company of the 1st King's in assaulting houses supposed to contain German machine-guns. At 5.20 a.m. this section succeeded in taking four houses on the Passchendaele-Berclacre road. These were loopholed and held by the section. At 9 a.m. another section advanced to support the first, and the two then held the houses all day, during which they suffered nine casualties. At dusk, they were relieved by infantry. The rest of the company worked until 5 a.m. next morning improving the trenches held by the King's Regiment. Major de Vitré was wounded, and was succeeded by Captain J. W. Skipwith, who was himself wounded two days later, and was succeeded temporarily by Captain A. J. Darlington, the adjutant. The latter returned to the division to act as C.R.E. on 1st November, and the command of the 11th Company passed successively to Lieutenant K. J. Martin, Lieutenant A. T. Shakespear, and Major C. H. Foulkes on 10th November. So heavy were the casualties in the 5th Company on 11th November that Lieutenant Shakespear was transferred to take temporary command on 12th November, but the 11th Company itself suffered two more casualties among its officers that day, Lieutenant A. Tyler being killed, and Lieutenant Bourdillon wounded.

In the 1st Division, both the 23rd and 26th Field Companies

* *War Diary of 5th Field Company, R.E. Journal, Oct., 1919.*

were frequently employed as infantry. On 31st October two sections of the 23rd Company were sent forward in extended order along the Ypres-Menin road near Veldhoek, in support of infantry; while the other two sections moved through woods farther south and had some fighting against small parties of Germans. They also man-handled one of the British guns out of action.

The 26th Company (Major H. L. Pritchard) advanced in a similar manner and ultimately came under the orders of Major-General Bulfin. On 1st November a heavy attack was made on Bulfin's force, and the 26th Company being the only reserve at hand, was put into the fight. The four sections were distributed to fill the gaps in the line. At dusk, the company was withdrawn, but continued at work through the night. It had lost Lieutenant A. G. Smith killed and about seventy other casualties—nearly half its strength.*

In the 1st Division, on 11th November, the divisional reserve included an engineer battalion 350 strong, composed of the 17th Company (5th Division), 56th Company (3rd Division) and 59th Company (5th Division) under Lieut.-Colonel C. S. Wilson, C.R.E. 3rd Division.

On 7th November, the two field companies of the 1st Division were turned out at 8 p.m. to try to localize the fires in Ypres, which by this time were burning continuously. They succeeded in putting out many fires near the main square, and in saving—for the time being—the tower and spire of the cathedral. But fresh incendiary shells kept falling on the town, and it was impossible to keep down the flames.

WINTER OF 1914/15

As the First Battle of Ypres died down, the stabilization of the line began, and for the rest of the winter the R.E. were employed without respite on improving the trenches, repairing roads, improving billets, and manufacturing all kinds of trench stores, makeshift bombs, grenades, periscopes and trench mortars. Nearly every field company had a bomb factory. It

* *Official History, 1914*, Vol. II, p. 356.

was not always possible to maintain full safety precautions under the haphazard conditions of the period, and some serious accidents occurred. An explosion in the bomb-shop of the 11th Field Company on the 11th January, 1915, killed six men and wounded eleven.

The 8th Division, C.R.E. Lieut.-Colonel W. H. Rotherham, arrived in France on 6th November, 1914. It contained the 2nd Field Company (Major C. E. G. Vesey) from Egypt, and the 15th Field Company (Captain P. K. Betty) from Gibraltar. It and the 7th Division were formed into the IV Corps in November.

During October the Indian Corps (Chief Engineer, Colonel H. C. Nanton) disembarked at Marseilles. It contained the Lahore and Meerut Divisions, with 20th and 21st Companies, 3rd Sappers and Miners, and 3rd and 4th Companies, 1st K.G.Vs. O. Sappers and Miners.

During the winter the B.E.F. was formed into two Armies composed as under :—

First Army (Chief Engineer, Major-General S. R. Rice).*

I Corps (Chief Engineer, Brigadier-General C. Godby).

IV Corps (Chief Engineer, Brigadier-General R. U. H. Buckland).

Indian Corps (Chief Engineer, Brigadier-General H. C. Nanton).

Second Army (Chief Engineer, Major-General A. E. Sandbach).*

II Corps (Chief Engineer, Brigadier-General G. M. Heath).

III Corps (Chief Engineer, Brigadier-General F. M. Glubb).

During November the Special Reserve Siege Companies arrived to supplement the very slender resources in Corps and Army engineers. They were the 1st and 2nd Royal Anglesey and the 1st and 4th Royal Monmouthshire, and were destined to have a very busy time for the next four years.

* The two Chief Engineers of Armies were appointed in February, 1915, but their successors in I and III Corps respectively were not appointed till April and May, 1915.

During the winter, an additional field company was sent out to each division. These were first line Territorial units who had mobilized on the outbreak of war, and had had, therefore, some five months' training before going to the front. The eight infantry divisions now in France received, between 10th December and 3rd January, additional companies as follows:—

- 1st Division—1st Lowland Field Company,
- 2nd Division—1st East Anglian Field Company,
- 3rd Division—1st Cheshire Field Company,
- 4th Division—1st (The St. Helens) West Lancashire Field Company,
- 5th Division—2nd Home Counties Field Company,
- 6th Division—1st London Field Company,
- 7th Division—2nd Highland Field Company,
- 8th Division—1st Home Counties Field Company.

These extra field companies were a welcome addition to the divisional engineers. Besides providing a third company to fit the three-brigade organization, they afforded relief to the overworked regular companies which by this time were very much in need of a rest. The new units brought a varied experience, which, if it was not war experience, was fruitful in organizing such growing necessities as workshops, saw mills, laundries and so on.

Breweries were converted into bathing establishments, where hot baths were obtainable close up to the lines. Old engines were searched for, and brought into use for driving saw-benches; and soon each company had its own saw-mill, from which it turned out timber scantlings of all sizes, mining and dug-out frames, loophole boxes and light wooden tramway track.

Each infantry brigade started a mining section, fathered at first by the field companies, and developing rapidly into the tunnelling companies. Most of the commanders of the original mining companies were drawn from the field companies.

Early in 1915, the difficulty of getting up supplies from the refilling points led to the manufacture of wooden 2-ft.

gauge tramways. The rails were 3 in. by 2 in. and the sleepers of 1 in. planking. Wheels for the trucks came from the mining area round Béthune or from the factories of Armentières. It was remarkable how these little railways stood up to the traffic and the shelling, and they proved to be valuable labour-savers. Owing to the quiet running on wooden rails, they could be taken close up to the support trenches. They were the forerunners of the light railways of 1917-18.

Operations against the enemy were kept up during the winter. The pressure was designed to maintain the offensive spirit of the troops, to remove an obnoxious proximity or to assist the French. During one of these operations by the 8th Division, two sections of the 15th Field Company assisted the 2nd West Yorkshire Regiment to consolidate on 18th December. The German advanced trench was seized, but the enemy counter-attacked next morning, driving our troops out again. Lieutenant P. Neame, 15th Field Company, displayed great gallantry on this occasion by standing up on the parapet and bombing the Germans while the West Yorkshire Regiment withdrew and carried back their wounded. He was awarded the Victoria Cross.

Another Victoria Cross won during this winter was that of Lieutenant C. G. Martin, 56th Field Company. He was in command of a small bombing party during an attack by the 7th Brigade near Spanbroekmolen on 12th March, and although wounded early in the action he led his party into the enemy's trenches and held back the German reinforcements for two and a half hours until the evacuation of the captured trench was ordered.

R.E. UNITS OF THE INITIAL BRITISH EXPEDITIONARY FORCE

AUGUST, 1914

Cavalry Division

1st Field Squadron,
1st Signal Squadron,
1st Signal Troop,
2nd Signal Troop,
3rd Signal Troop,
4th Signal Troop.

I ARMY CORPS

1st Division

23rd Field Company,
26th Field Company,
1st Signal Company.

2nd Division

5th Field Company,
11th Field Company,
2nd Signal Company.

ARMY TROOPS

1st Bridging Train,
2nd Bridging Train,
H.Q., G.H.Q. Signal Company,
H.Q., 1st A.H.Q. Signal Company,
H.Q., 2nd A.H.Q. Signal Company,
H.Q., 3rd A.H.Q. Signal Company,
Air Line Sections A to E,
Cable Sections F to I,
Wireless Section Q.

5th Cavalry Brigade

4th Field Troop,
5th Signal Troop.

II ARMY CORPS

3rd Division

56th Field Company,
57th Field Company,
3rd Signal Company.

5th Division

17th Field Company,
59th Field Company,
5th Signal Company.

L. OF C. UNITS

Railway Transport Establishment,
8th Railway Company,
10th Railway Company,
20th Works Company,
20th Fortress Company,
22nd Fortress Company,
1st Printing Company.

POSTAL UNITS

Base Post Office,
Advanced Base Post Office,
1st Stationary Post Office,
2nd Stationary Post Office.

ARRIVALS IN THE B.E.F. UP TO 6th OCTOBER, 1914

1st Cavalry Division

1st Field Squadron, H.Q. & 2 Troops,
1st Signal Squadron,
1st Signal Troop,
2nd Signal Troop,
4th Signal Troop.

*2nd Cavalry Division**

4th Field Troop,
1st Field Squadron, 2 Troops,
2nd Signal Squadron,
3rd Signal Troop,
5th Signal Troop.

* The 2nd Cavalry Division was formed on 16th September.

I ARMY CORPS

No change.

II ARMY CORPS

No change.

INDEPENDENT

7th Division†

54th Field Company,

55th Field Company,

7th Signal Company.

III ARMY CORPS*

4th Division

7th Field Company,

9th Field Company,

4th Signal Company.

6th Division

12th Field Company,

38th Field Company,

6th Signal Company.

ARMY TROOPS

20th Fortress Company, from L. of C.,

42nd Fortress Company, from L. of C.,

H.Q. of 3rd A.H.Q. Signal Company.

Otherwise no change.

ARRIVALS IN THE B.E.F. UP TO
22nd NOVEMBER, 1914‡*2nd Cavalry Division*

2nd Field Squadron,

4th Signal Troop.

3rd Cavalry Division

3rd Field Squadron,

3rd Signal Squadron,

Two Signal Troops.

IV CORPS

*7th Division**8th Division*

2nd Field Company,

15th Field Company,

8th Signal Company.

Secunderabad Cavalry Brigade

1st Indian Field Troop,

Signal Troop.

1st Indian Cavalry Division

2nd Indian Field Troop,

2nd Indian Signal Squadron,

Three Signal Troops.

INDIAN CORPS

Lahore Division

20th Company 3rd S. & M.,

21st Company 3rd S. & M.,

Lahore Signal Company.

Meerut Division

3rd Company 1st K.G.O., S. & M.,

4th Company 1st K.G.O., S. & M.,

Meerut Signal Company.

ARMY TROOPS

1st Siege Company, R. Anglesey R.E.,

1st Siege Company, R. Monmouthshire

R.E.,

2nd Siege Company, R. Anglesey R.E.,

4th Siege Company, R. Monmouth-

shire R.E.,

1st Ranging Section.

L. OF C. UNITS

2nd Railway Company, R. Mon-

mouthshire R.E.,

3rd Railway Company, R. Anglesey

R.E.

* The III Army Corps was formed on 31st August, the 4th Division having landed on 22nd August and the 6th Division landing on 9th September.

† The 7th Division landed at Zeebrugge on 6th October.

‡ Those who had arrived in France by this date received a bar, inscribed "5th Aug. to 22nd Nov. 1914," to the 1914 Star, and may wear a silver rosette on the ribbon.

CHAPTER X

BATTLES OF 1915 IN FRANCE AND FLANDERS

Neuve Chapelle Second battle of Ypres—Aubers Ridge—
Festubert Operations during the summer of 1915—
Preparations for Loos Loos Defensive work in 1915.

NEUVE CHAPELLE

EARLY in March, 1915, preparations began for the attack on Neuve Chapelle. This was the first planned battle which the B.E.F. fought; it was also the first battle fought by the British independent of French assistance. The plan was formulated by Sir Douglas Haig, commanding the First Army, and it was carried out by the IV and Indian Corps. The attack was to include the capture of the village of Neuve Chapelle and was designed as a step towards gaining the Aubers Ridge, with the possibility of an advance on Lille.

About ten days were available for the preliminary preparations, of which the engineer work can be classified under the following headings:—

- (a) Digging of trenches and building of breastworks for use as assembly places for the attacking brigades.
- (b) Construction of additional communication trenches.
- (c) Building of splinter-proof shelters for the report centres of brigades.
- (d) Laying wooden tramlines to facilitate supply of stores and ammunition to the trenches.
- (e) Formation of advanced depots of engineer tools and stores.
- (f) Training of sappers to work with the infantry trench-blocking parties.
- (g) Building of splinter-proof bomb depots in the trenches.

- (h) Construction of ladders to facilitate exit of the assaulting troops from the trenches.
- (i) Provision of light footbridges for the passage of wet ditches etc. in the German lines.
- (j) Cutting embrasures for machine-guns in front line trenches.
- (k) Reconnaissance of ground.
- (l) Issue of tools, sandbags etc. to the infantry.

The trench blocking parties were each composed of some twenty-five infantrymen with three sappers, carrying tools and sandbags. The sappers assisted in the construction of machine-gun emplacements, and in making stops, which were to be 40 yds. ahead of the machine-guns, blocking the trench but allowing one man to pass at a time. The grenadiers of the party bombed forward so as to cover the construction of the stops.

The field companies were allotted as follows :—

7th Division.—2nd Highland Field Company to 21st Brigade (leading), 55th Field Company, three sections to 20th Brigade (supporting), 54th Field Company, two sections to 22nd Brigade (holding the original British trenches on the left of the attack). In reserve at Laventie under the C.R.E.—One Section 55th Company and two sections 54th Company. Each field company had a hundred infantrymen attached as carriers.

8th Division.—15th Company, attached to 23rd Brigade (left attack), with one section split up among the infantry blocking parties, 2nd Company, attached to 25th Brigade (right attack), with one section split up among the blocking parties. The 1st Home Counties Field Company and 1st Siege Company Royal Anglesey R.E. (less one section each, detailed to dig communication trenches up to the captured lines) in reserve at Pont du Herm under C.R.E., 8th Division. Each field company also had a hundred attached infantry.

Meural Division.—The 3rd and 4th Companies of the 1st Sappers and Miners, with four companies of the 107th Pioneers, were told off in three parties to construct strong points behind the first objective.

In the 7th Division, a mobile depot of engineer stores was formed, together with eight pontoon wagons, and parked at Laventie. The wagons proved very useful later in getting stores forward. Some of the stationary dumps previously prepared were set on fire and destroyed before they could be used.

The Cs.R.E. of the 7th and 8th Divisions at this date were Lieut.-Colonels R. P. Lee and P. G. Grant respectively. Up to 7th March, Major C. E. G. Vesey (2nd Field Company) had been acting as C.R.E., 8th Division, pending Lieut.-Colonel Grant's appointment, and had been responsible for most of the preparations. The battle opened on 10th March.

The principal attack fell to the 8th Division in the centre. Careful preparations had been made by the C.R.E., and as soon as the village of Neuve Chapelle had been cleared of the enemy, the R.E. parties went forward and began the consolidation, loopholing walls and blocking up window openings and doorways. Work was carried on as long as possible but the shelling of the village was very heavy. In the afternoon, the 1st Home Counties Field Company and the 1st Royal Anglesey Siege Company were brought up from the reserve to clear and repair roads.

The attack was renewed next day, and the 2nd Company was allotted to the 25th Brigade holding Neuve Chapelle, while the 15th Company went to the 24th Brigade for the attack on the next objective. The 1st Home Counties and the Anglesey Companies were again employed on road work. Shelling and machine-gun fire were more severe than on the previous day, and little work was possible till nightfall when the R.E. parties carried on with their consolidation.

Although the first attack had been an undoubted success, and had given rise to impressions of an actual break-through—so much so that the cavalry were brought up to be at hand ready to exploit the breach—the impetus gradually spent itself, and the operations died down for want of sufficient force and ammunition. By the evening of 13th March, work had reverted to purely defensive consolidation.

The engineers of the 7th Division had not been able to

accomplish much, owing to the splitting up of the companies amongst the battalions. After the first day, there was difficulty in locating the sections, and the companies were therefore not used to the best advantage.

The R.E. casualties in the 8th Division alone amounted to five other ranks killed, three officers* and seventy-seven other ranks wounded, and four other ranks missing.

There were three distinct methods of employment of the engineers in this, the first, "set-piece" attack of the B.E.F. In the 7th Division, as mentioned above, the field companies were split up into sections working with battalions; in the 8th Division, the companies, although allotted to brigades, were given definite tasks by their C.R.E. and were kept to a certain extent under his control; in the Meerut Division, the companies with their attached pioneers worked definitely under their C.R.E. and independent of brigades. Of the three methods, the middle course became the general practice up to about 1917. The companies always did better work when under their own Cs.R.E., but it was considered essential that brigadiers should have engineer assistance immediately at hand. A compromise was therefore arrived at. While the front line was static, field companies could work in sectors, which were usually brigade sectors, and with which the R.E. officers soon became familiar. For operations, the companies were usually told off to brigades, but executed work detailed by the C.R.E. For movement from one part of the line to another, the field companies moved and billeted with brigade groups.

Even when the third field companies had arrived, there was always more work to be done than engineers to do it; and at the time of Neuve Chapelle there were very few opportunities for giving the companies any rest. The infantry had not been trained to do any consolidation of their own positions—indeed there was no reason why they should have been, if proper provision of engineer units had been made, and wiring the front line was still done by the field companies. The call for infantry

* Lieutenant G. J. Wellesley and 2nd Lieutenant H. J. Higgs of the 2nd Field Company, and 2nd Lieutenant H. A. Broadway of the 15th Field Company.

carrying parties to assist them was treated as a fatigue rather than a measure of mutual help. It was not until 1917 that the infantry as a whole fully realized the need for closer co-operation, and that the field companies really did exist for their benefit.

After Neuve Chapelle, the increase of the B.E.F. and the arrival of new divisions with new field companies (partly officered by promotions from the units of the first eight divisions) permitted a more rapid development of the rearward services which ministered to the comfort of the troops. Reliefs could be carried out more frequently, and men coming out of the line could obtain hot baths and clean clothing before enjoying a week or ten days' rest in barns and billets which had been rendered more habitable than before.

At the end of 1914 and during the first six months of 1915, the following new divisions with their Cs.R.E. and field companies arrived in France:—

27th Division, 19th December	Lieut.-Colonel S. Keen (T.F.), with 1st S. Midland, 1st and 2nd Wessex Field Companies.
28th Division, 15th January	Lieut.-Colonel H. W. Jerome, with 1st Northumbrian and 1st N. Midland Field Companies.
46th Division, 24th February	Brigadier-General C. V. Wingfield-Stratford, with 2nd N. Midland and 2/1st N. Midland Field Companies.
47th Division, 9th March	Colonel A. H. Kenney, with 3rd London and 4th London Field Companies.
48th Division, 28th March	Lieut.-Colonel E. S. Sinnott (T.F.), with 1st S. Midland and 2nd S. Midland Field Companies.
49th Division, 12th April	Lieut.-Colonel R. B. Heywood (T.F.), with 2nd West Riding Field Company.
50th Division, 18th April	Lieut. Colonel J. E. McPherson (T.F.), with 2nd Northumbrian Field Company.
51st Division, 30th April	Lieut.-Colonel C. L. Spencer (T.F.), with 1st Highland and 2/2nd Highland Field Companies.

9th Division, 9th May	Lieut.-Colonel H. A. A. Livingstone, with 63rd, 64th and 90th Field Companies.
14th Division, 18th May	Lieut.-Colonel H. Prentice, with 61st, 62nd and 89th Field Companies.
12th Division, 29th May	Lieut.-Colonel, S. F. Williams, with 69th, 70th and 87th Field Companies.

Early in April a further extension of the British front relieved more of the French troops, and there were now sixteen British divisions opposed to 11½ German. The new extension carried the British line round the Ypres salient once more, as far as the Ypres-Poelcapelle road, and from now until the end of the war, "The Salient" was held by British troops.

The trenches taken over were in poor condition, and very insanitary. The French, relying upon their famous artillery to smother any attack, had neglected their earthworks, and even the dead of the first battle of Ypres still lay unburied, in the Langemark area. There was thus much work to be done and, as it so happened, very little time to do it in, for the Germans were about to launch their first gas attack on the north-east shoulder of the salient.

Before this attack, the British II Corps had been making preparations to drive the Germans off Hill 60, an artificial mound adjoining the Ypres-Comines railway, about two and a half miles south of Ypres, giving the enemy a full view over that part of the salient right up to the ramparts of the town. The 28th Division had begun the preparations by mining towards the hill. A mining section had been formed of Welsh miners from the 1st and 3rd Battalions of the Monmouthshire Regiment (28th Division) and attached to the 1st Northumbrian Field Company. These men worked under the direction of Major D. M. Griffith, adjutant to the C.R.E., 28th Division. When the division was relieved by the 5th Division, the miners were left and were reinforced by the newly-formed 171st Tunnelling Company. The 13th Brigade was ordered to carry out the attack, which came as a complete surprise to the enemy. In the middle of a quiet evening, 17th April, five mines were exploded, a bombardment by twelve batteries immediately

burst out, and the storming party—a company of the 1st Royal West Kent Regiment and a section of the 1st/2nd Home Counties Field Company—dashed out to seize the craters. It was the first example of mining and crater-seizing on our front. The attack was completely successful, and consolidation began at once, but the inevitable counter attacks followed early next morning, and throughout the period 18th to 21st April, the hill was subjected to terrific bombardments and infantry attacks, and was finally lost on the 5th May.

SECOND BATTLE OF YPRES

As already mentioned, the British army now held two-thirds of the perimeter of the Ypres Salient. The remaining third was held by the French 45th and 87th Divisions (the former an Algerian division and the latter a Territorial) filling the line between the 1st Canadian Division and the Belgian army. The V Corps front was held by the 27th, 28th and 1st Canadian Divisions. Although there had been some authentic warnings that the Germans intended to use gas, they were set aside and, even when some of the gas cylinders had been blown up on Hill 60 on 17th April, the smell of gas had been attributed to gas shells.

At 5 p.m. on 22nd April, gas was released against a 4-mile front held by the French 45th and 87th Divisions, accompanied by a furious bombardment. The French troops immediately broke. All through that night, they were leaving their lines, with the single exception of the 1st/1st Tirailleurs, who stood their ground on the left of the Canadian Division.

This produced a great gap in the salient, and very few reserves were at hand to fill it, but the Germans were in no hurry to come on, apparently fearing the effects of their own gas, or perhaps unprepared to follow up so surprising a success. At midnight, the Canadians made a counter-attack through Kitchener's Wood, and by daybreak, there was some sort of a line, with large gaps, drawn back from the Canadian left flank to the Brielen bridge. Reinforcements were hurried up, and every battalion in the divisional, corps and army reserves was

put in. A deliberate counter-attack was made on the afternoon of 23rd April, in full daylight, but it was stopped by concentrated German machine-gun fire, with very heavy losses to the Canadians and the 13th Brigade of the 5th Division. The Germans were able to bring very heavy artillery fire to bear upon the British defences, and however stoutly the battalions fought, they were too few to withstand the enemy pressure; and the French, in spite of Foch's measures, were unable to do anything on their part to recover the ground they had lost.

At 4 a.m. on 24th April, another cloud of gas was released, and the British line was again forced back. Attacks and counter-attacks followed in rapid succession, but it was not until 1st May that the deliberate withdrawal to what was known as the Frezenberg Line began. During the night of 3rd/4th May the three divisions—27th, 28th and 4th—withdrawed to the new line, unmolested by the enemy. Further attacks followed on 8th May, forcing the line still farther back, and on 13th and 25th May more withdrawals were made, until the line came finally to rest on an arc little more than two miles from Ypres.

The battle included some of the heaviest fighting of the war. The casualties in the ten divisions engaged, including the 1st, 2nd and 3rd Cavalry Divisions, amounted to 2,150 officers and 57,125 other ranks.*

During all this fighting, the whole of the engineers of eleven divisions, as well as R.E. units of corps troops, were heavily engaged in consolidation, first of the G.H.Q. line, which had been begun in the days of the first battle of Ypres, and, during the later stages of the fighting, of the successive support positions necessitated by the withdrawal.

The R.E. units most heavily engaged were:—

1st, 2nd and 3rd Cavalry Divisions	1st, 2nd and 3rd Field Squadrons.
4th Division	9th and 171st West Lancs. (T.F.) Field Companies.
5th Division	59th, 122nd Home Counties (T.F.) and 21st N. Midland (T.F.) Field Companies.

* *Official History*, 1915, Vol. I, p. 350.

7th Division	54th and 55th Field Companies.
27th Division	17th, 1/1st and 1/2nd Wessex (T.F.) Field Companies.
28th Division	38th Field Company (transferred from 6th Division in April).
50th Division	1/1st and 1/2nd Northumbrian (T.F.) Field Companies.
Lahore Division	20th and 21st Companies, 3rd Sappers and Miners.
Canadian Division	1st, 2nd and 3rd Canadian Field Companies
II Corps Troops	1/1st Wiltshire Fortress Company (T.F.).
V Corps Troops	2nd Siege Company R. Anglesey and 4th Siege Company R. Monmouthshire Royal Engineers.
G.H.Q. Troops	2nd Bridging Train R.E., and 2nd Cornwall Fortress Company R.E. (T.F.).

The bridges over the Yser Canal were, of course, of vital importance to the conduct of the battle. In April, when the British took over the rest of the salient there had been only one bridge, built by the French on timber trestles with a canal barge in the centre, about one and a quarter miles east of Brielen, but a number of footbridges had been immediately added by the field companies of the Canadian Division. The roads through Ypres were still available for the 27th and 28th Divisions, as the cathedral and cloth hall were still standing, though heavily damaged, and the fine old houses round the Grande Place had not yet covered the roadway with their debris. On 5th and 6th May, pontoons of the 2nd Bridging Train were brought up, and two bridges were put across the canal by the 2nd Cornwall Fortress Company. The O.C., 2nd Bridging Train (Major C. M. Carpenter) was put in charge of the sixteen bridges on the section of the canal north of Ypres, with working parties drawn from the bridging train, the 1/1st Wiltshire Fortress Company and the 4th Siege Company, R. Monmouthshire Royal Engineers.

On 29th April, when preparations were being made by General Plumer for a withdrawal of the British line, all available

engineer companies, with large working parties from the 28th and 50th Divisions, were set to work on a new line, under the Chief Engineer V Corps (Brigadier-General R. D. Petric). The trenches could not be dug more than three feet deep, and the only shelters which at that time could be provided were merely splinter-proof. Supplies of timber were very scanty, and there was not yet a regular flow of stores to fill up the R.E. parks which had been established at Abeelee and Strazeele. The remnants of the villages left in the gradually narrowing salient were put into a state of defence by the field companies.

(

AUBERS RIDGE

While the Second Battle of Ypres was at its height, another large-scale operation was in preparation by the British First Army. Sir John French had agreed with General Joffre to co-operate with the French Tenth Army in a strong offensive north of Arras in order to drive the Germans from the high ground known later as the Vimy Ridge and, if possible, to break through to Cambrai and Douai. The British First Army was to advance on 8th May, the day after the French attack opened, towards the Aubers Ridge and La Bassée. The dates were later postponed twenty-four hours.

Sir Douglas Haig's plan was for the I and Indian Corps to attack between Chocolat Meunier Corner (about one and a half miles north of Festubert) and Neuve Chapelle, while the IV Corps attacked astride the Sailly-Fromelles road, on a frontage of 1,500 yds.

The I Corps comprised the 1st, 2nd and 47th Divisions; the Indian Corps, the Lahore and Meerut Divisions; the IV Corps, the 7th, 8th and 49th Divisions. In G.H.Q. reserve, there were the five cavalry divisions (1st, 2nd and 3rd British, and 1st and 2nd Indian), the Canadian Division and the 51st (Highland) Division.

As the result of the experience gained at Neuve Chapelle in March, the preliminary bombardment to cut the enemy's wire and to demoralize the defenders was to be intense, but, unlike the French who had ample supplies of ammunition, the British

were forced to limit their artillery preparation to forty minutes.

The amount of engineer work was greater than at Neuve Chapelle. The 54th and 55th Field Companies of the 7th Division had been sent to help at Ypres, and did not rejoin their division until 7th May. The preliminaries consisted of :— the preparation of assembly trenches close up to the front line ; the digging of communication trenches to cater for up and down traffic ; the cutting of steps in the parapets to facilitate exit ; the provision of light footbridges to cross the ditches and larger brooks ; the provision of portable artillery bridges to get the field artillery forward ; and the collection and protection of dumps of stores, ammunition and grenades.

The attacks were not successful. On the right, the I Corps and the Indian Corps were unable to reach their objectives ; and on the left, the IV Corps, attacking with the 8th Division, although it had some initial success, met with a similar failure. The Germans were too well-entrenched, and the British artillery had failed to smash their defences or to cut their wire. Further assaults on the enemy's position were first postponed and then cancelled. The loss of 458 officers and 11,161 other ranks had been incurred.

The field companies in the attacking divisions had been allotted similar tasks in each case. As a rule, one field company was allotted to each brigade, leaving one company in reserve under the C.R.E.

The following account (from the diary of the C.R.E., 8th Division—Lieut.-Colonel P. G. Grant) gives a description of the engineer work in the battle :—

On the night of 5/6th May the companies placed eighty footbridges across the Laves brook.

For the attack on Fromelles on 9th May each field company had one officer and sixty infantrymen attached. The R.E. were distributed for the attack as follows :—

Right attack 2nd Field Company, less one section.
(24th Brigade) One section, 1st Home Counties Field
Company.

Left attack 15th Field Company, less one section.
(25th Brigade) One section, 1st Home Counties Field Company.
In reserve, One section each of 2nd and 15th Field Com-
under C.R.E. panies.
 1st Home Counties Field Company, less two
 sections.
 1st Siege Company, R. Anglesey R. Engineers.
 1/1st W. Riding Field Company (from 49th
 Division).

The sections detached from the 2nd and 15th Field Companies were intended to work at Fromelles when the village had been captured. The 1st Siege Company, R. Anglesey and the 1st West Riding Company were temporarily attached with the object of rapidly improving roads through the British and German trenches so that the guns, cavalry and motor machine-guns could be got through to the front at the earliest possible moment.

C.R.E. headquarters were opened at 10 p.m. on 8th May in the Rue des Quesnes, alongside the divisional headquarters. At 4 a.m. on 9th May, the R.E. assembled in trenches close to these headquarters.

The bombardment started at 5 a.m. and at 5.40 a.m. two mines prepared by the 173rd Tunnelling Company (Major G. C. Williams) were fired, and the infantry assault started. At 5.50 a.m., the C.R.E. heard that the main assault had gained the German trenches, and he ordered the Anglesey Siege Company and the West Riding Company to move forward to start work on the roads. They were guided forward by the adjutant, Captain P. Neame, and were accompanied by Major R. Walker, Staff Officer to the Chief Engineer, IV Corps, who was to superintend the work as soon as it was started, leaving the C.R.E. free to devote his attention to the work in the captured localities.

At 7.50 a.m., Captain Neame and Major Walker returned and reported the position of the two companies they had taken out to the Rue Petillon. They had been unable to move these parties farther, as no more movement of supporting troops was taking place.

At 9.40 a.m., after ascertaining at divisional headquarters that no progress was being made by either the main or subsidiary attacks, the C.R.E. sent Major Walker forward again to ascertain the situation, and to arrange for the withdrawal of the Siege and West Riding Companies in small parties, should this course appear desirable. At 1.20 p.m., parties of these units began to arrive at headquarters, followed later by Major Walker, who had found it impossible, owing to shell-fire and the stoppage of the infantry advance, to move forward.

At 7 p.m., the C.R.E. accompanied the G.S.O.1 of the division to the headquarters of the 23rd and 24th Brigades, to arrange for the covering of working parties to dig communication trenches up to the lodgements held by the 2nd Rifle Brigade and the 2nd Lincolns. On arrival at 23rd Brigade headquarters, they learned that there was no longer any Lincoln lodgement, but that the Rifle Brigade were still holding out. Arrangements were then made to dig the communication trench from the point where the reclaimed sap met the Fromelles road.

Meanwhile, neither of the two field companies with the attacking brigades had been able to do any work but during the night, one section of the 2nd Field Company (Lieutenant H. J. Higgs) proceeded to the sap and started the trench. Very little progress was made, owing to the lateness of the hour at which the Rifle Brigade were able to report their situation, and owing to the difficulty of getting the party up to the work through trenches crowded with men, and the sap encumbered with killed and wounded. This party withdrew before daylight on the 10th and at 3 a.m. the Rifle Brigade were withdrawn from their lodgement. By daylight, all the R.E. companies were reassembled in the vicinity of headquarters.

During the night of 10th/11th May, the West Riding Company returned to the 49th Division, and the Anglesey Siege Company returned to its work under the Chief Engineer IV Corps. The companies of the 5th Division, with their attached infantry, carried forward *chevaux-de-frise* and blocked the openings made for the attacking troops in the wire entanglements in front of the breastworks. They also brought in a

number of wounded found in front of the breastwork and in the sap.

Next day, divisional headquarters and the C.R.E. returned to Sailly and the division settled down once more to trench routine.

FESTUBERT

The battle of Festubert lasted officially from 16th May to 27th May, 1915. It was a continuation of the effort to assist the French attack on Vimy Ridge. The R.E. units taking part were :—

<i>I. Corps</i>	Chief Engineer, Brigadier-General C. Godby.
2nd Division	C.R.E., Lieut.-Colonel G. P. Scholfield, with 5th, 11th and 1/1st East Anglian Field Companies,
7th Division	C.R.E., Lieut.-Colonel R. P. Lee, with 54th, 55th and 1/2nd Highland Field Companies,
47th Division	C.R.E., Colonel A. H. Kenney, with 1/3rd and 1/4th London Field Companies,
51st Division	C.R.E., Lieut.-Colonel C. L. Spencer, with 1 1st and 2 2nd Highland Field Companies,
Canadian Division	C.R.E., Lieut.-Colonel C. J. Armstrong, with 1st, 2nd and 3rd Canadian Field Companies,
Meerut Division	C.R.E., Lieut.-Colonel G. A. J. Leslie, with 3rd and 4th Companies, 1st Sappers and Miners,
Lahore Division	C.R.E., Lieut.-Colonel Campbell Coffin, with 21st Company, 3rd Sappers and Miners.

The work of the engineers was on the same lines as at the battle of Aubers Ridge. The result of the fighting was considerably more substantial: but the casualties amounted to another 710 officers and 15,938 other ranks.

The plan of the battle was that the German defences were to be breached in two places: by the 7th Division north of Festubert, and by the 2nd Division from the Rue du Bois, north of Chocolat Meunier Corner. The 2nd Division was to assault under cover of darkness with two brigades, supported on the left by a brigade of the Meerut Division; their objective was the capture of the German front and support trenches. "At daylight the operation was to be given a fresh impetus from the south by an assault of the 7th Division, the 2nd Division renewing its advance simultaneously from the line of the captured German support trench." "The right flank was to be secured by the 47th Division while on the left, the Meerut Division was to advance and build up as rapidly as possible a left defensive flank along the Port Arthur-La Bassée road."*

In the 2nd Division, a considerable ditch, 12ft. wide with 4 ft. of water, ran parallel with the line of breastworks and this had to be crossed before the troops formed up. Footbridges had been prepared by the R.E. and these were successfully laid by the 5th and 11th Field Companies. The assaulting battalions moved out over the ditch and lay down in no-man's-land.

The R.E. were distributed for the attack as follows:—

5th Field Company (to 5th Brigade); two sections accompanied the assaulting battalions with Bangalore torpedoes, etc.

11th Field Company (to 6th Brigade); two sections accompanied assaulting battalions.

1st E. Anglian Field Company, under C.R.E., to dig communication trenches.

Two parties of one N.C.O. and three men each also accompanied the assaulting battalions to look for mines, wires, etc.

The attack started at 11.30 p.m. on 15th May. The 5th Brigade was not successful; its assembly had been seen by the German flares, and as soon as the assaulting waves rose

* *Official History*, 1915, Vol. II, p. 51.

from the ground they were met by heavy machine-gun and rifle fire, which raked them from flank to flank. The shell-fire broke up some of the bridges over the ditch, and prevented the immediate advance of the supporting lines. The Bangalore torpedo parties returned with the remnants of the first line.

The 6th Brigade's assault was more successful. The two lines of German trenches were taken almost at once. Two sections of the 11th Field Company were able to do good work in the captured trenches, converting the paradoss, repairing breaches and making machine-gun emplacements. The R.E. sections went over with the third wave of the assault. As the distance to be covered was nearly 400 yds., all four waves of the attack were in the open before the leading wave had reached the German trench; the casualties were consequently heavy. The 11th Company lost one officer killed (Lieutenant A. Trewby), one wounded, four other ranks killed, twenty-one wounded and two missing. Lieutenant Bourdillon was shot through the shoulders but continued on duty for more than twenty-four hours. The casualties in the 5th Company were two officers wounded, two other ranks killed, twenty-three wounded, and two missing.

The 1st East Anglian Company, with 200 men from the 107th Pioneers (Meerut Division) dug a new communication trench 400 yds. long between the two front lines; the company lost one man killed and one wounded. At night, two sections of the 5th Company wired in the 5th Brigade's front, while on the next night the 11th Company wired in the whole of the 6th Brigade's new front and also its exposed right flank.

In the 7th Division, which made its attack at dawn on 16th May, the result was more successful, and a considerable bite into the German front line was made and held. The 22nd Brigade with the 54th Field Company attacked on the right, and the 20th Brigade with the 55th Company on the left. The 21st Brigade with the 2nd Highland Field Company was in reserve. The assaulting battalions formed up in the assembly trenches soon after midnight, and the assault began at 3.15 a.m. Six field guns had been quietly brought up and established in emplacements in the British front line. The 22nd Brigade

gained its objective by 7 a.m., but it was not until midday that a section of the 54th Company under 2nd Lieutenant Batho was able to get forward and construct a strongpoint in the captured front line, which was improved and wired in at night, together with the right flank. The 20th Brigade met with even more opposition than its neighbour, and the 55th Company had no work to do until darkness came.

By 9 a.m. on 16th May, the attacks of the 2nd and 7th Divisions had not reduced the gap which it was expected would be closed by the convergent directions of the two operations. The next stage was therefore planned to remedy this, and the 2nd Division was ordered to attack south-eastwards, while the 7th Division pressed north-eastwards. There was insufficient time to prepare these attacks, and they did not make much headway. As with so many battles at that time, the impetus of the attack petered out for want of the necessary weight and drive of fresh troops. In spite of the relief of the 2nd and 7th Divisions by the 51st and Canadian Divisions, and of the participation of the 47th Division, very little further progress was made, and by 25th May the line became stabilized again.

OPERATIONS DURING THE SUMMER OF 1915

A lesser attack at Givenchy by the 7th Division was made on 15th and 16th June to help the French farther south; and at Hooge, the V Corps of the Second Army also carried out operations in June to improve its position. The attack of the 7th Division resulted in no gains, and the only work that the engineers could do was to re-wire the British front line where gaps had been made for the assaulting waves.

Fighting around Hooge went on at intervals during July. The 14th Division (C.R.E., Lieut.-Colonel A. F. Sargeant; 61st, 62nd and 89th Field Companies) had some severe fighting to improve the position round Hooge Château, which by this time was a heap of ruins. On 30th July, the Germans, in one of their counter attacks used flame-projectors for the first time. These caused the loss of part of the newly-won trenches. On 31st July, Lieut. Colonel A. F. Sargeant, was killed by a

shell while inspecting the trenches with the G.O.C., 16th Brigade near Zillebeke. Major J. P. Mackesy, 61st Company, temporarily took over the duties of C.R.E., but on 4th August, Lieut.-Colonel T. A. H. Bigge arrived and assumed the post.

The situation at Hooge was finally restored on 9th August, when the 18th Brigade of the 6th Division made a successful attack, in which two sections of the 12th Field Company (Major A. Campbell) and two sections of the 1st London Field Company (Major S. H. Joseph) went over with the assaulting battalions, carrying barbed wire, which was put up in twenty minutes, immediately after the objective was gained. The R.E. were then split up along the whole new line and worked all day with the infantry digging, clearing and consolidating. The engineer casualties on this occasion were severe. In the 12th Company, Captain A. G. Turner and 2nd Lieutenant Frecheville were wounded, 2nd Lieutenant Sibbeth killed, nine other ranks killed, twenty-six wounded and seven missing. In the 1st London Company Captain R. W. Narracott was wounded, missing and believed killed, Lieutenant Gamage wounded, two other ranks killed, nine wounded and seven missing; nearly half the total number engaged. Shortly after this successful action, which had been prepared with unusual thoroughness, Lieut.-Colonel G. C. Kemp (C.R.E., 6th Division) left to take command of the 138th Brigade, 46th Division. He was succeeded by Major A. G. Stevenson, from the 20th Fortress Company.

PREPARATIONS FOR LOOS

There now followed a period of strenuous preparation for an offensive in conjunction with the French, who were planning an attack in Artois from Arras on the Vimy Ridge, and also a great offensive in Champagne. The coming battle was to be the largest operation yet undertaken by the British armies, and every possible effort was made to create the best chances of success.

More divisions of the New Army were sent out; some arriving in France only a few days before Loos, with no time

to settle down before they were thrown into the battle. These new divisions with their dates of arrival, their Cs.R.E. and field companies were :—

15th Division, 13th July	Lieut.-Colonel G. S. Cartwright, with 73rd, 74th and 91st Field Companies,
17th Division, 17th July	Colonel H. R. Gale, with 77th, 78th and 93rd Field Companies,
20th Division, 20th July	Colonel E. R. Kenyon, with 83rd, 84th and 96th Field Companies,
19th Division, 21st July	Lieut.-Colonel C. W. Davy, with 81st, 82nd and 94th Field Companies,
37th Division, 28th July	Lieut.-Colonel H. B. des Voeux, with 152nd, 153rd and 154th Field Companies,
18th Division, 30th July	Lieut.-Colonel T. C. Skinner, with 79th, 80th and 92nd Field Companies,
23rd Division, 25th August	Lieut.-Colonel P. J. J. Radcliffe, with 101st, 102nd and 128th Field Companies,
24th Division, 30 August	Lieut.-Colonel A. J. Craven, with 103rd, 104th and 129th Field Companies,
22nd Division, 4th September	Colonel J. A. Tanner, with 99th, 100th and 127th Field Companies,
21st Division, 9th September	Lieut.-Colonel Clifford Coffin, with 97th, 98th and 126th Field Companies,
26th Division 19th September	Lieut.-Colonel C. G. W. Hunter, with 107th, 108th and 131st Field Companies,
25th Division, 25th September	Lieut.-Colonel C. R. Dobbs, with 105th, 106th and 130th Field Companies,
Guards Division, formed in France	Lieut.-Colonel J. E. Vanrenen, with 55th, 75th and 76th Field Companies.

With these large reinforcements, the veteran divisions of the B.E.F. could be relieved and prepared for the coming battle. Although the original divisions had long since used up nearly all their regulars and reservists, there were, with the returned wounded, enough remaining to preserve something of the tradition of the units ; and the new forces now arriving consisted of the finest volunteer contingents, who lacked nothing but experience and training. The new engineer

companies were largely composed of groups of men from the same factories or works. They possessed the necessary trade skill and the will to work, but the handiness of trained sappers requires much time and training to achieve. If the new divisions could have had three or four months' service in France before being put to the test in battle, much more might have been accomplished.

On 11th July, a Third Army was formed under Sir Charles Monro, and took over a new front sandwiched between the French Sixth and Tenth Armies. Major-General J. E. Capper was its first Chief Engineer.

The Third Army at first consisted of :—

VII Corps	Chief Engineer, Brigadier-General J. A. Tanner, 4th, 37th and 48th Divisions.
X Corps	Chief Engineer, Brigadier-General J. A. S. Tulloch, 5th, 18th and 51st Divisions.
Indian Cavalry Corps	1st and 2nd Indian Cavalry Divisions.

Other Corps formed at this time were :—

VI Corps, 1st June	Chief Engineer, Brigadier-General C. Hill, 6th, 14th and 49th Divisions.
XI Corps, 29th August	Chief Engineer, Brigadier-General L. Jones, Guards, 21st and 24th Divisions.
XII Corps, 6th September,	Chief Engineer, Brigadier-General C. Godby, 22nd, 26th and 27th Divisions.
Canadian Corps	1st and 2nd Canadian Divisions.

The XII Corps with its three divisions went to Salonika in November, 1915.

The New Army divisions came out with pioneer battalions, but the original regular divisions were not yet provided with these units, who were organized and armed as infantry, but had had a little training in entrenching. They worked under the orders of the divisional C.R.E.

In addition to the divisional field companies, each Corps now had two or more army troops companies. These units were

intended for rear area work such as water supply, work on corps defence lines, observation posts for artillery, gun positions for heavy artillery, trench tramways, road-screening, corps engineer dumps and workshops and erection of hangars for the Royal Flying Corps—in fact, a very varied programme. They were smaller than field companies and less mobile. Their establishment was three officers and 139 other ranks, but they were provided with mechanical transport, an advantage much desired by the field companies, but never obtained. The A.T. Companies were first produced by converting the four regular fortress companies already in France—the 20th, 25th, 31st and 42nd; the two Special Reserve siege companies of the Royal Anglesey and Royal Monmouthshire Engineers (which each formed two A.T. Companies); and ten Territorial fortress companies. In the spring of 1915, eighteen new companies, numbered from 132 to 149, were raised and trained at Buxton. They were at first called Fortress Companies, but in August were renamed Army Troops Companies.

By this time, the accumulated experience of Ypres, Neuve Chapelle, Aubers Ridge and Festubert had provided many valuable lessons. It was recognized that in order to smash the German defences, far more artillery was needed, and of heavier calibre. The B.E.F. was still worse off in this respect than the French army, who themselves were worse off than the Germans. A break-through could only be expected by a crushing local superiority in men and guns. The R.E. preparations for the battle of Loos were therefore directed to increasing the accommodation for stronger forces, improving the means of communication and supply, strengthening the existing front-line defences, increasing the number of artillery observation posts, and collecting engineer stores of all kinds, both for the work in hand and for the consolidation of the objectives when they had been won.

The addition of the third field company to each division had enabled Cs.R.E. to relieve those engaged in the front line, and to employ the "resting" companies on rear area work. The arrival of army troops companies further relieved the divisional engineers by releasing a number of skilled men who had been

drawn from the field companies for employment in workshops, etc.

The intention to use gas involved alterations to the trench parapets for the installation of the cylinders. There had been little time since the German gas surprise in April to organize retaliation, but no time had been lost, either at home by the small body of scientists under Colonel L. Jackson, late R.E., or in France by the improvised companies organized by Major C. H. Foulkes, R.E., lately commanding the 11th Field Company. These units (the 186th and 187th) were designated Special Companies, R.E., and were raised at Helfaut, near St. Omer, in July, with men transferred from the infantry in France, stiffened by a number of specially enlisted R.E. from England. Two more companies (the 188th and 189th) were added in August. This was the beginning of the Special Brigade, R.E., which became responsible for all the gas operations on the Western Front, and, under the command of Brigadier-General C. H. Foulkes, turned the tables on the Germans and gave them far more gas than they ever gave the British. Their work is described in Chapter XX.

The installation of about 5,500 gas cylinders in the front-line trenches required the labour of 8,000 men. The cylinders were brought up from railhead by lorry, and then carried some one and a half miles to the front line. There they were handed over to the special companies, R.E., who mounted them in the recesses made under the parapets. This arduous and dangerous work was carried out without the loss of a single cylinder. Unfortunately, the supply of cylinders from England provided only about half the number required to give a steady flow of gas: the deficiency meant intermittent discharge, supplemented by smoke candles. The gas programme covered forty minutes from zero hour; that is to say, the infantry assault was to take place forty minutes after zero, by which time the gas was expected to have swept over the German lines and to have been followed by a protective smoke screen. The discharge of the gas was in the hands of the special companies, one officer and 180 men from these units being allotted to each of the six divisions making the assault.*

* *Official History, 1915*, Vol. II, p. 160.

There was no offensive mining, and the 180th Tunnelling Company was used for running Russian saps out into no-man's-land where the distance between the two front lines was too wide to be covered in the time allotted.

On the 47th divisional front, the line opposite the Double Crassier formed a re-entrant curve unsuitable for the launching of the assault. A new front line was therefore dug, in the form of a chord across the arc and joining up with the heads of saps. This line, some 1,500 yds. long, was dug at night by successive infantry working parties supervised by the 2/3rd London Field Company (Major H. E. T. Agar) and was completed in all respects, with gas-cylinder recesses, traverses, bomb stores, and wiring. Assembly trenches 50 yds. in rear were also dug, and communication trenches leading into them—a total of about two miles of digging in three weeks, but with very little interference from the enemy.

Loos

The gas was released at 5.30 a.m., on 25th September. Owing to a drop in the wind, it did not travel at the speed hoped for; and it moved more slowly in some sectors than in others. Consequently, the degree of surprise varied in different parts of the German front.

The 47th Division, on the right, was on the whole successful, gaining and holding its objectives and covering the right flank of the 15th (Scottish) Division.

The 15th Division was to capture the village of Loos and Hill 70, a low but dominating feature of the flat battlefield. The 15th Division played a very important part and made a more successful advance than any other. It had been in the line since the end of July and was therefore well acquainted with the trench system. Its preparatory work was also very thorough. The attack was made by two brigades; the 44th on the right and the 46th on the left. The 73rd Field Company and one company of pioneers (9th Gordons) were allotted to the 44th Brigade, and the 91st Field Company and one company of pioneers to the 46th Brigade. No less than five objectives

were given to the brigades, but the principal one was Hill 70, east of Loos. The assault was made in four columns, two from each brigade, each column consisting of one battalion with machine-guns, one section R.E., and one platoon of pioneers. This left two battalions, two sections, R.E., and half a company of pioneers in each brigade reserve. The 74th Field Company and two companies of pioneers were in divisional reserve, under the C.R.E. (Lieut.-Colonel G. S. Cartwright). The 180th Tunnelling Company (Captain W. E. Buckingham) in Mazingarbe, was also placed under his orders.

When the battle began, half each of the 73rd and 91st field companies formed part of the assaulting columns; the other halves moved with their brigade supports. Parties from each company were detailed to lay out and superintend the digging of communication trenches from the British to the German front line. The two leading sections, Nos. 1 and 2, of the 73rd Company (Major S. Mildred) followed the 9th Black Watch and 8th Seaforth respectively. As soon as his section was extended, Lieutenant Inglis was killed by a shell, and Sergeant Baldwin took command. Both sections continued their advance about a hundred yards behind the infantry until they came to the barbed wire in front of Loos. Here 2nd Lieutenant Ryan was killed, and eleven sappers either killed or wounded. Sergeant Baldwin then took charge of both sections, although wounded himself, and carried on for the rest of the day and night. In front of Loos, the two sections separated; No. 1 followed the main body of the infantry, and No. 2 worked round the village on their right. No. 1 section went through Loos with the infantry and eventually arrived on the top of Hill 70. They remained there until driven back to a line below the crest, where they assisted the infantry to entrench. They continued this work until 10 p.m., when they were withdrawn by order of the brigadier. Meanwhile, No. 2 section moved via the outskirts of Loos to a line about sixty yards from the top of Hill 70. On their way they picked up a party of infantry without an officer. Three German cables were cut at this point by the sergeant in command. The section then advanced with the object of reinforcing the

Black Watch and Seaforth, but they came under such heavy fire that they had to lie down. When the infantry retired over the ridge, the sappers helped them to dig in, and a part of this section remained behind all night to help hold the line.

In the meantime, the rest of the 73rd Company (Nos. 3 and 4 sections) waited in support with the 10th Gordons. No. 4 section was ordered to bridge a trench over the Lens road. During this work, 2nd Lieutenant Nolan was killed, and ten N.C.Os. and men killed or wounded. Captain E. D. Carden then took command, and ordered the two sections to advance behind the Gordons. They reached the crest of Hill 70 at about 9.30 a.m., and saw some infantry at the Keep, very hard pressed. They advanced to the Keep and tried to hold it, but the machine-gun fire was too hot, and they had to retire. Captain Carden and 2nd Lieutenant F. H. Johnson then found a machine-gun, and with ten sappers made for the Keep again. This time they got inside but were soon driven out. Captain Carden was severely wounded, and 2nd Lieutenant Johnson was wounded in the leg, but carried on until midnight. He led several charges to retake the Keep, but the enemy remained in possession. For his splendid example and gallantry he was awarded the V.C.* The sappers now retired to the line held by the infantry, who had arrived in support, and besides helping them to dig in, remained behind all night to assist in holding the line.

In the 91st Company (Major H. de L. Pollard-Lowsley) the two sections (Nos. 3 and 4) under Captain A. P. Sayer, with the 46th Brigade, had similar experiences, but found more difficulty in keeping in touch with the advancing battalions, on account of congestion in the communications trenches. No. 3 section lost its officer, Lieutenant MacNaught who was twice severely wounded, at the outset, and all its N.C.Os. except one, the section being reduced to fourteen men. Lance-Corporal Melvin then led the section up to the German support trench, where he found some infantry. He set his men to assist in converting the trenches. At 10.15 a.m. he reported to Captain

* *Official History*, 1915, Vol II, p. 205. Lieutenant Johnson died of wounds as a Major on 26th November, 1917.

Sayer, who put Sergeant Hay in charge, and led the section up to Hill 70. Under Captain Sayer's instructions, Corporal Bannister reconnoitred Chalk Pit Wood, and Sergeant Hay put some houses in a state of defence by loop-holing the walls and making fire-steps. At about 6 p.m., however, an officer of the 11th Argyll and Sutherland Highlanders ordered Sergeant Hay to hand over his tools to the Highlanders, who required them to dig themselves in.

No. 4 section, under Lieutenant J. A. Parker, went forward at 6.45 a.m. and advanced by short rushes towards the German lines. Unfortunately, he took a wrong direction, crossed the Loos road and entered the zone of another column. Two casualties occurred almost immediately the section left its trenches, and two more very soon afterwards. At about 7 a.m. the section reached a point about fifty yards from the German trenches. There they were subjected to an extremely heavy fire and were unable to advance. Eight or nine of the remaining men were hit at once, and only a few got within twelve or fifteen yards of the German wire. Lieutenant Parker sent back a message asking for instructions. He was ordered to withdraw his men and proceed to Hill 70 or, if he could not proceed, to join Captain Sayer on his right. Meanwhile, Parker had been busily engaged under heavy fire in applying first-aid dressings to his wounded men. He did this entirely unaided, and continually exposed himself. The slightest movement was followed by enemy fire, but he was not hit. On receipt of orders, he withdrew his section, and brought in the remaining wounded to the Loos road, where they were in comparative safety. In order to bring in Corporal Parrish, he had to crawl forty yards and fetch a Hambré line, which he fastened round Parrish and himself, and dragged him to a safe position. After getting his section under cover, he returned and helped in a badly wounded man of the Highland Light Infantry. With the remnant of his section, reduced to twelve men, he now led them towards Hill 70, and leaving them near the Loos-Benifontaine road, he went ahead to reconnoitre. He found Lieutenant A. H. Davenport with No. 1 section near Puits 14, digging a trench, and returned to fetch his men, but

as they now had no tools, he decided to take them back to collect some. He reported to the O.C. in Loos Keep at about 7.30 p.m. As he had so few men left and they were thoroughly exhausted, he asked permission to leave them where they were for the night. Parker himself, though nearly worn out, went out again at 10.30 p.m. to satisfy himself that all his wounded had been brought in. Next day, Parker's section joined the 98th Company of the 21st Division, which had now come into the battle, and were extended with them in the old front-line trenches. During the afternoon, the G.O.C., 46th Brigade told him to withdraw, and the section returned to Mazingarbe to get food and rest. After this, Parker and his men were sent out again that night to collect stragglers, and brought in some 200 to 300 men. Although no R.E. work had been done, the section had displayed great courage and endurance, under a most determined officer.

No. 1 section (Lieutenant Davenport) of the 91st Company went over the top at about 7.45 a.m. They also lost position and found themselves in front of the 8th K.O. Scottish Borderers, who had themselves taken a wrong turn in the trenches. The section, with a platoon of pioneers, moved towards Hill 70, but were directed by the O.C., 8th K.O.S.B. to a house near the Chalk Pit, which he ordered them to fortify. This house was duly converted, three machine-gun positions being constructed inside it, and the walls loop-holed. Then at about 1 p.m. Davenport with his own men and two sections of the 8th K.O.S.B. dug in on the west side of the Lens-Benifontaine road. At about 3 p.m., a few sappers of the section made two machine-gun emplacements in the yard of a house immediately north-east of Puits 14 bis. This house was heavily shelled, but the section suffered no casualties. Later in the afternoon, the sappers and the platoon of pioneers with them dug in on a line held by the 6th Cameron Highlanders. At about 9 p.m., the O.C., 6th Camerons ordered Davenport to advance across the Lens-Hulluch road and dig in on the other side. They finished digging here at about midnight, having been at work almost continuously since 8 a.m. They then rested until 3.30 a.m. on the 26th September, when a general stand-to was

ordered. About 11 p.m., the heavy shelling made the Bois Hugo untenable, and a retirement was made to the Loos-Benifontaine road, the R.E. and pioneers holding their trench until all the troops had moved back. The R.E. section then became scattered, and after spending the afternoon searching for his men, of whom he only had one N.C.O. and two sappers left with him, Davenport reported to his O.C. at 4.30 p.m. He was then ordered to assist in diverting stragglers back to the old front-line trenches. He continued at this task until midnight. Early on the morning of the 27th September, his section was reassembled and returned to Mazingarbe.

No. 2 section (Lieutenant McCourt) advanced over the parapet at 8.15 a.m., with a platoon of pioneers under Lieutenant Bisset (9th Gordons). When they reached the German front line, they halted and were joined by Captain MacWhirter, who commanded the company of pioneers furnishing the platoons which accompanied the R.E. sections. He ordered them to continue the advance, and under rifle and shrapnel fire they reached a line near the crest of Hill 70. Here they halted and lay down, while Lieutenant McCourt sent a man forward to reconnoitre. But before this scout returned, Lieutenant Bisset moved his pioneers over the crest. They were immediately subjected to heavy fire, and Lieutenant McCourt did not see them again. He then moved his section a short way over the ridge, but the fire was so heavy that he withdrew to about a hundred yards below the crest. Almost immediately after this, at about 9.30 a.m., the infantry, who had advanced beyond the crest of Hill 70, began to retire in some disorder. They quickly rallied behind McCourt's position, and he then fell back to their line. During the day the enemy made a few weak attacks but were repelled without difficulty. In the afternoon, the sappers filled the sandbags which they had carried with them, to improve cover. Soon after dusk, reinforcements arrived, and McCourt withdrew his section to a house on the edge of Loos, and sent a report to his O.C. However, before receiving the latter's reply ordering him to stay where he was, and be prepared to assist in the consolidation of Hill 70, he had withdrawn to Quality Street, where he arrived

at about 5.30 a.m. on the 26th September, and reported to the O.C., 74th Company. At 9.30 a.m. he was ordered to rejoin his own unit with such men as he could collect, but unable to find his company he remained with the 74th. Finally, the O.C., 91st Company found him at about 2.15 p.m., by that time exhausted, and ordered him to join Lieutenant Parker and go back to Mazingarbe. Parker was collecting stragglers on the Lens road, and between them they collected about 500 men by 8.30 p.m.

Meanwhile, the 2nd-in-command of the 91st Company (Captain A. P. Sayer) had had a varied experience. When No. 3 section had lost its officer and all but one of its N.C.Os., he took charge and led it forward through Loos towards Hill 70, to which all available R.E. were now being directed in order to assist in consolidating such footing as had been obtained by the infantry. Leaving the section in charge of Sergeant Hay, he returned to report to his brigade headquarters, where he remained for the rest of the day assisting the brigade staff. Next morning, at 7 a.m., he went out with the brigadier to advanced brigade headquarters. Parties of infantry were returning from Hill 70, and the brigadier ordered Sayer to collect them and take them back to support the troops which were to attack Hill 70 again at 9 a.m. He collected 3 N.C.Os. and about 120 men from various units, including the 8th Somersets and Durham Light Infantry from the 21st Division. With these, he lined a bank along the Loos-Hulluch road behind a battery of howitzers. At about 9.15 a.m. a company of the 13th Royal Scots, who had lined the road on his right, moved forward up the hill. Assuming that these men were advancing to carry forward the attack ordered for 9 a.m., and as their left flank appeared to be exposed, Captain Sayer took his party to cover it. This became all the more necessary, because some Germans now appeared, advancing on the skyline in that direction. On arriving at the front trenches, he found them crowded with mixed troops, a large proportion being from the 8th Somersets. Sayer called on these troops to charge. The distance was only about fifty yards, and the wire was not strong. The Scottish troops followed, and being

met with a very severe fire, they were obliged to fall back. A second effort failed in the same way. Sayer then got into telephonic communication with 46th Brigade headquarters, and reported his situation. He was ordered to hold on. At about 10.30 a.m. the troops on his left suddenly began to give way and to retreat rapidly down the hill. The fire from his left checked the pursuit, but some Germans coming out of Chalk Pit Wood brought reverse fire on the position. At the same time, the men on the right began to retire. Sayer rallied a party of stragglers and put them in a support line under an infantry officer, while he himself went off to rally other parties. The retirement on the left continued rapidly, and he endeavoured to form a line along the Loos-Hulluch road, but only succeeded in placing one sergeant and sixteen men in some houses which had already been prepared for defence (see above) and in a short line on either side under a subaltern of the Somersets. He met the brigadier of the 62nd Brigade, who ordered him to rally more troops who were retiring to the south. He collected a certain number into the original British front line, but the men were worn out. Some symptoms of gas were beginning to be felt; this was probably as much due to leakage from unfinished cylinders left in the British trenches, as to the effects of German gas shells.* All through the afternoon of the 26th August, Captain Sayer, although feeling the effects of gas, continued to assist the brigade staff in rallying men. Thus the officers of the 73rd and 91st Field Companies played a conspicuous and soldierly part in the battle. When they could do no R.E. work, they helped to rally the troops and hold the line.

The 74th Company, in reserve, was sent forward by the C.R.E. at about 9.30 a.m., on 25th September with the 180th Tunnelling Company to bridge the trenches and prepare tracks for the artillery to move forward. The guns advanced about noon. On the 26th the 74th and 180th Companies were employed on improving the Lens road and clearing it for traffic. The 74th also assisted in preparing the original German front

* This account of the experiences of the 73rd and 91st Field Companies is based on the reports of the O.S.C. of the companies and Captain Sayer's narrative in the War diaries.

line and support trenches for defence. At midnight, both the 73rd and 74th Companies, although very exhausted, were sent out again to do further work on the road to Loos, which was made passable for motor ambulances by 4 a.m.

On the 27th September, the three field companies were re-assembled at Le Saulchoy Farm, Mazingarbe. The 180th Tunnelling Company returned to Verquin and reverted to the IV Corps. The total casualties in the 15th Divisional Engineers during 25th to 27th September, amounted to six officers and 132 other ranks, or about one-third of the strength with which they went into action. The 15th Division had held on with magnificent courage, and its field companies had shown themselves as stubborn as the infantry. The division was relieved on the night of 26th to 27th September by the Guards Division, and its survivors withdrew to Mazingarbe.

The 1st Division (C.R.E., Lieut.-Colonel H. F. Thuillier) came next in the line. The 23rd Field Company (Brevet Lieut.-Colonel C. Russell-Brown) was allotted to the 1st Brigade, and the 26th Company (Major H. L. Lewis) to the 2nd Brigade; one section of the 1st Lowland Company (Captain W. Downs) was attached to Green's Force (London Scottish and 9th King's); another section, with half a company of infantry, formed a bridging party to make crossings over trenches for field guns. The remainder of the Lowland Company was in divisional reserve at Philosophe.

As the attack was preceded by a gas discharge, two sections each of the 23rd and 26th companies were in the front trenches to assist the sappers of the 187th Company in working the gas cylinders. They were then to concentrate on their right and carry out consolidation work. Owing to the wind being nearly parallel to the British trench, the gas was not a complete success; the 26th Company's sections were very badly gassed and had to be withdrawn, being replaced by the 1st Lowland Company.

As soon as the 1st Brigade had broken through north of the Bois Carré and advanced towards Hulluch, the 23rd Company followed and began consolidation of two points, while the Lowland Company began work on reversing captured trenches

to the south of the 23rd Company. The trench bridges were sent forward at about 4 p.m., and these enabled the field guns to come into action along the spur running north-east towards Hulluch. In the 23rd Company, Lieutenant B. B. Edwards and ten men became gas casualties. Nos. 1 and 4 sections, under 2nd Lieutenant W. R. Wilson, were ordered at about 10.30 a.m. to move forward into Hulluch and consolidate. But Hulluch was not yet occupied, so Wilson took his men as far as the Lens-La Bassée road, and went forward to reconnoitre. Seeing no British troops in the village, he withdrew his sections to work on a strong point farther back.

In consequence of the early replacement of the 26th Company by the Lowland Company, there was no R.E. reserve left, and the 23rd and Lowland Companies were almost continuously at work for 72 hours, the men being completely exhausted. Great difficulty was experienced in getting water and rations to the front sections after the attack. The roads were practically impassable after the guns had gone forward, and the ground was very open, with no covered approaches, so that wagons could get nowhere near the front. The casualties in the 23rd Company were one officer wounded (Lieutenant J. W. D. Mallins), one officer gassed and forty-two other ranks killed, wounded or missing.

The 7th Division (C.R.E., Lieut.-Colonel G. H. Boileau) had taken over its sector on the right of the I Corps on 4th September, with headquarters at Labourse. The 95th Field Company had joined the division on 30th August, to replace the 55th which had been transferred to the newly-formed Guards Division. The other field companies in the 7th Division were the 54th and 1/2nd Highland (later the 401st Company).

The front line had a re-entrant which was an awkward feature from which to advance. So, between 5th and 25th September, a new line, 300 yds. in front of the old one was dug, with two new support lines and numerous communication trenches. Accommodation for gas cylinders and gas operators was made in the new fire trench, and various dug-outs provided. Some of the communication trenches were roofed to give cover from shrapnel. About 3,500 trench ladders and 2,500 foot-bridges

were made and placed in position for the assault. A section of the 1st Bridging Train was allotted to the division, its wagons being used for carriage of stores, as there was no bridging in prospect.

In this division, the field companies were not split up. The 54th Company was attached to the 22nd Brigade; the 95th to the 20th Brigade, and the 1/2nd Highland to the 21st Brigade, in reserve. It had been arranged that the field companies were not to be frittered away and exhausted by day, and so rendered useless for work at night.

One of the objectives of the division was the Quarries, which were captured by 9.30 a.m., and afforded good cover. The main task was to wire them in, but this could not be done in daylight, owing to heavy fire from Cité St. Elie. The 54th Company held back in the support line, sent an officer to reconnoitre the position at 3 p.m., and at 6 p.m. the whole company went forward with stores and wired the whole position, about 1,000 yds. in perimeter. They were assisted during the night by the other two field companies. However, the Germans, by a clever infiltration between the 9th and 7th Divisions, at about 1 a.m., managed to surprise the garrison, capturing the brigadier of the 27th Brigade who had gone into the Quarries to telephone.

During the succeeding nights, the field companies were chiefly occupied in consolidating strong points and in wiring the new line which was completed by the night of 27th September. The 31st Fortress Company and the 1st Hants Fortress Company were lent to the C.R.E. for the repair of the Vermelles Hulluch road, up to the old German line. On 1st October, the 7th Division was relieved by the 5th Brigade of the 2nd Division, and moved northwards to take over the Cambrin-Cuinchy sector from the 2nd Division. The casualties among the 7th Divisional R.E. during the period 25th to 30th September amounted to two officers killed, one officer wounded, five other ranks killed, thirty wounded and six missing.

The 9th Division (C.R.E., Lieut.-Colonel H. A. A. Livingstone) had been given a particularly hard task, the capture of the Hohenzollern redoubt and the slag heap at Fosse 8. The

division had not been in action before, and its first experience was certainly a very exacting one. The field companies (63rd, 64th and 90th) as well as the pioneers (9th Seaforths) were held in reserve under the C.R.E., who, in his diary, complains of the complete lack of accurate news obtainable at headquarters during the battle.

The 26th Brigade had complete success at first, but the 28th Brigade suffered many casualties from gas, blown by the changeful wind back into its trenches before the men had started. A large part of the 26th Brigade's success was marred by the consequent exposure of its left flank, as the 28th Brigade did not capture its first objective. The 90th Company was sent up from reserve to assist in consolidating Fosse 8; it also helped to fill the gap in the defenders' line. On the night of the 26/27th September, Lieut.-Colonel Livingstone was wounded by a shell splinter, and his place was taken by Major G. R. Hearn. On the 27th many of the gains of the 26th Brigade were retaken by the Germans.

The 2nd Division (C.R.E., Lieut.-Colonel G. P. Scholfield) was faced with a more difficult no-man's-land than any of the other divisions. The months of underground warfare had devastated the ground and left many large craters whose lips obscured the opposing front-line trenches. The famous brick-stacks opposite Cuinchy concealed well-protected machine-gun posts and shell-proof dug-outs. The division was ordered to attack on a three-brigade front. The gas discharge was a partial failure owing to a change in the direction of the wind, and to add to the factors against success, two mines laid by the 173rd Tunnelling Company were by order fired ten minutes before zero, which gave the Germans time to man their parapets.* The assaulting waves could only reach the German lines through the narrow gaps between the mine craters, and these gaps were only too well covered by German machine-guns. Just before zero two mines were fired by the 170th Tunnelling Company and one by the 176th Company, but the Germans had evacuated their front line and the effects were negligible. Many of the troops waiting to attack had been

* There was a similar instance at the Battle of the Somme.

gassed in their own trenches. The R.E. officers in charge of the special companies considering that it was too risky to discharge the gas had referred to divisional headquarters, but had been told that the programme must be adhered to. The men were much hampered by having to wear their gas-helmets, which at that time were merely bags of flannel chemically treated, with eye-pieces that became dimmed as soon as the helmet was pulled down over the face. As a result many of the men wore their helmets rolled up. The three field companies, the 5th, 11th and 1/1st East Anglian, were affiliated to brigades, but owing to the failure of the attacks, no consolidation work was possible and they were for the most part little used.

Thus at the end of the day, the main battle of Loos ended with a substantial success by the 47th and 15th Divisions on the right; a moderate success by the 7th Division in the centre; a slight success by the 9th Division on the left, and for the rest, only possession of the German front line. Fresh divisions were at hand, but not near enough. A whole new Corps, the XIth, consisting of the Guards, 21st and 24th Divisions, was coming up, and it was hoped that a renewal of the assault would bring about the rupture.

Meanwhile, three subsidiary attacks farther north had been staged to prevent the enemy from moving his reserves. These were carried out by the Meerut Division of the Indian Corps, the 8th Division of the III Corps, and the 3rd Division of the V Corps. None of them succeeded. In the 8th Division (C.R.E., Lieut.-Colonel P. G. Grant) the attack was made in the Bois Grenier sector, south of Armentières, and was intended to break through towards Fromelles and join up with the Meerut Division's attack on Aubers Ridge. The field companies (2nd, 15th and 1/1st Home Counties) were kept under the control of the C.R.E., definite tasks being given to each.

The assault, carried out by the 25th Brigade, succeeded in capturing the German front trench, but the three battalions were driven back later by a strong counter-attack. The R.E. could not carry out all their tasks, but they did dig a new trench connecting the two salients, Bridoux and Well, which considerably shortened the line, and during the night it was further

improved and communication trenches provided. Casualties were suffered by the 15th Field Company (six killed and eight wounded) which was exposed to heavy shelling and machine-gun fire while trying to get to their work by day. The 8th Division had been in this sector since 10th May, and a feature of the work done by the field companies during this time was the development of the trench tramway system. The rails were still of wood only, but "the trams were of the utmost value in removing stretcher cases, and by their means and by the communication avenues, made in the last two months, the work of evacuating the wounded was carried out quickly and without any further casualties— a very great improvement on the conditions which existed on the 9th May, when the wounded had to be carried for a long way over the open by the stretcher-bearers."* The subsidiary attack by the 3rd and the 14th Divisions was directed against Hoge and the Bellewaarde Ridge. The attack was preceded by the explosion under the German trenches of four mines, prepared by the 175th Tunnelling Company. As soon as the debris had subsided, parties of the 56th and 1st Cheshire Field Companies with Bangalore torpedoes rushed over and blew gaps in the wire entanglements.

The initial attack on the German lines having come to a standstill, there was no corps or army reserve immediately at the disposal of the First Army. The three divisions of the XI Corps were kept tightly under the hand of the Commander-in-Chief until 25th September, when Sir Douglas Haig received the 21st and 24th Divisions who were making a painful night march at a very slow pace on congested roads. The Guards Division was still kept in G.H.Q. reserve. The action of the 21st Division (C.R.E., Lieut. Colonel Clifford Coffin) and of the 24th Division (C.R.E., Lieut.-Colonel A. J. Craven) on the 26th September, resulted in failure. Both divisions had to be withdrawn and reassembled. The field companies were largely employed in collecting stragglers and repairing the old British trenches. The Guards' Division (C.R.E., Lieut.-Colonel J. E.

* *Report on the Leos operations, 25th September, 1915, by the G.O.C., 8th Division.*

Vanrenen) came up and relieved both divisions during the night 26/27th September.

The battle dragged on until 13th October. Fresh divisions were put in to relieve tired ones, and a line was finally stabilized. This included Loos (now covered by the French 18th Division) and some of the open ground between Loos and the Quarries, but it was otherwise the old British line again.

In addition to the units already named, the following also took part in the battle of Loos:—

3rd Cavalry Division	3rd Field Squadron—O.C., Captain V. H. Simon.
12th Division	C.R.E., Lieut.-Colonel S. F. Williams, with 69th 70th and 87th Field Companies.
19th Division	C.R.E., Lieut.-Colonel C. W. Davy, with 81st, 82nd and 94th Field Companies.
28th Division	C.R.E., Lieut.-Colonel A. R. Winsloe, with 38th and 2/1st Northumbrian Field Companies with 101st Field Company attached.
46th Division	C.R.E., Brigadier-General C. V. Wingfield-Stratford, with 1/1st, 1/2nd and 2/1st North Midland Field Companies.
First Army Troops	145th Army Troops Company.
I Corps Troops	31st and 1/1st Hants. Army Troops Companies.
IV Corps Troops	25th and 138th Army Troops Companies.
Indian Corps Troops	1st Siege Company, Royal Anglesey R.E. (S.R.) and 139th Army Troops Company.

The Victoria Cross was won on 13th October by Corporal J. L. Dawson of the 187th (Special) Company at the Hohen-zellern Redoubt. In the words of the *London Gazette* "During a gas attack, when the trenches were full of men, he walked backwards and forwards along the parapet, fully exposed to a

very heavy fire, in order to be able the better to give directions to his own sappers, and to clear the infantry out of the sections of the trench that were full of gas. Finding three leaking gas cylinders, he rolled them some 16 yards away from the trench, again under very heavy fire, and then fired rifle bullets into them to let the gas escape. There is no doubt that the cool gallantry of Corporal Dawson on this occasion saved many men from being gassed."

DEFENSIVE WORK IN 1915

Considerable progress was made during 1915 in the organization of the trench systems. The year was one of allied offensives, undertaken to relieve the pressure on Russia and to take advantage of the absence of the German reserves due to their concentration in the eastern theatre, but it was also a year of continual strengthening of the defences although not on the same scale as those of the enemy, as the Germans were always able to command more labour. The British had to rely upon tired infantry and sappers to improve their trenches and communications. Their store depots, for the first half of the year at any rate, were short of the necessary materials especially timber, as the British exploitation of the available French forests had not yet begun. The location of the British line in the low-lying fields of Flanders had rendered necessary the change over from the trenches of the Aisne valley to breast-works and this involved a large increase in revetting materials. The Germans always saw to it that they preserved whatever high ground there was and left the British line to be overlooked from above. Drainage became so urgent a problem that two special units—the 196th and 197th Land Drainage Companies—were formed in January, 1916, of experienced farmers and sent out to France. Water was always the chief trouble of the field companies in the First and Second Army areas, but when the Third Army was formed in July, 1915, it took over a line in the chalk uplands north of the Somme, and its engineering problems were of a different kind.

The heavy casualties in the original field companies of the

B.E.F., especially among the officers, had necessitated a restriction on the wastage of skilled troops, and the infantry were now charged with a larger share in the work of making their own front line stronger and more habitable; but owing to the inexperience of the officers and N.C.Os. it required a great deal of coaxing to persuade them that their own safety and comfort depended on the state in which they kept their trenches. Although there was much variation in this respect among the British divisions, it was, however, almost always the case that sectors of the line taken over from the French were in a worse condition than those handed over.

The British offensives of 1915 (Neuve Chapelle, Aubers Ridge, Festubert and Loos) resulted in heavy battering of the front-line trenches, and very heavy was the task of rebuilding them after each successive failure to break through the German lines and get on to drier ground. Throughout the year, the trench system still consisted of the front line, a support line, and occasionally a reserve line with detached posts or keeps. Farther back, there were Corps Lines and G.H.Q. Lines consisting of detached "localities," rather spasmodically worked on, and often allowed, for want of labour, to fall into sad disrepair. Dug-outs, such as they were in 1915, were beginning to be kept out of the front line, and to be put behind, with short connecting trenches. The deep mined dug-out was as yet in its infancy, owing to lack of skilled labour, and to the trouble with the water. The dug-out of 1915 was still a mere splinter-proof shelter.

The new divisions arriving in France had very few staff officers of experience, and there was a wide variation in the organization and administration of the defences. In some divisions, there was a sound system, and regular maintenance and the cleaning up and repair of trenches were taken seriously. In others, it was quite the reverse. The officers of the field companies became the best guides to the trenches, and where there was good liaison between them and the brigade staffs, the result was almost invariably a good trench sector. Communications would be properly marked with signboards, fire-steps would be kept clear, sandbag revetments maintained in

good order and so on. Throughout 1915, there remained a general shortage of materials. Chief Engineers and Cs.R.E. had to send officers back to the base ports to search for timber supplies which were still to be found in merchants' yards. There had been no provision in peace-time for trench warfare, and very little encouragement had even been given to the digging of trenches. Consequently the infantry were untrained in actual digging; they were still less skilled in the more difficult tasks of revetment, etc.

"Duck-boards"—or "trench mats" as they were first called—came into general use in 1915. The improvised workshops of the field companies were soon engaged in ripping up timber and turning out hundreds of these articles every day. These duck-boards themselves were next improved by being supported on "A-frames," which served the dual purpose of holding the revetments and of carrying the footway above the mud and water.

Trench tramways, to which reference has already been made, were an early development in 1915, especially in the Neuve Chapelle sector, where the 8th Division was stationed for so long. The light wooden rails, made in the company workshops, stood up well to the rough treatment they had to undergo, and all units found that they saved much toil and labour. In the coal-mining district around Béthune, the necessary wheels for the trucks were not difficult to come by.

There were never enough troops available to adopt a system of defence in real depth, which became possible in 1918. Divisions held the line with two brigades, the third in reserve, and often all three brigades were up. Behind them was the G.H.Q. Line, a disjointed system of defended localities, very lightly wired, and only worked upon when Chief Engineers of corps could collect sufficient men. Until the army troops companies appeared, gangs of civilians and occasionally a field squadron from a cavalry division were normally the only sources of labour.

One of the chronic difficulties with which a divisional C.R.E. had to contend was the lack of a motor-car. Throughout the war no C.R.E. of a division had a car allotted to him for his

sole use, and always had to borrow. He was thus heavily handicapped in trying to control work over a very large area.

To make up for the lack of training in elementary field engineering, various classes of instruction were formed in the field companies, through which batches of infantry officers and N.C.Os. passed. "Show grounds" were established where samples of trench devices, revetments, etc., were on view, and drills for the rapid erection of barbed wire entanglements were practised.

CHAPTER XI

BATTLES OF 1916 IN FRANCE AND FLANDERS

Preparations for the Somme—Battle of the Somme—R.E. units engaged.

PREPARATIONS FOR THE SOMME

THE winter of 1915/16 was spent in reorganizing the B.E.F., and in the formulation of the allied plan for a combined offensive in the summer. A new army, the Fourth, formed on 1st March, under General Sir Henry Rawlinson (with Major-General R. U. H. Buckland as Chief Engineer), took over the line from the right of the Third Army at Hebuterne down to Maricourt just north of the Somme. It comprised three new corps: the VIII Corps (Chief Engineer, Brigadier-General G. S. Cartwright) the X Corps (Chief Engineer, Brigadier-General J. A. S. Tulloch) and the XIII Corps (Chief Engineer, Brigadier-General S. H. Powell).

As more reinforcements arrived, divisions were regrouped and six new corps were formed. These were the XIV Corps (Chief Engineer, Brigadier-General H. R. Gale, succeeded in March by Brigadier-General C. S. Wilson), the XV Corps (Chief Engineer, Brigadier-General P. G. Grant), the XVII Corps (Chief Engineer, Brigadier-General H. C. Nanton) the I Anzac Corps (Chief Engineer, Brigadier-General A. C. Joly de Lotbinière), the II Anzac Corps (Chief Engineer, Brigadier-General A. E. Panet) and the reconstituted IX Corps from Gallipoli (Chief Engineer, Brigadier-General E. H. Bland).

The R.E. were considerably increased. Army troops companies were authorized to a scale of one per division. An electrical and mechanical company to take charge of machinery, chiefly power-driven pumps and electric light, was formed in September, 1915. (In December 1916, additional E. and M. companies, numbered 350 to 354, were added to allow one for each army.

As the new allied offensive was not planned to begin until July, 1916, there were several months in which to organize the armies. The corps areas were now comparatively settled, and could be fully exploited. The German attack on Verdun beginning in February, 1916, caused the French to withdraw their Tenth Army from Arras, and this necessitated an extension of the British front, which was made by extending the right and left flanks respectively of the First and Third Armies until they met. This caused the transfer of the VI Corps from the Albert area to Arras, and the interpolation of the new XVII Corps north of it.

It was now necessary to prepare for the large forces which would be engaged on the Somme. Most of the work fell upon the Chief Engineers of corps and their army troops companies, but the field companies of "resting" divisions were also engaged to the fullest extent.

In those areas where the villages were not heavily damaged accommodation was increased by fitting up the barns and other farm buildings with bunks in tiers, made of wooden framing and wire netting. Several thousands of these were turned out every day, the construction being of the simplest type. Quite a rivalry grew up among some of the sections of field companies as to the largest number of bunks to be erected in a day's work. The Nissen hut was introduced about this period, and the time required for the erection of one of these was also reduced to its lowest terms by the rivalry among the erecting parties. The water supply arrangements called for many new pumping stations with piped supplies to groups of storage tanks, to horse-watering points and even to the trenches. This work was principally carried out by army troops companies working under the Chief Engineers of corps, with a field engineer acting as Corps Water Supply Officer.

The administrative preparations for the Somme operations, which of course included all the engineer work, were the subject of a long memorandum issued by G.H.Q. in February, 1916 (see Appendix 16 to the *Official History, 1916*, Vol. I). The front of attack had been forced upon the British by General Joffre. It was by no means suited to the development

necessary for the preliminary accommodation of the large forces that would have to be assembled, or for their maintenance and supply when operations began. The *Official History* describes the area selected as follows :

" The front having been thus arbitrarily settled, the communications had to be extended and improved, and measures taken to provide facilities, including water, for at least seven weeks lodging of over 400,000 men and 100,000 horses. The railways were inadequate ; the roads in the area behind the front where the troops would have to be concentrated were few and indifferent and, owing to enemy observation, there was practically only one near the front (the Contay-Hédauville-Engelbelmer-Martinsart-Aveluy road) which could be used both by day and by night. The accommodation in the scattered villages had to be supplemented by bunks put up in barns, larger rooms and huts ; although, if the weather was good, the troops could, if necessary, bivouac. Except for a small length of stream between Vadencourt and Contay, and on the right the Somme and the Ancre, there was no surface water and no other water readily available in the area, except the few village wells. To obtain more in this chalk country meant sinking deep bore-holes, although in the valleys, water could be obtained by relatively shallow bores."*

" The railways serving the Somme front had from the first been insufficient and, in view of the battle, required much improvement and extension. Between the river and Arras, a distance of 25 miles, only two lines approached the front, covering on Albert, which lay within easy reach of the enemy's guns. These were the double line from Amiens, which beyond Albert crossed into the German position, and the single metre-gauge line Doullens-Albert. At the northern end, two single lines from Doullens and St. Pol converged on Arras. Lateral communication was provided by the great main line Amiens-Abbeville-Calais, and the line Amiens-Doullens-St. Pol-Béthune, single beyond St. Pol ; but this last had two disadvantages : it was hilly in some sections, and only 20 miles behind the front. Besides having to supply military requirements these lateral lines had to carry heavy traffic of coal from the north for the railways, munition factories and

* *Official History*, 1916, Vol. I, pp. 271-2.

city of Paris, amounting to fifty trains a day. It was calculated that the Fourth Army would need eleven trains daily to carry supplies; fourteen trains for ammunition, carrying a total of 5,250 tons; six trains for reinforcements, remounts and stores; thirty-one trains in all, and the total requirements of the Third Army were reckoned at twenty-eight. These numbers might be expected to rise in times of stress, when there were many wounded, to seventy and fifty-eight trains respectively. To reach these latter figures, it was agreed to cut out the carrying of stone for roads, a decision which was to have dire consequences in the later stages of the battle.

"The necessity for better north and south communications had been realized as early as October, 1914, when the Allied troops reached Flanders, and during 1915 the Amiens-Béthune line, originally single, had been doubled as far as St. Pol. It had been proposed to convert the Doullens-Albert metre-gauge to standard, but it was eventually decided on 1st April, 1916, to build a new 17-mile standard-gauge line from Candas (on the railway about four miles south of Doullens) to Acheux. This provided four or five new railheads for the battle front. Another new standard-gauge line, completed towards the end of May, was constructed from Daours, on the Amiens-Albert line, northward up the valley of the Hallue, to Contay (8 miles west of Albert) where a large ammunition dump was formed. This line gave three more railheads. A spur line, which left the main line at Dernancourt, constructed in November, 1915, was, at the request of the Fourth Army, extended eastwards to serve gun positions on the high ground south-east of Albert. Much work on additional sidings and improvements to stations was also undertaken. Vignacourt, on the Amiens-St. Pol line, was enlarged to deal with two divisions instead of one, with an ammunition depot east of it at Flesselles; a supply siding ('Edge Hill') was laid out near Buire on the Albert-Amiens line, and the Dernancourt line was further extended to the 'Loop' east of the Bray-Fricourt line."*

"There were in June, 1916, no light railways or 'foreway' tramway systems as there were later. Before the Somme the definite policy of the Q.M.G. was to concentrate all efforts on standard-gauge railways, and to push the railheads forward

* *Official History*, 1916, Vol. I, pp. 272-4.

within reach of divisional horse transport, thus eliminating mechanical transport and saving petrol. Only in cases where their necessity could be clearly demonstrated were 60-cm. lines to be laid. Use was made, however, during the dumping period, of the existing light railway from Acheux to Albert and its spurs, and of a field 60-cm. system taken over from the French when they were relieved.

"In anticipation that the war would again become one of movement, and the zone devastated by trench warfare would be rapidly passed over, it was considered wasteful to embark on an extensive system of light railways which might soon be left far in the rear.

"Not only had the existing water supply arrangements—for drinking, washing, baths and laundry work—to be improved, but provision had to be made for the large number of divisions and other troops, including cavalry divisions, which would soon be arriving. In anticipation of the operations, special measures had been taken by the Engineer in Chief for the collection of a very large quantity of water-supply plant and equipment. It included pumping sets of every description—even powerful steam fire-engines obtained from the London County Council, which on occasions proved of exceptional value. A few boring plants were also successfully employed. Two water supply barges, equipped with purification plant and large pumps for forcing water through pipes, were sent to the Somme. These and other sources supplied large systems of water distribution during concentration. A shop for the repair of pumps was established at Varennes near Acheux. Elaborate arrangements were made for the extension during the advance, of systems of 4-in. and 6 in. piping, which were laid either on the ground or in trenches, close up to the front line, and for the provision of water-points; also for the establishment, as new areas were conquered, of similar pipelines based on the Somme or existing wells, and on new bore-holes. Mobile pumping sets on lorries were prepared to aid in the supply of water.

"For the distribution of water to the troops, the normal regimental equipment of units was largely augmented by the allotment to each corps of eighty water-carts or G.S. wagons carrying 200-gal. tanks, and the provision of a water-tank column, consisting of 192 3-ton and 111 1-ton lorries, carrying

550- and 135-gal. tanks, and equipped with apparatus for the purification of surface water or water from shallow wells."*

"The roads in the area were nominally in charge of the French *Ingénieur-en-Chef des Ponts et Chaussées* at Amiens, but for war purposes under an Anglo-French *Sous Commission d'Armée du Réseau Routier* of which the *Ingénieur-en-Chef* and the Chief Engineer of the Fourth Army were members, with a British and a French officer as joint secretaries.

"The main roads were not constructed for heavy or extensive traffic; the thickness of metal was only about three inches on a foundation of chalk, and it broke up if the surface was cut and the water reached the chalk. The side roads were little better than tracks. To define responsibility, a line was drawn running approximately through corps headquarters, in front of which corps carried out repairs, and in rear, the *Sous Commission*, which had at its disposal two companies of an R.E. labour battalion and two companies of French cantonniers. Each corps had two companies of an infantry labour battalion. The lack of stone for repairs was the great problem. In the whole Fourth Army area there was only one quarry, north-east of Corbie, and this yielded poor metal with a lot of clay intermixed. The supply for the British was always behind requirements, as neither sufficient stone nor trucks to carry it were available, and the roads could not be used less or closed (as an eminent civilian road expert from home suggested). Repairs had therefore to be carried out as traffic permitted, the road gangs, who worked amidst the vehicles and horses, mending the worst places during halts and blocks.

"Log and sleeper roads over bad places were not in general use until September, 1916; plank roads, for which 2½-in. or 3-in. planks were required, did not become general until October, although one was made through Fricourt by the 74th Field Company and the 7th York and Lancaster (Pioneers) on 4th, 5th and 6th July. Planks, when available, practically solved the problem of forward roads, as they could be laid at a great pace, and if the road suffered from bombardment repairs could be easily and quickly executed.

"Special attention had to be paid to the roads leading to the dumps and railheads; but owing to the lack of stone, little more could be done than 'darn' the worst places, fill

* *Official History*, 1916, Vol. I, pp. 275-6.

potholes and improve drainage. To make roads fit for continuous military traffic was quite beyond the available labour, metal and plant. There was a shortage of steam rollers. In addition to upkeep, a great deal of work had also to be done in repairing and widening bridges, and widening roads, or at any rate in providing passing places; in constructing causeways over the Ancre, laying out tracks, and marking and preparing fords; in making approaches to the new camps, and metalling halting-places at the railheads, in the station yards, and alongside the new sidings.

"It was intended to form forward dumps of road metal, but the shortage prevented this from being done, and only a few small heaps for repairs in the worst stretches in use could be provided. During the preliminary period, although the condition of the roads gave great anxiety, there was no actual breakdown, and it was hoped that the success of the Allies in the offensive would soon carry them out of the zone devastated by artillery fire and cut up by battle traffic on to roads kept in good repair by the enemy. During the first fortnight of the battle, the roads just managed to hold out, but after that the consignments of stone received were a very small fraction of the essential minimum, and both transport and labour being difficult to obtain, the thin crust of road metal was cut through by the heavy traffic, the rain penetrated to the chalk, the surface became a mass of liquid mud without bottom, and a nightmare situation arose."^{*}

"Extra accommodation for the troops was provided by tents and by erecting huts of wooden framework covered by tarpaulins, enough to close-billet at least 15,000 men per division being required. In some cases, the shelter provided was no more than tarpaulins spread over small-arms ammunition boxes. The huts were grouped around villages and woods, six or seven of these localities being allotted to each division. Each of these little settlements had to be given a water supply, either led to it, or pumped from springs, wells and streams. A permanent town major with a small staff was allotted to each divisional or other area."[†]

"As the divisions took over from the French, or arrived later to augment the British forces, their engineers and the

* *Official History*, 1916, Vol. I, pp. 276-8.

† *Official History*, 1916, Vol. I, p. 278.

pioneer battalions were at first fully employed in putting the defences into a satisfactory state in case the enemy should try to forestall the allied offensive by attacking. The divisions were made responsible for the front system, the corps for the second line and for a third line which formed an arc round Amiens. The few working parties which could be obtained—the infantry out of the line were busy training—were mostly employed in shifting stores, repairing roads, felling trees in the local woods, and handling tree-trunks for dug-outs, for the supply of timber was never sufficient. Very soon, all available labour had to be diverted to assist the infantry in the line in the work of preparation both for defence and attack, and the heavy artillery in the construction of emplacements. No deep mined dug-outs were constructed at this period in the front system, although the galleries of some of the mines were specially widened and heightened to accommodate troops before the assault. A few deep dug-outs were, however, made in the second line, or excavated in the chalk in the sides of hills by ordinary working parties under engineer supervision. The dug-outs required for divisional and brigade battle headquarters, observation posts, reserves, signals, forward magazines and stores, aid posts and dressing-stations, where no burrowed into the hill or cliff-side, were still of the 'cut-and-cover' description. By this time, the thickness of cover which a heavy shell would penetrate was pretty well known. A typical roof, just sufficiently proof against 5.9-in. shell, was 6 in. of earth, 6 in. of bricks for a bursting course; 2 ft. of earth in sandbags, corrugated iron sheets, and a layer of rails or 10-in. timbers touching each other, for a distributing course; well supported on stout timber frames, strutted and dogged together.

"Over observation posts and machine-gun emplacements such a thickness of cover could not be put, as it would have made them too conspicuous, unless they were sheltered behind the ruins of a building. When this was not the case, they were sometimes constructed of concrete. A certain number of steel domes with loopholes, when available, were used to cover the observation posts, and were of course far less conspicuous than built-up roofs. In order to avoid having the entrances—always a weak point—too near, tunnels to these posts were often dug from some convenient natural cover. Many of the field-gun emplacements, easily dug in the chalk, had overhead

cover, proof against fragments and shrapnel, resting either on elephant shelters or on timber frames ; but the heavier natures of guns stood mostly in the open, shelters for the detachment and cartridges being provided in dug-outs close by. To induce the enemy to scatter his fire numbers of dummy emplacements were made.

" The construction of jumping-off and assembly trenches was as a rule carried out by the infantry. These were rows of deep trenches, covered over until the last moment with wire netting and grass, that they might escape aerial observation.

" The mining programme included eight large and eleven small mines : two large mines on the Mametz front, with nine small ones ; three at the Tambour opposite Fricourt ; two near La Boisselle, with two small ones ; and one near Beaumont Hamel. Lack of man-power prevented more being undertaken.

" The tunnelling companies, besides mining, constructed a number of Russian saps (shallow tunnels, under no-man's-land), and the field companies made a few more. Some were to be used merely for communication purposes, either as tunnels, or, by removing the earth over them, as trenches ; others, after going a certain distance, were widened to form emplacements to be opened out at the last moment for machine-guns and mortars."*

The methods adopted by the divisions to carry out their engineer work varied according to the personality of their C.S.R.E. Practically all of them, during the period of preparation, employed two of their field companies in the line, and the third company in the rear area, working on hutting, water supply, divisional schools, laundries, baths, etc. There was, without doubt, a considerable difference in the degree of thoroughness with which the divisional trench areas were organized and maintained. Generally speaking, when the British divisions took over from the French they found the trenches well sited, deep and plentiful, but insanitary and poorly revetted. When British divisions relieved each other, they were always critical of the state in which their predecessors had handed over but given a reasonably long period in

* *Official History*, 1916, Vol. I, pp. 284-6.

one sector, a British division usually made considerable progress. The British infantryman does not take kindly to digging, but, by 1916, he had come to realize that the more he helped himself, the more he relieved the sappers and thus enabled them to improve his comfort and well-being.

Some C.S.R.E. employed an officer borrowed from a field company to act as a Division Officer, R.E. or Field Engineer; others added a Tramway Officer, and a Water Supply Officer. The adjutants usually attended to the supply of stores and materials.

Responsibility for the policy of the work to be done in a divisional area rested, of course, with the divisional commander, but it was the C.R.E. who drew up the programme. The following programme drawn up by the C.R.E., 8th Division (Lieut.-Colonel F. G. Guggisberg), when his division took over a portion of the III Corps front on the Somme, in April 1916 is typical of a well-organized plan of action:—

PROGRAMME APPROVED BY G.O.C. FOR R.E. IN RIGHT BRIGADE
SECTOR

1. Laying out and superintending the digging of a front-line fire trench to join Largo St. to the junction of Inch St. and the old firing line. Wiring to be left to the infantry.
2. A definite support line: to be made fit for defence under R.E. supervision.
3. A definite reserve line: to be made fit for defence under R.E. supervision.
4. *Approaches.* Put them in a fit state for traffic, and label them; after which they will be handed over to the infantry.
5. *Dug-out accommodation.* Is to be increased as much as possible, especially in the trenches in and behind the support line. Old dug-outs now in disrepair should be reclaimed in preference to starting new ones. All dug-outs to be numbered in accordance with the system handed over by the 32nd Division. Deep dug outs should not be made in advance of the support line.

6. Wiring of the front line will be left to the infantry, as will also the wiring of the support and reserve lines, but both the latter under R.E. supervision.
7. *Machine-gun emplacements and casemates.* Each machine-gun should have a deep dug-out to hold the gun and crew during an enemy bombardment, for it will rarely be possible to provide cover to the actual gun position, that will resist a direct hit from a 5.9-in. shell.
8. *Posts and defended localities.* To be kept in a state of defence by their garrisons, under supervision of O.C., 15th Field Company: Bécourt Wood; Maxse Redoubt; Usna Redoubt; Tara Redoubt.
9. *Marking the trenches.*
10. *Trench gratings (duck-boards), pumps, etc.*
11. Reconnaissance for a decauville tramway, mule-drawn, will be made, and the line pegged out with numbered pegs. Starting-point, near the cemetery, north-west of Bellevue Farm.

Without such a programme, there was likely to be a haphazard employment of the field companies. When the companies were attached to brigades for work, the C.R.E. lost control and the best results were rarely obtained.

Although the time had not yet come for a large-scale use of trench-tramways and forward light-railways (later known as foreways) several divisions laid decauville tram-lines.

By this time, the selection of officers for the appointments of Chief Engineers of corps and Cs.R.E. of divisions was based upon experience in the field and, as a rule, a Chief Engineer was selected from those who had been Cs.R.E. of divisions, and Cs.R.E. from those who had commanded field companies in the line.

The Fourth Army made its headquarters at Querrieu on 1st March, 1916. It took over the XIII and X Corps from the Third Army and the recently formed VIII Corps was in army reserve. The III Corps came in on 25th March, and took over the 8th and 34th divisions from the X Corps, and new XV Corps took over the 7th and 21st Divisions from XIII.

On the eve of the battle of the Somme the divisions of the Fourth and Third Armies, from right to left, are shown below. The field companies in the divisions are tabulated at the end of this chapter :—

FOURTH ARMY

(Chief Engineer, Major-General R. U. H. Buckland)

XIII Corps (Chief Engineer, Brigadier-General S. H. Powell):—

30th Division C.R.E., Lieut.-Colonel A. E. Panet,
18th Division C.R.E., Lieut.-Colonel H. G. Joly de Lotbinière,
9th Division in reserve.

XV Corps (Chief Engineer, Brigadier-General P. G. Grant):—

7th Division C.R.E., Lieut.-Colonel G. H. Boileau,
21st Division C.R.E., Lieut.-Colonel Clifford Coffin,
17th Division in reserve.

III Corps (Chief Engineer, Brigadier-General A. L. Schreiber):—

34th Division C.R.E., Lieut.-Colonel A. C. Dobson,
8th Division C.R.E., Lieut.-Colonel F. G. Guggisberg,
19th Division in reserve.

X Corps (Chief Engineer, Brigadier-General J. A. S. Tulloch):—

32nd Division C.R.E., Lieut.-Colonel E. P. Brooker,
36th Division C.R.E., Lieut.-Colonel P. T. Denis de Vitre,
49th Division C.R.E., Lieut.-Colonel T. E. Kelsall.

*VIII Corps** (Chief Engineer, Brigadier-General G. S.

Cartwright):—

29th Division C.R.E., Lieut.-Colonel H. Biddulph,
4th Division C.R.E., Lieut.-Colonel S. Mildred,
31st Division C.R.E., Lieut.-Colonel J. P. Mackesy,
48th Division C.R.E., Lieut.-Colonel H. J. M. Marshall.
(in reserve)

ARMY RESERVE

1st Cavalry Division
3rd Cavalry Division
2nd Indian Cavalry Division

* Commanded by Lieut.-General Sir Aylmer Hunter-Weston (late R.E.).

- 12th Division C.R.E., Lieut.-Colonel S. F. Williams,
 25th Division C.R.E., Lieut.-Colonel C. R. Dobbs
II Corps (Chief Engineer, Brigadier-General C. Godby) :—
 3rd Division C.R.E., Lieut.-Colonel C. A. Elliot,
 23rd Division C.R.E., Lieut.-Colonel A. G. Bremner,
 38th Division C.R.E., Lieut.-Colonel G. S. Knox.

THIRD ARMY

(Chief Engineer, Major-General W. Huskisson)

- VII Corps* (Chief Engineer, Brigadier-General J. A. Tanner) :—
 56th Division C.R.E., Lieut.-Colonel H. W. Gordon,
 46th Division C.R.E., Lieut.-Colonel C. V. Wingfield-Stratford,
 37th Division C.R.E., Lieut.-Colonel H. B. Des Vocux.
VI Corps (Chief Engineer, Brigadier-General C. Hill) :—
 55th Division C.R.E., Lieut.-Colonel C. B. Bonham,
 14th Division C.R.E., Lieut.-Colonel J. E. E. Craster,
 5th Division C.R.E., Lieut.-Colonel R. F. A. Hobbs.
XVII Corps (Chief Engineer, Brigadier-General H. C. Nanton) :—
 51st Division C.R.E., Lieut.-Colonel C. F. Randall.

ARMY RESERVE

- 35th Division C.R.E., Lieut.-Colonel H. W. Rushton.

The 37th Division, VI Corps and XVII Corps did not take part in the initial assault.

BATTLE OF THE SOMME

The greatest battle in British history—up to that time—opened on 1st July. During the early hours of the morning all the assaulting troops reached their assembly positions with few casualties. So slight was the enemy's interference that it was thought that the seven days' artillery bombardment had done its work and completely broken down the enemy's trench system. But the Germans had provided their garrisons with deep mined dug-outs, so well protected that even the storm

of shells which had been showered upon their trenches had been unable to touch them, and as soon as the British opening barrage had lifted to allow the assault to begin, the machine-gunners emerged unscathed, to open a murderous fire on our advancing infantry. It was this feature which broke up all the carefully made plans for the assault; it was this that entirely blunted the edge of the first day's attack, and caused the very heavy casualties that took all the weight out of the blow so long prepared and so hopefully launched. It was this and one other factor. In deference to the French, the assault was not made until 7.30 a.m., when the waves of men had to advance in broad daylight, instead of at dawn as we should have preferred. They were thus exposed to the full effect of the German machine-gun fire.

This failure to achieve the expected success resulted in the work of the divisional engineers being limited to little more than the repair of roads and the opening up of communications. All divisions had sections of their field companies allotted for the rapid construction of strong-points to form part of the consolidation of their final objectives, but in only a few cases were these objectives attained.

XIII Corps. On the right, the assault of the 30th and 18th Divisions was remarkably successful, and by the end of the day both had secured their final objectives, but with casualties amounting to some 5,000 in both divisions. The field companies in both had been given similar tasks. In the 18th Division (79th, 80th and 92nd Field Companies), two sections of each company were allotted to brigades for the consolidation of captured positions, and they began their work before nightfall. In the 30th Division, the 201st Company, all of which was working on the consolidation of Montauban village, was subjected to heavy bombardment and suffered many casualties. During the night, which was quiet, much progress was made in opening up communications and clearing the roads and tracks.

XV Corps.—The attack of the 7th and 21st Divisions made good progress on both flanks, but in the centre, Fricourt proved too strong, and by the evening the Germans were still in the

village. The 7th Division (54th, 95th and 13rd Durham Companies) secured Mametz and carried the line forward in conjunction with the 18th Division on their right. The three field companies and the 24th Manchester Regiment (Pioneers) completed the wiring of the whole of the new front during the night, and built four strong-points. Two roads through Carnoy and Wellington Redoubt were repaired and each brigade had two communication trenches duck boarded by the evening. The 21st Division (97th, 98th and 126th Companies) had a hard task in the village of Fricourt. The village was not in the first objective, but was to be pinched out by the advances on its east and west before being attacked in the second stage. The consolidation parties were unable to do anything on the night of 1st July, but the sections of the 98th Company became involved in the fighting and were utilized to strengthen the 63rd Brigade's right flank.

Prior to the opening of the battle "the original front of the 64th Brigade had a salient at each end with a drop back of sixty or seventy yards in the centre, but the divisional engineers, without even the infantry knowing it, had mined a Russian sap from salient to salient. The top of this tunnel was knocked in on the night of the 30th June/1st July, so that the first wave could start from a straight line in front of the British wire, which, however, was almost entirely removed."* In other sectors, many Russian saps had been mined towards the German front line in order to provide covered communication trenches. The ends of these in no-man's-land were blown open by small charges, and they provided an excellent covered approach. Six of these saps were dug by the 183rd Tunnelling Company on the XIII Corps front, and four by the 178th Tunnelling Company on the XV Corps front. But not all the saps fulfilled their rôle, as will be seen.

Three large mines, prepared by the 178th Tunnelling Company, were fired at about 7.28 a.m. under the German line opposite the Tambour, a salient facing Fricourt. "The purpose of these mines was to distract the enemy's attention, and form craters which would block enfilade fire against the 21st

* *Official History*, 1916, Vol. I, p. 359.

Division."* Unfortunately the enemy established himself in the crater lips before the British infantry could reach them.

III Corps.—On this front the 179th Tunnelling Company had prepared two very large mines under the salient round La Boisselle. One mine was charged with 60,000 lb. of ammonal and the other with 40,000 lb. The explosion of these mines was very effective but comparatively local, and the German machine-guns, safe in the deep dug-outs beyond the radius of the mine, were as usual rushed up to the surface, and took a very heavy toll of our advancing infantry waves. Three Russian saps across no-man's-land had been dug on the III Corps front in order to provide a covered approach after the assault, but owing to the secrecy under which they had been prepared their existence was not realized until the time to make the best use of them had passed. The use of such saps by assaulting troops was, of course, impractical, as only a few men could emerge at a time, and once the exits were disclosed it would not have been difficult for the Germans to have bottled up all the men still underground. A view was held, however, especially among the tunnelling officers, that the saps might have been used to get selected bombing parties across, so that as soon as the barrage lifted, these men could dash in to attack the machine-gun crews as they emerged from their dug-outs.† On the other hand troops packed in shallow tunnels before the mines were exploded would have been exposed to grave risks from the collapse of walls and roof. The real use of the Russian saps was for messengers and reinforcements after the successful capture of the enemy's front line.

X Corps.—On this front, the only success of the day was the capture and retention of the Leipzig Salient by the 32nd Division, both the 32nd and 36th Divisions having suffered heavily from enfilade machine-gun fire. In the 32nd Division (206th, 218th and 219th Companies) each brigade had a section of a field company affiliated. The 219th Company consolidated

* *Official History*, 1916, Vol. I, p. 348.

† *Tunnellers*, by Captains W. Grant Grieve and Bernard Newman, p. 128.

the Leipzig Salient during the night, but elsewhere very little work could be done. In the 36th Division (121st, 122nd and 150th Companies) two sections were attached to each brigade, but owing to the failure of the assault, they could do no engineer work, and were employed in collecting and carrying in the wounded. The 150th Company sent a section forward with the 11th Royal Inniskilling Fusiliers to assist in consolidating the "Crucifix," which was the southern tip of the Schwaben Redoubt, but the section officer, Lieutenant Peacock, was killed, and none of the sappers returned. This company also extended the trench tramway system and opened up tracks.

VIII Corps.—The 29th, 4th and 31st Divisions and two battalions of the 48th Division were in the line. Opposite Beaumont Hamel, a large mine (40,000 lb.) had been laid under Hawthorn Redoubt by the 252nd Tunnelling Company. There was a controversy concerning the time at which this mine should be fired. The Corps Commander, Lieut.-General Sir Aylmer Hunter-Weston (late R.E.), wished to fire it four hours before zero, so that the resulting crater could be occupied and consolidated before the assault, and so that the alarm on the German side should have subsided.* But G.H.Q. views were against this, on the ground that it was much more likely that the Germans would occupy the crater first and have a strong vantage point. In the end, a compromise—so often a danger in war—was made, and the mine was fired ten minutes before zero. This was against the advice of all the tunnelling experts, and had the very effect it was desired to avoid. The Germans had ten minutes warning of the attack, and they made full use of their time. The premature blowing of the mine also compelled us to lift the heavy barrage ten minutes earlier. Thus the enemy were given ample time to come out of their shelters and receive our men with withering fire, while in the act of forming up.†

The attachment of the field companies to brigades in VIII Corps varied widely. In the 29th Division (C.R.E.,

* *Official History*, 1916, Vol. I, p. 429.

† *Official History*, 1916, Vol. I, p. 432.

Lieut.-Colonel H. Biddulph, with the 1st West Riding, 1/3rd Kent and 1/2nd London Field Companies) a whole company was attached to each brigade, but this was more nominal than actual, because special requirements for work on roads and water supply left little more than a section available for consolidation work. In the 4th Division (C.R.E., Lieut.-Colonel S. Mildred, with the 7th, 1/1st Durham and 1/1st Renfrew Field Companies) a section only from each company was attached. In the 31st Division (C.R.E., Lieut.-Colonel J. P. Mackesy, with the 210th, 211th and 223rd Field Companies) three sections of the 210th Company were attached to the 34th Brigade and the remaining section and the 211th and 223rd Companies were kept in reserve.

VII Corps.—Two divisions, the 56th (C.R.E., Lieut.-Colonel H. W. Gordon with the 1st Edinburgh, 2/1st and 2/2nd London Field Companies) and the 46th (C.R.E., Brigadier-General C. V. Wingfield Stratford, with the 1/1st and 2/1st North Midland Field Companies) were used to make a diversionary attack on the Gommecourt Salient. On the 56th Division front, the width of no-man's-land—some 800 yds.—had been reduced by the rapid digging in one night (26th/27th May) of a new line 350 yds. farther forward. This feat was accomplished by the 167th Brigade with the 1st Edinburgh Field Company and a company of the 1/5th Cheshire Regiment (Pioneers). By good organization and careful preparation, 2,900 yds. of fire trench and 1,500 yds. of communication trench, were completed at the cost of only eight men killed and fifty-five wounded.* The attack on the Gommecourt Salient failed for the same reasons as the attacks along the Fourth Army front, and no consolidation was possible.

The results of the first day of the battle were a heavy disappointment. The troops were nearly everywhere back in their own lines, and it was only the 30th, 18th, 7th, 21st, 34th and 56th Divisions who had made any gains still held by nightfall. Consolidation parties elsewhere could do nothing, and for the most part the field companies were used to help carry the wounded. In the 7th Division, the three companies were

* *Official History*, 1916, Vol. 1, pp. 457-8.

able to do a considerable amount of clearing of trenches, and Mametz village was consolidated by the 95th Company. In the 34th Division, the companies were each affiliated to the brigades, and as usual in such cases, they were unable to effect any considerable amount of work. They had to carry their own stores, which limited their capacity, and were able to do little beyond repairing wire and clearing trenches. In the 36th Division, detachments of the companies were sent forward early in the day.

It had not yet been established that no useful purpose could be served by pushing the engineers forward until the situation was sufficiently stabilized to enable them to carry out their work. Sections which went forward with the infantry waves were frittered away in casualties; those that were kept a little way back were exhausted by the long strain of waiting under shell-fire. It was proved time and again that companies working under their Cs.R.E., and where necessary, held back until nightfall, did more useful work than any of the dispersed sections affiliated to brigades.

Although the field companies could do very little in the front line, the army troops companies and tunnelling companies were fully engaged that night in clearing the roads and opening up communications. Upon the former fell the task of providing water and repairing the damage done by the German artillery fire. The elaborate plan for carrying forward the water-supply, worked out for the Fourth Army area by Major H. S. Rogers, R.E., was put into operation, and the careful arrangements proved of great value in the subsequent operations. The collection of material and the reconnaissances which had been made all facilitated the rapid opening up of fresh supplies of water to keep pace with the stage-by-stage advance into which the battle now developed. "The most successful pipe-line in point of time was the extension of the Fricourt system, one water-point being actually established in Fricourt within twelve hours of the taking of the village, the entire system being completed in about ten days after the advance."*

At Army and Corps headquarters the true state of affairs

* *Water Supply in France*, p. 65.

after the first day's fighting was not fully appreciated. The grim total of the casualties had not yet been compiled. The Germans were thought to be more badly shaken than they were, and although the progress achieved had fallen so short of the objectives for the day, the battle had only begun. Reserves were at hand, and orders were given for a continuation of the assault.

The night of 1st/2nd July, following the attack, was quiet, and so was the next day, Sunday. Both sides were reorganizing and regrouping their forces; but for the engineers, the days were now crowded with heavy work. The long bombardments had torn up the ground and obliterated all tracks and roads. The wells in the shattered villages had to be cleared and opened up. The ruined cottages, now little more than heaps of rubble, had to be converted for machine gun posts. Dug-outs had to be cleared and their entrances reversed. Fricourt, Mametz and Montauban were the first villages to fall into our hands; the capture of others proved to be a long and costly process. Although the infantry brigades, gradually reduced to skeletons, were taken out of the line and replaced by fresh divisions, the engineer companies had to be left behind to work under the new-comers. This necessity continued throughout the war. There were very few intervals when the field companies and pioneers could be taken back for a complete rest and change; there were none at all for the tunnelling and army troops companies, but these units had more comfortable billets and their men were taken to their work in their own mechanical transport. The men in the field companies had to march, carrying their tools and materials.

There followed a rapid succession of divisions until by the end of the battle—officially reckoned as 18th November—the only divisions serving on the Western Front who had not been “through the Somme” were the 40th and 42nd. Some divisions had been put in three times, and most of them twice.

A list of the field, army troops and tunnelling companies who served on the Somme in 1916 is given below.

R.E. COMPANIES WHO SERVED ON THE SOMME FROM JULY TO
NOVEMBER, 1916

Divisional Engineers

<i>Division</i>	<i>Field Companies</i>
Guards	55th, 75th and 76th.
1st	23rd, 26th and 1st Lowland.
2nd	5th, 226th and 1st East Anglian.
3rd	56th, 1st Cheshire and 1st East Riding.
4th	9th, 1st Durham and 1st Renfrew.
5th	59th, 1st Durham and 1st Home Counties.
6th	12th, 1st London and 2nd West Riding.
7th	54th, 95th and 1st Durham.
8th	2nd, 15th and 1st Home Counties.
9th	63rd, 64th and 90th.
11th	67th, 68th and 86th.
12th	69th, 70th and 87th.
14th	61st, 62nd and 89th.
15th	73rd, 74th and 91st.
16th	155th, 156th and 157th.
17th	77th, 78th and 93rd.
18th	79th, 80th and 92nd.
19th	81st, 82nd and 94th.
20th	83rd, 84th and 96th.
21st	97th, 98th and 126th.
23rd	101st, 102nd and 128th.
24th	103rd, 104th and 129th.
25th	105th, 106th and 130th.
29th	1st Kent, 1st London and 1st West Riding.
30th	200th, 201st and 202nd.
31st	210th, 211th and 223rd.
32nd	206th, 218th and 219th.
33rd	11th, 212th and 222nd.
34th	207th, 208th and 209th.
35th	203rd, 204th and 205th.
36th	121st, 122nd and 150th.

R.E. UNITS WHO SERVED ON THE SOMME, 1916, *contd.*

<i>Division</i>	<i>Field Companies</i>
37th	152nd, 153rd and 154th.
38th	123rd, 124th and 151st.
39th	225th, 227th and 234th.
41st	228th, 233rd and 237th.
46th	1/1st, 1/2nd and 2/1st North Midland.
47th	1/3rd, 2/3rd and 1/4th London.
48th	1/1st, 1/2nd and 2/1st South Midland.
49th	57th, 1/2nd West Riding and 2/1st West Riding.
50th	7th, 1/1st and 2/2nd Northumbrian.
51st	1/1st, 1/2nd and 2/2nd Highland.
55th	1/1st, 2/1st and 2/2nd West Lancashire.
56th	1/1st Edinburgh, 2/1st and 2/2nd London.
63rd (R.N.)	1st, 2nd and 3rd Field Companies, R.N. Division.

Army Troops Companies

133rd,	238th,
134th,	280th,
135th,	281st,
142nd,	282nd.
145th,	1/1st Hants (later 559th).
148th,	1/1st Wilts (later 265th).
149th,	1/3rd Cornwall (later 573rd).
214th,	1/1st Sussex (later 577th).
216th,	1/1st Devon (later 567th).
221st,	1st Siege Company, R.Mon. R.E.,
232nd,	4th Siege Company, R. Mon. R.E.,
236th,	2nd Siege Company, R. Anglesea R.E.

Tunnelling Companies

174th,	181st,
178th,	183rd,
179th,	252nd.

The five field squadrons, two railway companies and three R.E. labour battalions also served in the area.

The casualties suffered in some of the R.E. companies were severe, and were sustained chiefly in the periods of waiting in exposed positions rather than while doing actual work. The 11th Company had four officers wounded and sixty-four other ranks killed and wounded in the period 15th to 22nd July in High Wood. On 14th July, in the 7th Division, the 54th Company had one officer wounded, five other ranks killed and eighteen wounded; the 95th Company had one man killed and twelve wounded; and the 1/3rd Durham Company had one officer wounded and thirteen other ranks killed or wounded. On 29th August, in the 14th Division, one section of the 59th Company lost one officer killed, one wounded, and ten other ranks killed or wounded. In the 34th Division, which had some of the stiffest fighting, the engineers lost seven officers and sixty-eight other ranks in the first five days of July. In the first twenty days, the 9th Divisional Engineers lost eleven officers and over 200 other ranks, i.e., more than the equivalent of a whole field company.*

On 29th July, No. 3 section of the 82nd Field Company (19th Division) working "under the 57th Brigade, was engaged under fire in building strong points in front of Bazentin-le-Petit during the night. The infantry assisting the section was withdrawn to prepare for an attack next day, but the sappers volunteered to go on with the work, and did so, until nine were killed and nearly all the others wounded. In the village there now stands a brick memorial to 'Nine Brave Men'."[†]

There were many occasions when the field companies took part as infantry in the operation. "The sections of the 98th Field Company (21st Division) sent up to consolidate, became involved in the fighting, and were utilized to strengthen the 63rd Brigade's right flank."[‡]

"Two attempts made by the 207th Field Company (34th Division) and a company of the 18th Northumberland Fusiliers (Pioneers) to reinforce this party (of the 15th Royal Scots, left to deal with Sausage Redoubt) across no-man's-land also

* *Official History*, 1916, Vol. II, p. 106, footnote.

† *Official History*, 1916, Vol. II, p. 205, footnote.

‡ *Official History*, 1916, Vol. I, p. 359.

failed owing to machine-gun fire : it was obvious that until the Germans could be cleared out of the Redoubt, the troops of the second column lying out in no-man's-land could neither be reinforced nor relieved during daylight."*

"Brigadier-General Gordon made a similar reply when asked to renew the attack of the 70th Brigade (8th Division)—there was indeed little of it left, and its front was held by a hundred of its men and the 15th Field Company, R.E."†

"Meantime, the other field companies R.E. (2nd and 1st Home Counties) of the 8th Division, which had not left their positions of assembly, were sent up to assist in holding the line. They actually spent the night in bringing in wounded."‡

"Soon the 1/3rd Durham Field Company, R.E. (7th Division) arrived and proceeded to construct strong-points at the eastern and southern angles (of High Wood) ; again and again the sappers had to pick up rifles and assist the infantry to repel counter-attacks."§

"The 64th Field Company, R.E. (9th Division) which had been attached to the South African Brigade, was relieved next morning (20th July) ; it had done excellent work, both in such consolidation as was possible, and as a fighting unit."¶

"The 20th Royal Fusiliers, following close behind the right of the advance with the 11th Field Company, R.E. (33rd Division) now pressed into the fight, and the southern half of the objective was cleared of the enemy. The 11th Field Company which had taken its share of the fighting, lost all its officers and was brought out of action by a corporal."¶

"The Germans did, indeed, make several attempts to re-enter Ginchy during the evening, and in repelling them a distinguished part was played by the engineers (16th Division).**

* *Official History*, 1916, Vol. I, p. 381.

† *Official History*, 1916, Vol. I, p. 390.

‡ *Official History*, 1916, Vol. I, p. 391.

§ *Official History*, 1916, Vol. II, p. 87.

|| *Official History*, 1916, Vol. II, p. 106.

¶ *Official History*, 1916, Vol. II, p. 111 and footnote.

** *Official History*, 1916, Vol. II, p. 275.

CHAPTER XII

BATTLES OF SPRING AND SUMMER 1917 IN FRANCE AND FLANDERS

German withdrawal in March—Preparation for Arras—Arras—
Messines Projected landing on the Belgian coast.

GERMAN WITHDRAWAL IN MARCH

THE months of January and February, 1917, were occupied by the Fifth Army in carrying out several minor operations to improve its positions and to embarrass the Germans, while the Fourth Army was engaged in taking over further large sectors of the front in accordance with British agreements with the French. By the end of February, the British front had been extended as far south as the Roye—Amiens road, near Andechy, and the Fifth Army was following up the Germans who had already begun to withdraw from the muddy valley of the Ancre. The extension of the front southwards brought the Fourth Army line over the Somme, and this immediately gave rise to heavy engineering problems necessitating extensive bridging in the troublesome valley and the opening up of fresh roads. When, in March, the Germans made a much larger withdrawal back to their Hindenburg Line, the problems were increased by the bridging required over the Somme—Oise canal, and by the communications required over the devastated area left between the opposing armies.

The Hindenburg Line, a broad defended belt, had been prepared by the Germans with considerable secrecy during the autumn and winter. They had used forced labour from France and Belgium, Russian prisoners of war and German civil contractors. It shortened their front by 25 miles, and ran from near Vailly, on the Aisne—east of La Fère—west of St. Quentin and Le Catelet—Havringcourt—Mœuvres—Quéant—Bullecourt to Tilloy, south-east of Arras.

As the Germans fell back, they carried out a most thorough destruction, long prepared and scheduled, and in execution exceeding all the laws and customs of warfare between civilized nations. Not only were the roads mined, but all buildings were demolished to deny their use as billets, to block the roads and as a source of useful material. Fruit trees were hacked down, wells were polluted by farmyard manure and the carcasses of animals, and "booby-traps" were laid to catch the unwary. The mentality of the German race was certainly well exhibited.

The problems of the engineers of the Fourth and Fifth Armies thus multiplied just at a time when the reserve divisions and technical troops were being withdrawn in preparation for events farther north. First of all it was necessary to keep close touch with the retreating enemy; he could not be allowed to settle himself into his new line of defence without molestation. The British artillery must be pushed forward as soon as possible to pound the defences, and the British line must be established in time to give support to the Third and First Armies in their Arras offensive.

It was on the Fourth Army front that the problem of getting forward was the heavier, as the Fifth Army had no river obstacle. It fell to the III and IV Corps, (Chief Engineers, Brigadier-Generals A. L. Schreiber and S. F. Williams) to bridge the Somme and its tributaries. Here was a situation which called for the application of peace-time teaching; a river to be crossed which ran parallel to the front; the enemy known to be retiring; six divisions in the line; materials to be found near the sites; and the full bridging equipment of the engineer units at hand. It was decided that the first requirement was to bridge for infantry and pack animals; to be followed by medium pontoon or trestle bridges for divisional transport and field artillery; and then by heavy bridges to carry mechanical transport and heavy artillery.

The line had recently (in February) been taken over from the French, and G.H.Q. had warned armies and corps to be prepared for a German withdrawal. The policy to be followed had been discussed as recently as 15th March, at a conference

of Chief Engineers held by the Engineer-in-Chief, Major-General Sir Robert Spring Rice. It was then agreed that the first reconnaissances were the duty of the divisional engineers, that each corps should place an officer in charge of the bridging, that each army should select one of its Chief Engineers to control bridging material sent up from the base, that an army troops company in each corps should be earmarked for the erection of the heavy bridges and that estimates of requirements should be immediately prepared. The German retirement began, however, before full effect could be given to all these arrangements.

The *Official History* thus describes the Somme obstacle:—

" From the right flank at Offoy to Péronne, the Somme ran roughly parallel to the front. It was a very formidable obstacle, with a canal following the left bank, the main stream under the right, and in between them marshy ground, cut in places by narrow channels with osier beds. Every bridge had been destroyed by the enemy. The roads crossed the marshes on causeways, which banked up the water into pools nearly half a mile wide. Where there were mills, as at Offoy, Bethencourt and Brie, there had been bridges over the mill-pond and spill-way, as well as over the flood-water channels already mentioned, the canal and the main stream. Crossings were practicable only where the causeways existed. To make a new way, as the Germans had done at Rony-le-Grand, would have entailed the construction of a fresh causeway as well as of at least three bridges. At Péronne, the Somme curls westwards towards the Channel. The left flank of the Fourth Army, the XV and XIV Corps, had in front of it the Somme's tributary, the Tortille, and the unfinished Canal du Nord, whose alignment here followed its bed. Although the bow-string bridges of the canal had been dropped on to their abutments, and the brick arches over the stream had been cut, neither the canal nor the Tortille formed an obstacle in any way comparable with that of the Somme. The crossings over the other small tributaries flowing westward into the Somme (the Germaine, the Omignon, and the Cologne) had also been destroyed. As these streams ran roughly parallel to the advance, the crossings had to be re-established for the sake of lateral communication, but did not represent a very urgent problem."*

* *Official History*, 1917, Vol. I, p. 130.

The R.E. units on the Fourth Army front, from right to left, at this time were:-

FOURTH ARMY

(Chief Engineer, Major General R. U. H. Buckland)

IV Corps (Chief Engineer, Brigadier-General S. F. Williams):-

32nd Division C.R.E., Lieut.-Colonel R. H. Thomas, with 205th, 218th and 219th Field Companies.

61st Division C.R.E., Lieut.-Colonel G. E. J. Durnford, with 476th, 478th and 479th Field Companies.

35th Division, in reserve C.R.E., Lieut.-Colonel H. W. Rushton, with 203rd, 204th and 205th Field Companies.

III Corps (Chief Engineer, Brigadier-General A. L. Schreiber):-

59th Division C.R.E., Lieut. Colonel G. B. Roberts, with 467th, 469th and 470th Field Companies.

1st Division C.R.E., Lieut.-Colonel C. Russell-Brown, with 23rd, 26th and 409th Field Companies.

48th Division C.R.E., Lieut.-Colonel V. Giles, with 474th, 475th and 477th Field Companies.

XV Corps (Chief Engineer, Brigadier-General P. G. Grant):-

40th Division C.R.E., Lieut. Colonel R. J. B. Mair, succeeded by Lieut.-Colonel A. C. Baylay on 25th March, with 224th, 229th and 231st Field Companies.

8th Division C.R.E., Lieut.-Colonel C. M. Browne, with 2nd, 15th and 490th Field Companies.

33rd Division C.R.E., Lieut.-Colonel G. F. Evans, with 11th, 212th and 231st Field Companies.

XIV Corps (Chief Engineer, Brigadier-General C. S. Wilson):-

Guards Division C.R.E., Lieut.-Colonel A. Brough, with 55th, 75th and 76th Field Companies.

29th Division C.R.E., Lieut.-Colonel H. Biddulph, with 455th, 497th and 510th Field Companies.

20th Division C.R.E., Lieut.-Colonel A. Rolland, with 83rd, 84th and 96th Field Companies.

Army and Corps Troops Eight army troops companies, two tunneling companies and one pontoon park.

It will be convenient to describe separately the bridging work done by each division.

32nd Division.—The field companies of this division on 17th March, were widely scattered. The Somme was twelve or thirteen miles from the front line, and the intervening roads had been thoroughly obstructed and damaged. News of the enemy's retirement was circulated in divisional orders. Two sections each of the 206th and 218th Field Companies were attached to the 96th and 14th Brigades respectively, in order to assist the brigadiers, but no steps appear to have been taken to make R.E. reconnaissances of the bridges likely to be required or of the area ahead. On the 18th March, a reconnaissance was made by the IV Corps Mounted Troops (1st King Edward's Horse and Corps Cyclists) who reached the canal, and reported all bridges destroyed between Voyennes and Épanancourt. No engineer officer accompanied this reconnaissance, and the mounted troops withdrew for the night as far back as Rosières, leaving no patrols on the river.* The bridging equipment of the 206th and 218th Companies was, however, brought forward.

On the 19th March, another reconnaissance was made by the 1st King Edward's Horse, and a line of cyclist patrols reached the Buny-Matigny road, which they held until relieved in the evening by the 56th Royal Scots. The bridge at Bethencourt was found to be but slightly damaged, and King Edward's Horse repaired it themselves and crossed by 4 p.m. The absence of any R.E. officer from this reconnaissance is again to be remarked. At Rouy-le-Petit, the 1st Dorsets also repaired their own crossing over the Ingon, a tributary of the Somme, by building what amounted to a causeway. The pontoons of the 206th and 218th Companies reached the river in the evening, and the O.C. 218th Company (Major F. C. Westland) was placed in charge of the bridging to be started next day. The rest of the divisional engineers were employed on the roads. It would seem that some time was lost in getting to grips with the bridging problem in this sector, but doubtless there were many other jobs to do.

* *Official History*, 1917, Vol. I, p. 133.

On the 20th March, King Edward's Horse were again able to help themselves. They put a company of cyclists across at Voyennes at 6 a.m. and took in hand the repair of the bridge there to carry cavalry. This was ready by 11.40 a.m. Meanwhile, the 218th Company began work on a pontoon bridge at Voyennes. This was ready to take cavalry by 2.30 p.m., and completed for wheeled traffic by 6 p.m. The 219th Company, previously working on roads, was now moved up to Voyennes and began the construction of another medium pontoon bridge which was completed next day, 21st March. It was not until then that the 32nd Division began to push its infantry across the Somme—four days after the German retirement had been notified.

On the 21st March, the three field companies were at last placed under the C.R.E. for bridging. The 218th Company now joined with the 219th in the building of a heavy trestle bridge at Voyennes, and on 22nd March, the 206th Company made the preliminary repairs to the lock at Offoy, which controlled the canal as far down as Péronne.

In addition to the bridges over the canal and the Somme, the 32nd Division had a number of smaller ones to deal with. A serious problem was presented by the demolition of a large stone culvert under the railway near Quiquery. The thoroughness of the demolition had dammed up the little river Ingon which joins the Somme near Rouy-le-Grand. The 219th Company and three companies of the 2nd K.O.Y.L.I. began work upon it, but eventually a section of the 256th Tunnelling Company had to be called upon to drive a tunnel through the embankment. In all, the 32nd Division built twenty-one bridges between 20th and 28th March, when they were taken off to resume their tactical rôle in the advance.

61st Division.—This division was much nearer to the Somme, on 17th March, than its neighbour on the right. It suffered in the same way from the lack of appreciation of the bridging problems, and its C.R.E., Lieut.-Colonel Durnford, was taken away and placed in charge of roads in the IV Corps area. The 35th Division was about to be withdrawn into corps reserve; all its field companies were employed on roads, and

its C.R.E. could have been more appropriately placed in charge than the C.R.E. of a division advancing across the Somme. It was Major C. B. Hosegood (O.C., 476th Field Company) who acted as C.R.E. during this important time.

Orders for the advance of the division were issued on 17th March, followed by further orders issued on the 18th, neither of which made reference to any bridging. Nor was there any engineer reconnaissance. The division seemed to be entirely preoccupied with the road problem. It was not until 4.30 p.m., on 19th March, that the pontoon equipment was ordered up, and no work began on bridge-building until 20th March. On that date, the 476th Company started a heavy trestle bridge at Epanancourt, using local material; the 478th Company began a medium pontoon bridge at Bethencourt; and the 476th Company reconnoitred the crossing at Pargny. On the 21st March, the pontoon bridge at Bethencourt was finished and next day the 478th Company began a heavy pontoon bridge at the same place. From 22nd to 27th March, the 476th Company worked on the heavy trestle bridge at Epanancourt, and on a medium bridge at Pargny. On 28th March, the division was finally over the Somme and the field companies followed up. Bridges were built over the Omignon at Devise and at Vermand.

59th Division.—This division of the III Corps had only one river-crossing on its front, at St. Christ, some three miles ahead of its line on 17th March, but no reconnaissance was made until the 19th, when the adjutant of the divisional engineers went forward to examine the possibilities. On that day the 469th Field Company built a footbridge and started a medium bridge, which was not completed until the 22nd. It was not until then that the 470th Company began a heavy trestle bridge with material from a German dump left at Bethencourt. This bridge was completed on 27th March. There was apparently no hurry about getting this division across.

1st Division.—On the front of the 1st Division (C.R.E., Lieut.-Colonel C. Russell Brown; 23rd, 26th and 409th Field Companies) there were two important crossings, at Eterpigny

and at Brie, where the main Amiens-St. Quentin road had no less than six gaps. There was no delay in this division in getting to work on the problem. On 18th March, the 23rd Company sent Lieutenants Smith and Cowley to reconnoitre Eterpigny, and the 409th Company sent Lieutenant Bost to Brie. An officer of the 3rd Brigade found a boat and crossed to Brie, which he found empty. A patrol of the 1st Gloucesters then got across, followed at 11 a.m. by the O.C. 1st Royal Munster Fusiliers and his company commanders. The field companies were scattered, but half of the 409th Company reached Brie on the evening of 18th March, and had built an infantry bridge by 10 p.m., allowing the Munster Fusiliers to cross and form a bridgehead. The 23rd Company had completed their infantry bridge at Eterpigny by 9 a.m. on 19th.

The next stage was to build medium bridges for the divisional mounted troops and transport. At Eterpigny, the German crossing was reconstructed. The bridges had been heavily damaged, and the demolition craters had softened the river-bed so that trestles and piles gave much trouble. The obstacle consisted of the canal and the river, with a stretch of marshy ground between. A mixture of pontoons, Weldon trestles, pile piers and timber trestles lashed with wire was used. Work went on from dawn to 10 p.m. on 20th March, and the crossing was ready for field artillery by 1.30 p.m. next day. The 23rd Company was then taken off for urgent road-repairs between Barleux and Villers-Carbonnel, but some of the bridge piles sank and the decking caused trouble, so the company was brought back to the bridge, on the 23rd March, to effect repairs.

Meanwhile, at Brie, the size of the task was becoming only too clear. The crossing had consisted of a series of bridges and some 600 yds. of causeway over the marshes. The Germans had blown six gaps: over the canal (35 ft.), the canal's flood-water channel (28 ft.), the mill-stream (93 ft.), the mill spillway (24 ft.), a breach in the causeway (78 ft.) and finally the river itself (33 ft.). Three mines had been laid in the causeway, but only one had exploded.

It was decided to reconstruct this crossing to take divisional transport and guns. The necessity for a heavy bridge was not appreciated locally, the corps having failed to step in until the division had completed its own arrangements to work at high speed on a medium crossing. It is clear that a heavy bridge, if required, must have the shortest alignment and the pick of the abutments. The divisional crossing should, therefore, have been made as a deviation, leaving the original site for the corps bridge. Had this been done, much time and labour would have been saved, as we shall see.

The 409th Company (Major W. Downs) started work on the divisional bridge at 5 a.m. on 19th March, with orders for completion by dawn on the 20th. The weather was very wet, and it was soon apparent that help was needed. Two sections of the 26th Company (Major W. Shanks) were therefore brought up during the afternoon of the 19th, and started work at the Brie end the same evening. Until five gaps had been bridged, however, work on the sixth could not start.

Very good progress was made during the day. The first gap, over the canal, was completed by 1.30 p.m., and the next by 4 p.m. Work continued during the night by the light of bonfires, the mill-stream being bridged by 8 p.m., and the spill-way by 10 p.m. There remained the gap in the causeway and the bridge over the river. The former was the more troublesome, as the mine had softened the bottom, and the stream was very rapid. Three Weldon trestles with the old-pattern grip-straps were used, but with the legs sinking fast into the mud, it was a matter of great difficulty in the dark to keep the transoms corrected. These difficulties were all overcome, and the gap in the causeway was bridged by 1.30 a.m. The final gap was crossed with trestles built of timber found in Brie, and with rails from the railway west of the canal. At 5 a.m. on 20th March, the whole crossing was ready for the passage of cavalry and field guns, just 24 hours after starting work. The credit for this fine performance belongs to the 409th (1st Lowland) Field Company, who worked without a break in the wettest of weather and on a very difficult site. Credit is also due to the two sections of the 26th Company

who, arriving after dark, lost no time in preparing their end of the crossing and so being ready when the rails could finally be put across.

There was, however, no respite. It now became necessary to make a deviation bridge to carry the medium traffic while a heavy bridge was built under III Corps arrangements on the very site just used by the 1st Division. It was decided to build the deviation north of the divisional bridge. The remainder of the 26th Company was now brought up and both companies were placed under the orders of the Chief Engineer, III Corps (Brigadier-General A. L. Schreiber). Major Downs (O.C., 409th Company) was chief executive engineer, with Major Shanks (O.C., 26th Company) as his assistant, while Lieutenant Stephens (574th Army Troops Company) acted as corps technical adviser.

The corps scheme for the heavy bridge comprised the following spans, numbering the gaps in the same order as before :—

- No. 1 gap—30 ft. on crib piers,
- No. 2 gap—21 ft. 6 in. on crib piers,
- No. 3 gap—60 ft. on crib piers,
- No. 4 gap—16 ft. on crib piers,
- No. 5 gap—Filled in by means of a coffer-dam,
- No. 6 gap—60 ft. on crib piers.

These heavy bridges were ordered up from the base. Two trainloads arrived at La Flaque, ten miles from Brie, on 21st March, and two more on the 22nd. From La Flaque all this material had to be carried by horse transport to the site.

The deviation bridges at gaps 1, 2, 3 and 6 were started on the 20th. At gap 4 the embankment did not readily admit of two bridges; it was therefore decided to postpone the erection of the second for some days. No. 5 gap (the breach in the causeway) was to be filled in with brick rubble, for which purpose, a coffer-dam had to be built. Piles were driven to protect each abutment, giving it a point on the up-stream side. These points were again joined by further lines of piles, also meeting in a point up stream. A dam was then built round these outside piles, and also straight between the

abutments. A certain amount of the pressure was taken off this gap whilst the dam was being built, by driving piles across the channel up stream, and also by cutting new channels in the mud banks so as to divert the water through gaps 3, 4 and 6. The dams were composed largely of sandbags filled with brick rubble and a little cement. They caused the water to rise about fifteen inches, but it was successfully carried off by gaps 3 and 4. As each deviation bridge was completed, the original medium bridge was dismantled to make way for the abutments of the heavy bridges, which were commenced at once.

On 22nd March two sections of the 427th Field Company, under Major Mousley from the 42nd Division, were attached to the 1st Division for work on the bridges, and on 23rd March the 23rd Field Company (Major W. R. Wilson) was brought up and took over work on No. 6 gap.

On 24th March, the C.R.E., 1st Division was at last put in charge of the work, Lieutenant Stephens remaining as corps technical adviser. On 25th March, the heavy bridge across No. 2 gap was completed and the dam at No. 5 gap ready for filling in. Next day, the four lattice girders for No. 1 gap were in position; by 10 p.m., No. 5 gap had been filled; and one heavy girder of No. 3 gap was in place. On the 27th, the bridges over gaps 1, 3 and 6 were completed, and only No. 4 remained. As the construction of a deviation bridge here would require several days, it was decided to postpone this work and to convert the existing medium bridge into a heavy one in one night. All materials were brought up and laid out, and at 2.30 p.m. traffic was stopped. The decking of the medium bridge was then lifted so that the abutments for the heavy bridge could be started, the decking being temporarily replaced to enable traffic to cross between 5 and 6 p.m. The bridge was then again closed, and the medium bridge was finally removed. By 3 a.m. on the 28th, gap No. 4 was completed. All that remained to be done was the decking on the 60-ft. spans at gaps 3 and 6 and some of the approaches. By midday all the decking was fixed, and by 4 p.m. the crossing was ready for heavy traffic of all descriptions.

The heavy bridges had thus taken five days in all—a very fine performance. In addition to the field companies mentioned, a detachment of the 142nd Army Troops Company had assisted with the erection of the steelwork, transport of the 4th Pontoon Park had carried material to the site, and large working parties had been furnished by the 1st Northants and 1st Loyal North Lincs. During the last days of March, the 23rd and 26th Companies made further improvements and additions. A new medium bridge was built alongside the heavy one over gap 4, which was completed on 10th April by the 26th Company; while a more permanent medium bridge was built at gap 6 by the 23rd Company. Thus, by 10th April, there were two complete crossings at Brie, for medium and for heavy traffic.

On 6th April, the 23rd Company was sent to work on the bridge at Lamire Farm. This had no particular value as a line of communication, but was required as a tactical crossing in the event of a German counter-attack, a possibility which was always present in the minds of the Fourth Army staff. The 59th Division had started work, and a succession of field companies had begun to reconstruct the tangled German bridge, but all had been called off to other more urgent work. When the 23rd Company arrived, there was a veritable tangle of timber wreckage. As an instance of confused planning the story of this bridge is given from the history of the 23rd Field Company:—

“A new line was set out, avoiding the worst portions of wreckage, a 20-ft. pile-driver with a half-ton monkey was brought down from Brie bridge and re-erected on a two-pontoon raft, and two smaller pile-drivers were also utilized. A deviation footbridge was constructed to keep traffic off the main bridge. Pontoons which had been in bridge over the eastern main channel were taken out to allow piling, and first a 24-ft. pile (made up of two piles strapped together) was driven to 1-in. sinkage with a 4-ft. drop of the monkey. All was well under way when, on 9th April, orders were received to stop work on this bridge, to put all pontoons into the water and to get a bridge through quickly. Then came another order cancelling the last. Finally, two sections were left to complete

the bridge as a footbridge only; one section being diverted to Eterpigny bridge to replace the pontoons by 30-ft. piled piers, and one section being taken out for training."*

On 17th April, the 1st Division was relieved by the 42nd and the field companies were withdrawn for rest and training. They had well earned some repose.

48th Division.—This Division (C.R.E., Lieut. Colonel V. Giles: 474th, 475th and 477th Field Companies) was much nearer to the Somme than any of the others. Its responsibilities extended from Lamire Farm on the south, to Bazincourt Farm on the north, and it faced the old walled town of Péronne. It was clear that the first requirement for the advance of the division would be the bridges, and no time was lost in making preparations, the situation being admirably handled. As early as 14th March, as soon as he learnt the first news of the enemy's retirement, Lieut.-Colonel Giles ordered up all the pontoon equipment, to be assembled at Frise by the 17th.

"Next evening, 15th March, he ordered a reconnaissance of the canal and river crossings from Bazincourt Farm to Halle for an infantry footbridge and a medium bridge, the equipment to come up at once. During the night of the 15th/16th and early the next morning, the 475th Company carried out the reconnaissance, and the 474th Company took up two pontoons from Frise to Buscourt Lock, where they launched them and concealed the superstructure. On the afternoon of the 16th, the C.R.E. and his adjutant made a personal reconnaissance from the front line and approved the arrangements.

"That evening (16th March) the 475th Company brought the remaining four pontoons and one trestle wagon from Froissy to Buscourt Lock. All six pontoons were then towed through the cutting while the superstructure went by road. At Sormont Farm three rafts were formed, and loaded with the superstructure and a special trestle made up for the canal. The rafts rowed away at 11 p.m. The night was very dark and cold; the journey slow and difficult. The bottom of the canal was full of snags; nine tree trunks lying across had to

* *History of the 23rd Field Company in the Great War.* R.E. Journal, June, 1929.

be sawn through; 200 yards of ice an inch and a half thick had to be broken; all had to be done noiselessly, with the enemy but a quarter of a mile away. The first raft took four hours for the voyage of a mile, and arrived at the site of the bridge about 3 a.m. on the 17th.

Work was begun at once. To place the trestles, holes were cut in the roadway of the destroyed bridge, which it was impossible to move. By noon, the span of 60 ft. across the canal was complete, but left unchessed, so as not to attract attention from the air. One shell and a few rifle shots were the only enemy interference. At dusk, the 474th Company arrived, chessed the canal bridge, and completed a rough footbridge over the river on the piles of the old bridge. 'A' Company of the 8th Royal Warwicks who arrived at 7.30 p.m., crossed the canal by the bridge, and were ferried across the river on pontoon rafts, followed by another company at 10 p.m., 18th March. These were the first troops into Péronne.

The Germans had made a successful demolition of the bridge over the river, destroying the heavy timber piles by fire and explosive down to the water-line. Some thirty feet of the shore bays on either bank were however fairly sound. Orders were received by the 475th Company at 10 p.m. (17th March) to make good this bridge for medium traffic, and to prepare landing stages and a raft for ferrying field artillery. A new pier was built on the north side, and the old bridge made good on the south; a raft of six pontoons was made up with superstructure from a German timber dump at Biaches and at 2 p.m. the ferry was ready.

Work on the bridge began at noon, and went on, one bay at a time, all through a cold afternoon and a very dark night. At 7.30 a.m. on the 18th a battery arrived and was ferried across with its ammunition wagons, and by noon, two troops of yeomanry, a platoon of cyclists and a company of infantry had been carried over. The ferry interfered with the work on the bridge, but this was ready by 3.30 p.m., built on the piles of the old bridge, with four pontoons in the centre bays, which were to be replaced later by trestles.

The Divisional Commander (Major-General R. Faushawe) had stated his requirements the day before for bridges on the main roads south from Péronne, at the Faubourg de Paris at La Chapellette and at Lamié Farm, farther up stream. The 474th Company began work at the Faubourg de Paris

and the 477th at the other two places. On the 21st, a portion of the division advanced as 'Ward's Column,' and the 477th Company was withdrawn to go forward with it. The bridge at Lamire Farm was taken over by the 474th Company and finished on the 24th. This company, at the end of two days' work at the Faubourg de Paris, was told that their bridge was to take lorries. After completing the horse transport bridge, they, therefore, began a timber girder bridge, using material from the Biaches dump. This was finished by the 30th.

"The 475th Company after a day's rest on the 20th, began the repair of four footbridges between the Faubourg de Paris and Bazincourt. Three of them were mined, and one underwater charge exploded and killed 2nd-Lieutenant H. R. Lambert and wounded two sappers—the only casualties in the bridging operations. Repair of footbridges and the maintenance of the Bazincourt bridge occupied the 475th Company until the 24th when it was moved to work with the 474th Company on the timber-girder bridge at the Faubourg de Paris.

"Thus in the course of ten days, the field companies of the 48th Division, with their infantry working-parties, had built three horse-transport bridges, some six footbridges, and a heavy timber bridge from local material, without any help from an army troops company; and one of the field companies had gone forward to deal with engineer work arising from the further advance of the division."*

Thus the 48th Division handled its own bridging problem, and the story of it is a model of efficient planning and execution.

The 40th and 8th Divisions.—Farther north, there were no such river crossings to construct. Only the 224th Field Company of the 40th Division was called upon to repair a bridge over the little tributary of the Tortille on the Cléry-Peronne main road. This was subsequently rebuilt into a heavy bridge of 16-ft. span by the 239th Army Troops Company. Several other minor bridges were repaired or rebuilt on the small

* From the narrative supplied by Lieut.-Colonel J. S. Yule, R.E. The substance of this narrative is embodied in the *Official History, 1917*, Vol. I, pp. 131-2, for which it was written. The rest of this chapter on the bridging of the Somme is based on notes supplied by Colonel Yule.

streams—the Tortille, the Cologne and the Omignon—on the advance towards the Hindenburg Line, but it is time to carry the narrative up to the north, where bigger operations were now impending.

PREPARATIONS FOR ARRAS

Preparations for the battle of Arras began soon after the Chantilly Conference of 16th November, 1916. The operations were to be the British share in General Joffre's plan for a full offensive in the spring of 1917. Sir Douglas Haig also had a plan for large scale operations farther north, with a view to driving the Germans away from the Belgian coast. This latter operation developed later as the battles of Messines Ridge and the third battle of Ypres. The preparations for Arras were in the hands of the Third Army (Chief Engineer, Major-General E. R. Kenyon), and the front selected for attack stretched from Bapaume to Arras. A secondary attack on the Vimy Ridge was entrusted to the First Army.

In the midst of the preparations, the German withdrawal to the Hindenburg Line, which began on 17th March, 1917, pivoting just south of Arras, took away a considerable part of the selected front. This had the effect of creating a third type of terrain for the Third Army. In the southern sector, they were faced with a "scorched earth" territory between the original line and the Hindenburg Line; in the central sector, the city of Arras provided a unique accommodation area close up to the front trenches, well furnished with billets for troops, covered approaches, and underground shelter and communication. On the left, the sector remained as taken over from the French in March, 1916, and included the chalky lower slopes of the Vimy ridge with no good accommodation within two or three miles of the front line, and only two roads, radiating northwards from Arras.

There were three corps in the Third Army at this time: the VII Corps (Chief Engineer, Brigadier-General J. A. Tanner), the VI (Chief Engineer, Brigadier-General C. Hill) and the XVII (Chief Engineer, Brigadier-General H. C. Nanton). All three corps had been in their positions for nearly a year;

the XVII Corps had been temporarily withdrawn in October, 1916, but had returned to its old area early in January, 1917. Each corps had to prepare for large increases in the number of the troops to be accommodated, and the usual problems at once arose, with the usual state of urgency and lack of sufficient stores.

The main engineering problem of all offensives that of roads—was a matter of material. The French roads, admirably made for their peace-time purposes, were founded upon chalk. Whenever frosts occurred, this foundation broke up in the subsequent thaw under the heavy pounding of the army's mechanical transport, and a chalky ooze would appear on the surface, the granite setts would work loose, and the whole road would begin to disintegrate. This would necessitate a closing of roads to all traffic for a few days, with consequent delay in getting up supplies. The winter of 1916-17 was a particularly severe one, with frosts and snow prolonged into March, and snow even fell on 10th April, after the battle had begun.

There were, therefore, urgent reasons for accumulating an ample supply of road material, for organizing a large force of labour for maintenance and repair, and for building up dumps of material for carrying forward the roads through the newly won ground. Unfortunately, serious delays on the railways coincided with the beginning of preparations, as the new organization of the Transportation Directorate had not yet got into its stride. Chief Engineers found themselves with empty dumps and a huge programme of work,* while the

* "From 17th March to 9th April, the day of the attack, the situation as regards trains was as follows:—

	Asked for	Received
Ammunition trains	216	215
Stone	206	125
R.E. Stores	56	35
Railway Material (estimated)...	91	88

Thus, while the full complement of ammunition was received, only about five-eighths of the stone and R.E. stores was made available." *Official History*, 1917, p. 190, footnote.

accumulation of ammunition demanded that the roads should be ready to carry it. They and Cs.R.E. were, in addition, hampered by insufficient road transport. Throughout the war, this had to be begged for, and was never placed automatically at their disposal.

Roads.—A large programme was prepared at the outset by Major-General Kenyon. He selected twelve routes to the front, and aimed at accumulating sufficient material at the head of each to build five miles of timber-planked road by which it was hoped to bridge the interval destroyed by gunfire and to reach the German road system on the far side. In actual fact, the bombardment did not do so much damage as was expected to the main roads leading out of Arras. The Arras-Cambrai road was found to be in fairly good order when it came into our hands, and was used by the VI Corps for the operations against Monchy-le-Preux, as far forward as Fenchy Chapel and as early as 10th April.

The creation of the Directorate-General of Transportation largely removed the responsibility for roads from the shoulders of Chief Engineers, who after about January, 1917, had only to concern themselves with roads ahead of the "D.G.T. Line", which was usually the line of railheads. Divisions were responsible only for forward roads and for clearing them for light traffic. Chief Engineers of corps usually had one R.E. labour battalion at their disposal for road work, and they also drew on the engineer units of divisions as they came successively out of the line.

Water Supply.—The next important item was the supply of water, but it did not present so much difficulty as on the Somme. The town supply of Arras was in working order, and the numerous villages in the rear areas were supplied with wells, developed during the previous two years of military occupation. In the VII Corps area, however, the Germans had destroyed or contaminated all wells as they retreated, and much work was necessary to clean these out or to run fresh supplies by pipe. The rivers Scarpe, Authie and Ternoise above Arras ensured ample supplies for horses, but a large number of watering places had to be installed in places where the

cavalry divisions could be billeted, as well as in areas occupied by the horse-lines of artillery brigades. There were many artesian wells in the Third Army area, the word "artesian" actually being derived from Artois, the old name for that part of France. The supply for the town of Arras itself was obtained from the ancient springs which the French had protected. The pumping station at the town waterworks was also well strengthened and suffered no serious damage in spite of several direct hits. The French army had put in a powerful centrifugal pump, and the Third Army added another as a stand-by. In addition to the installation of numerous watering points for horses and men within the town of Arras—where the points were screened from view, although the front line was so close—4-in. mains were carried into the Ronville and St. Sauveur caves, with storage for the cook-houses and dressing stations.

The personnel employed for the development of these water supplies consisted of a Corps Water Supply Officer attached to the Chief Engineer, detachments of army troops companies, the 352nd Electrical and Mechanical Company, attached to the Third Army and parties supplied by labour battalions. The divisional engineers were mainly concerned with the finding and clearing of wells in the forward area, and in digging new wells 10-20 ft. deep. Any sapper with experience of internal combustion engines had by this time been withdrawn from field companies; indeed, the army troops companies, too, had been "milked" for personnel to form the new electrical and mechanical units.

Accommodation.—The villages in the Third Army, except those destroyed in the VII Corps area, were for the greater part fully occupied by their inhabitants, who still carried on their valiant efforts at cultivation. The town of Arras, although subjected to daily bombardment, still held about 1,000 French civilians; but there were many habitable billets still standing, and the discovery of the extensive caves under the Ronville and St. Sauveur suburbs, which were rapidly joined up by the New Zealand and 179th Tunnelling Companies, gave remarkable additional accommodation right up to the front line. The cellars of the town provided shelter for another 13,000 men.

These facilities helped with the accommodation of the divisions holding that part of the line, but for the large reinforcements which were to be brought in, it was necessary to build numerous hatted camps over the whole Third Army area. Over 4,000 Nissen huts—giving cover for 100,000 men, say, eight divisions—were asked for by the Chief Engineer. A large number of village barns, now emptied of their stores of grain, were filled with wire-netting bunks in two or three tiers and provided fairly comfortable billets for large numbers. The fitting up of these barns was the work of the army troops companies, assisted by sections of the field companies whenever they came out of the line.

Tramways.—In the XVII Corps area, where roads to the front line were almost non-existent, an elaborate 60-cm. light-railway system had been established by the French, and had been enlarged and improved by the XVII Corps until it formed a complete supply system for the front line, and had a length of about thirty-two miles. It was connected to the broad-gauge line at Marœuil, and from there to the corps depot at Bois de Bray, where petrol-driven tractors worked the trucks. Forward from the Bois de Bray they were pulled by mules. The tramway was used for taking up ammunition, rations, engineer stores and water, and worked punctually to a time-table. The average nightly traffic grew from 30 tons, when the system was taken over from the French, to 100 tons by the end of 1916. One of the Chief Engineer's field assistants was placed in charge, and drivers for the tractors and mules were obtained from the divisions in the line and from the army troops companies. In February, 1917, this light railway was taken over by the Assistant Director of Light Railways, Third Army.*

In the VI Corps area, a tramway had been laid by the New Zealand Tunnelling Company in the old Crinchen sewer through

* It is interesting to note that Mr. Lloyd George in his *Memoirs* claims that nobody had thought of using light railways in the forward areas until his creation of the Directorate of Transportation. Trench tramways, of course, had been in use long before this—since early 1915 at least.

Arras, and connected up with the Ronville and St. Sauveur caves. The sewer, really a tunnelled stream, was egg-shaped in section and had a footway throughout its length.

Front-line preparations.---In the front trench system, a large number of trench-mortar emplacements was constructed. These provided camouflaged cover for the 2-in., 6-in. and 9.45-in. mortars which were now in plentiful supply. The emplacements were of the cut-and-cover type. The spoil from the excavations was distributed over the chalk-littered surface at night, and so pitted was the whole area that it was difficult to detect any daily changes. As a result there was far less retaliation from the enemy during the long preparatory period than might have been expected in view of his commanding positions.

The ammunition dumps for the field artillery were usually in slit trenches; but the guns themselves were provided with overhead cover carried on rolled steel joists. Help given to the artillery in the erection of these shelters was usually limited to the attachment of a field company officer, but in some cases R.E. sections were employed to assist. By this stage of the war, units had become very handy in helping themselves.

Among the miscellaneous duties falling to the field companies were the protection of bomb-stores, the making of trench ladders, of trench bridges to carry the field guns, of notice boards for marking captured trenches, the doubling of communication trenches so that each brigade should have at least two "up" and two "down" routes, and finally the establishment of dumps of engineer stores, of water-cans and of material for the tramways.

ARRAS

The battle of Arras started on 9th April, 1917, the disposition of the engineer troops from right to left being :—

Third Army (Chief Engineer, Major-General E. R. Kenyon) :—

VII Corps Chief Engineer, Brigadier-General J. A. Tanner; 21st, 30th, 56th and 14th Divisions, with 33rd Division in reserve.

- VI Corps Chief Engineer, Brigadier-General C. Hill ;
3rd, 12th and 15th (Scottish) Divisions, with
29th and 37th Divisions in reserve.
- XVII Corps Chief Engineer, Brigadier-General H. C.
Nanton ; 9th, 34th and 51st (Highland)*
Divisions, with 4th Division in reserve.

Third Army Reserve

- Cavalry Corps C.R.E., Lieut.-Colonel W. H. Evans ; 1st,
2nd and 3rd Cavalry and 17th Divisions.
- XVIII Corps Chief Engineer, Brigadier-General H. G.
Joly de Lothinière ; three divisions.

First Army (Chief Engineer, Major-General G. M. Heath) :—

- Canadian Corps 1st, 2nd, 3rd and 4th Canadian Divisions,
with 5th (British) Division in reserve.

First Army Reserve

- XIII Corps Chief Engineer, Brigadier-General E. P.
Brooker ; three divisions.

G.H.Q. Reserve

- 58th Division C.R.E., Lieut.-Colonel E. M. Newell,
11th Division C.R.E., Lieut.-Colonel F. A. K. White.

The first day of the battle was a shining success. Although there was no break-through and no gap, for which the cavalry still waited, the depth of the advance on the Third Army front, the number of prisoners and guns captured and the comparatively light British casualties, all marked a hopeful improvement upon the methods and results of the Somme operations. There was good ground for hoping that the next few days would open up still greater possibilities.

The successful infantry advances on the VI and VII Corps fronts enabled the divisional engineers to carry out a large part of their programme on the first day. Strong-points were built in numerous places even in daylight ; trench tramways were carried forward ; the old British trenches were bridged ;

* Commanded by Major-General G. M. Harper (late R.E.).

mule tracks were laid out and constructed : booby traps were removed ; the captured German trenches were sign-boarded ; and numerous German dug-outs were bombed and cleared.

The R.E. and Pioneers worked all through the night of 9/10th April. On the VII Corps front, where progress had been more difficult on the right flank, the roads between Mercatel and Neuville, Beaurains and Mercatel, and Beaurains and Tilloy were all cleared and made passable. On the VI Corps front, the main Arras Cambrai road was made fit for lorry traffic as far as Tilloy by midnight, and for the next three days and nights this road became densely packed with streams of traffic, especially at night when sometimes four lines of wagons, gun-teams, limbers and infantry struggled along in opposite directions through the darkness. Large craters had to be filled in and the *pavé* setts re-laid, tree trunks cleared away, and drainage restored. By the night of 11th April, this road was restored as far as Feuchy Chapel, where a road leading northwards to Fampoux gave valuable lateral communication under cover of Orange Hill.

On the right flank of the XVII Corps, the road up the narrow valley of the Scarpe through St. Nicholas and St. Laurent Blangy was cleared by the 9th Division, while before dusk the 34th Division had made the St. Nicholas-Bailleul road fit for wheeled transport as far as the old German front line. The 15th Division began the clearing of the river Scarpe to take pontoons loaded with ammunition and to bring back wounded on specially made rafts. This proved a very useful line of communication, and by the evening of 11th April a passage had been cleared of snags as far as Athies. Each division, as it came in turn to this part of the front, carried on the clearance, the 15th, 17th, 9th, 4th and 51st Divisions all having a share in it. The forward traffic was limited by the landing and unloading facilities at the enemy's end, but as a means of getting wounded back to Arras without jolting, the waterway was welcomed by the medical staff.

The work thus begun on 9th April, was carried forward without intermission by night or day throughout the operations lasting until 30th May. During these the front line was

carried forward beyond Guemappe, Monchy-le-Preux, Roeux, Gavrelle and the Vimy Ridge, extending the lines of communication for the engineers, but not varying the work.

There was comparatively little bridging to be done. The Cojeul river had to be crossed in one or two places, but it was in Arras itself that the heaviest task appeared. The bridge carrying the main Arras-Cambrai road over the railway just north of the station was destroyed on 9th April by the explosion of the ammunition dumped under it for the howitzers in the railway cutting. A chance shell hit the ammunition and the loss of the bridge was the result. A new heavy bridge was started a few days later by the 557th (Glamorgan) A.T. Company, assisted by a section of a field company from the 29th Division. Shelling was fairly continuous and it was here that Major-General E. R. Kenyon, Chief Engineer of the Third Army, was wounded while on a visit to the work. Some thirty other casualties, mostly among the carrying parties, occurred during the three weeks of construction.

"Two bridges were built, side by side, each consisting of a 60-ft. span, a 21-ft. 6-in. span and a 14-ft. span carried on steel cube piers, resting on concrete foundations. Another important road bridge over a railway cutting near Arras was repaired under heavy fire by the 280th A.T. Company, holes in the arches being filled with reinforced concrete, involving the erection of falsework to a height of between thirty and forty feet. Orders for this work were issued on 16th April, and the bridge was reopened for traffic on 11th May, during which period fourteen R.E. and eighty three others engaged in the work were killed or wounded."*

The R.E. Bridging School established at Aire in December, 1916, with Major A. V. T. Wakely as Commandant, had already trained a number of officers and N.C.Os. of field and army troops companies in the erection of heavy bridges, and this work was now bearing fruit in the new and less static conditions. The army troops companies with their heavier equipment and their motor transport were better placed than the

* *Work of the R.E. in the European War. Bridging*, p. 29.

field companies for erecting girder bridges, and it was not the normal function of the field companies to do more than ensure the passage of their division.

The new front line of the Third Army underwent a number of changes due to successful attacks and counter-attacks, especially at Wancourt on the right, at Monchy in the centre, and at Roeux and Oppy on the left. The field companies and pioneers were continuously engaged in making new switch lines, communication trenches, and overland tracks. By the end of May, the Army line became more or less stable, while the storm of battle shifted still farther north.

On 1st May a welcome change was made in the organization of the field engineers. A C.R.E. (Lieut.-Colonel) and an adjutant were appointed to each corps to administer all R.E. units attached to the corps (army troops and tunnelling companies, R.E., labour units etc.), and to relieve Chief Engineers of administrative responsibilities. At the same time, the status of the staff officers, R.E., attached to Chief Engineers was improved by their grading as Brigade Majors. Hitherto they had been classed merely as Field Engineers.

MESSINES

The Battle of Messines was a separate operation with a limited objective, but it formed a stage in the larger operations which Sir Douglas Haig planned with a view to driving the Germans from their dominating position round Ypres and to securing the Belgian coast. The whole plan had been maturing in 1916, but the German offensive at Verdun and Nivelle's plans for 1917 had interfered. When Nivelle's plans had failed and the French army had become perilously involved in large-scale mutinies, it became imperative for the British Commander-in-Chief to relieve the French.

The Second Army was to assault the Messines-Wytschaete ridge on a frontage of three corps, the II Anzac Corps on the right, the IX Corps in the centre, and the X Corps on the left, with the XIV Corps in G.H.Q. reserve. The preparations for the battle had been begun long before the date fixed for

the assault 7th June, 1917. The battle was to be opened by the explosion of nineteen gigantic mines, which were designed to destroy the enemy's front-line defences on a wide sector, and to demoralize his front-line garrisons. These mines had been systematically prepared, and were carried to completion on a carefully thought out scheme by the Controller of Mines, Brigadier-General R. N. Harvey. The story of this vast tunnelling scheme is told in Chapter VIII of this history. It is sufficient here to say that the arduous and gallant work of the tunnelling companies through the whole of 1916 and the first half of 1917 was rewarded by the successful explosion of the largest mines ever used in warfare. So thorough had been the work of these companies that the charges, some of which had been laid and tamped for a year or more, exploded without a hitch.

The engineer preparations for the offensive were on a vast scale. The chief services required were additional roads and railways. Much had already been done during 1915 and 1916 to increase the railway facilities. The main line between Hazebrouck and Ypres had been doubled, and a new line from Bergues to Proven had been laid, which was doubled early in 1917. From the standard-gauge lines, narrow-gauge branches were laid to serve the ammunition dumps, and to relieve the traffic on the roads. All the existing roads were improved and metalled roads were carried into the forward area almost to the front line. Large dumps of stone and of beech-wood slabs were accumulated for the rapid extension of the roads over the new ground that it was hoped would be gained. The use of timber roadways had become more common, for after the experiences of the Somme, it was realized that a timber road could be laid far more rapidly than a metalled one, and did not require so much consolidation. The operations in the Ypres salient during the latter half of 1917 saw a wide development of this type of road. The slabs were ten to twelve feet long, two and a half inches thick, and roughly trimmed on the edges. They were cut by the forestry companies, R.E., in the rear areas, and were usually laid by pioneer battalions, R.E. labour companies, tunnelling companies and sometimes by "resting"

field companies. The formation was prepared by digging side drains and filling the shell-holes with the spoil, or with rubble from the ruins. The construction and maintenance of these improvised roads, often under heavy shell-fire, involved high casualties; but without them, the essential artillery barrages could not have been fed with ammunition. The Flanders campaign became a long struggle with the mud, and R.E. work consisted almost entirely of constructing and maintaining the tracks and roads.

The plank roads served the battery positions and formed the traffic circuits; the duck-board tracks led forward to the infantry positions, or rather, the line of shell-holes which served as such. Light railways and tramways were laid wherever a firm enough formation could be prepared, but the ground was so pock-marked with water-filled shell-holes that only a very few lines were practicable. These proved very useful for the transport of wounded, who otherwise had to be carried along the duck-board tracks by relays of stretcher-bearers with much suffering and further casualties.

In addition to the corps and army work on the mines and roads, there was the usual heavy programme for the divisions during the preparatory stages. Field companies and pioneer battalions were kept busy right up to zero day (7th June) on the construction of battery positions, artillery group, brigade and battalion headquarters, advanced dressing stations, water pipe-lines, assembly and communication trenches, ammunition stores and R.E. dumps.

The divisions engaged in the opening of the battle were :—

II Anzac Corps (Chief Engineer, Brigadier-General A. E. Panet):—

3rd Australian and the New Zealand Divisions.

25th Division C.R.E., Lieut.-Colonel R. J. Done, with
105th, 106th and 130th Field Companies.

4th Australian Division, in reserve.

IX Corps (Chief Engineer, Brigadier-General G. P. Scholfield):—

36th Division C.R.E., Lieut.-Colonel A. Campbell, with
121st, 122nd and 150th Field Companies.

16th Division	C.R.E., Lieut.-Colonel R. F. A. Butterworth, with 155th, 156th and 157th Field Companies.
19th Division	C.R.E., Lieut.-Colonel P. E. Hodgson, with 81st, 82nd and 94th Field Companies.
11th Division in reserve	C.R.E., Lieut.-Colonel F. A. K. White, with 67th, 68th and 86th Field Companies.
<i>X Corps</i> (Chief Engineer, Brigadier-General J. A. S. Tulloch):—	
41st Division	C.R.E., Lieut.-Colonel E. N. Stockley, with 228th, 233rd and 237th Field Companies.
47th Division	C.R.E., Lieut.-Colonel H. R. S. Christie, with 517th, 518th and 520th Field Companies.
23rd Division	C.R.E., Lieut.-Colonel E. H. Rooke, with 101st, 102nd and 128th Field Companies.
24th Division* in reserve	C.R.E., Lieut.-Colonel T. T. Behrens, with 103rd, 104th and 129th Field Companies.

The experiences of the 25th Divisional Engineers may be taken as an example of the engineer work in the battle. This division had taken over the Wulverghem sector of the II Anzac Corps on 6th April, with orders to prepare it for offensive operations. They therefore had the practical advantage of making the preparations in the sector from which they were subsequently to attack. Except for a short rest for ten days in corps reserve, the division was continuously employed on these preparations up to the day of the assault. For the battle, the field companies and the pioneer battalion were, as was usual in this division, held in divisional reserve, with the exception of the 106th Company, which was detailed to assist the 75th Brigade in the consolidation of its objectives. Definite tasks were allotted to the remainder. Two companies of pioneers (the South Wales Borderers) were to clear the Wulverghem-Messines road, starting work an hour and a half after zero; the other two companies of pioneers were to extend an existing trench tramline to the Messines ridge, starting work an hour after zero. The 105th Field Company was to employ one section on clearing a track forward to enable

* Commanded by Major General J. E. Capper (late R.E.).

field guns to advance; the remainder of the company was to make tracks across no-man's-land, passable at first by pack transport, and later by wheeled transport. The 130th Company was to assist the 7th and 74th Brigades in the construction of communication trenches across no-man's-land into the captured area. The tracks were successfully cleared by midday, when the sections were withdrawn to rest. The 130th Company worked on the communication trenches until 4.30 p.m., resuming work at night. During the next three days the forward tracks and communication trenches were extended and improved, so that by the afternoon of 10th June, it was possible to take wheeled transport by two separate routes up the west slopes of the Messines ridge, to within about 400 yds. of the Messines-Wytschaete road.

In the 41st Division, the three field companies worked in turn on the alignment and consolidation of a reserve line in rear of the newly-won position on the ridge. As the whole attack had been so successful, the companies were able to work in daylight, with consequent great advantage to the progress made.

The field companies of the 24th Division, brought up from reserve, assisted the 41st Division by extending a light railway, fitting up the water-supply in the forward area and making overland tracks for mule transport. The 47th Divisional Engineers had similar tasks alongside the 41st Division.

The three reserve divisions (4th Australian, 11th and 24th) carried the advance as far as the Oosttaverne Line, which was the farthest objective of the plan. Although it had been originally intended to exploit a successful issue of the battle of Messines, the plan had been modified and a considerable pause in the offensive operations now followed, while further preparations were made for the large-scale operations by the Second and Fifth Armies.

PROJECTED LANDING ON THE BELGIAN COAST

In conjunction with the Fifth Army's attack against the Passchendaele ridge, an operation was planned for the Fourth

Army against the Belgian coast. A force was to be landed behind the German line and to move on Ostend. This operation depended on the successful advance of the Second and Fifth Armies across the Passchendaele plateau, but as the attack did not succeed in achieving this result, the plan was never carried out. It was proposed to attack on the coastal sector, to facilitate the difficult operation of landing; and a division, specially trained for the purpose, was to be put ashore behind the German landward defences.

The coastal sector had been held for a long time by the XXXVI French Corps, and it was necessary to relieve this corps by British troops, as the operations would involve a combined naval and military landing. The XV Corps (Chief Engineer, Brigadier-General C. W. Singer) was sent northwards and took over from the French on 11th June, 1917. The 1st Division (C.R.E., Lieut.-Colonel C. Russell-Brown; 23rd, 26th and 409th Field Companies) and 32nd Division (C.R.E., Lieut.-Colonel R. H. Thomas, succeeded on 2nd July by Lieut.-Colonel G. C. Pollard) were sent to form the corps, the 1st Division being selected for the special training in landing operations.

The 1st Division had first of all, however, to take over a sector of the front line. The French had handed over only three floating bridges communicating with a precarious bridgehead on the right bank of the Yser, and these were continually damaged by shell-fire. The 23rd Field Company bore the brunt of the maintenance and repair of these bridges, and built a medium bridge on barrel-piers to supplement them. The seaward crossing was so exposed to the rough waters at the river mouth that the 23rd Company's diary records two men seasick on the bridge. The 26th and 409th Companies were employed on camp construction. On 7th July, the 23rd Company was relieved by the 458th Company of the 40th Division (lent to the 66th Division), and was withdrawn to join the rest of the 1st Divisional Engineers in the preparation of Le Clipon Camp.

On 10th July, the Germans, realizing that the appearance of the British in place of the French portended no good, strongly

attacked the bridgehead held by two battalions on the right bank of the river. The bridges were quickly destroyed by the intense bombardment, and the infantry were cut off and overwhelmed. The bridgehead was lost and the foothold on the far bank was given up. On 16th July, the 1st Division was withdrawn for its special training and was relieved by the 66th Division (C.R.E., Lieut.-Colonel G. C. Williams;* 430th, 431st and 432nd Field Companies).

In the meantime, a special camp was being prepared at Le Clippon, six miles west of Dunkerque, by the C.R.E., 1st Division. The nature of the landing operation required the greatest possible secrecy, and in order that there should be no leakage, the camp was fenced off, and all the troops, except those which were not taking part in the landing, were confined within the very strictly-guarded perimeter. Since horses were excluded, all transport within the camp was by decauville railway.

The 26th Field Company (less one section, dealing with stores arriving by rail at Coudekerque-Branch, just south of Dunkerque) and half the 409th Company were employed at the camp; the other half of the 409th Company was quarrying stone near Dunkerque for the roads leading to it. On 7th July the 23rd Company also joined in the work. All stores had to be obtained direct from Calais, and owing to congestion on the railways, considerable delay was experienced. Stores arrived at the stations at Loon Plage, Boulbourg and Grave-lines, and were delivered by lorry. Accommodation for the troops was in tents, but each brigade headquarters was allowed one Nissen and one Armstrong hut, and each battalion had one Nissen. Water, although very near the surface, caused some anxiety. At first, shallow wells, six to ten feet deep, were dug and lined with timber or corrugated iron, and each provided with storage for 200 gallons. But this proved insufficient, and the Fourth Army provided two sterilizers, and installed them at Loon Plage, whence tank lorries carried the water to reservoir tanks at the camp. The brigades moved in on 17th July, and the camp was practically finished by the end of the month.

* Later, General Sir Guy C. Williams, K.C.B., C.M.G., D.S.O., Chief Royal Engineer.

The field companies then began their own special training for the landing operations.

This training and the plan of the operations are fully described in an article in the *R.E. Journal* of June, 1924, by Colonel W. G. S. Dobbie,* who was G.S.O.1 of the 1st Division at the time. Very thorough training for such an operation was essential, for the selected landing places had peculiar difficulties owing to the profile of the steep sea-wall, which had a bulging coping, and up which the assaulting troops would have had to climb. A full-sized model of this profile was built, and the men practised with it until they could negotiate the slope with ease. A model of one of the huge 600 ft. naval pontoons or barges was made in the camp so that details of loading and the distribution of loads—stores, vehicles and personnel—could be worked out. Each pontoon was to carry one brigade of infantry, with a complete battery of artillery, a field company, a pioneer company, a motor machine-gun battery, a cyclist battalion and three tanks—in fact, a whole expedition in each vessel. There were three such pontoons, each to be pushed along by two shallow-draft monitors lashed together on either quarter at the stern. In all these exercises the field companies took their part. The landing, however, never took place.

In addition to the special work involved in the training of the 1st Division, there was much engineer work required in the maintenance of the corps sector of the line which, on account of its exposed frontage, necessitated continual upkeep of communications. The XV Corps, which had with it six army troops companies, two tunnelling companies and the 12th Pontoon Park, carried out a large programme of work, the chief items of which were the extension of the water-supply and the maintenance of roads. The corps laid a 4-in. water-main from Rosendael to Oost Dunkerque, whence extensions carried the water to a point within 3,000 yards of the front line, a total length of pipe of about sixteen miles. A small fleet of barges brought a daily supply of 50,000 gallons by the canal to Bray Dunes from a sterilizing plant at Bergues. The two

* Later, Lieut.-General Sir William Dobbie, G.C.M.G., K.C.B., M.S.O., of Malta fame.

tunnelling companies: the 257th and the 2nd Australian—were employed chiefly on making and repairing dug outs in Nieuport and its neighbourhood.

On 27th June, a 15 in. shell completely demolished the Chief Engineer's office, but as this happened at 5.30 a.m. no harm was done to personnel.

The German attack on 10th July, and its preliminary bombardment fell heavily on the 1st and 32nd Divisions. The field companies (the 23rd, 206th, 218th, 219th and 432nd; the last named being borrowed from 66th Division) had considerable casualties while replacing the broken bridges. On the 32nd Division front alone there were eight heavy, three medium and fifty-three light bridges to maintain.

The field companies of the 66th Division having no previous experience in France, went through a short course of pontooning and rafting on the canal near Furnes while out of the line.

The 32nd Division was relieved on 17th July by the 49th, and the 66th Division on 25th September by the 42nd. The 42nd Division was in turn relieved on 7th October by the 41st who handed over to French troops on 17th November. The 33rd Division took over from the 32nd for the last half of August. The R.E. units who served on the coast during this period were:

XV Corps (Chief Engineer, Brigadier-General C. W. Singer):—

1st Division	C.R.E., Lieut. Colonel C. Russell-Brown, with 23rd, 26th and 409th Field Companies.
9th Division	C.R.E., Lieut.-Colonel G. R. Hearn, with 63rd, 64th and 90th Field Companies.
32nd Division	C.R.E., Lieut.-Colonel R. H. Thomas, later Lieut.-Colonel G. C. Pollard, with 206th, 218th and 219th Field Companies.
33rd Division	C.R.E., Lieut. Colonel G. F. Evans, with 11th, 212th and 222nd Field Companies.
41st Division	C.R.E., Lieut.-Colonel E. N. Stockley, with 228th, 233rd and 237th Field Companies.

42nd Division	C.R.E., Lieut.-Colonel D. S. McInnes, with 427th, 428th and 429th Field Companies.
49th Division	C.R.E., Lieut.-Colonel D. Ogilvy, with 57th, 456th and 458th Field Companies.
66th Division	C.R.E., Lieut.-Colonel G. C. Williams, with 430th, 431st and 432nd Field Companies.
Corps Troops	148th, 283rd, 284th, 285th, 289th and 557th Army Troops, 257th and 2nd Australian Tunnelling Companies and the 12th Pontoon Park.

On 6th November, the Fourth Army headquarters were moved south again to take the place of the Second Army, now ordered to Italy. The XV Corps remained in the Nieuport sector until 18th November, when the French XXXVI Corps again took over.

CHAPTER XIII

BATTLES OF AUTUMN 1917 IN FRANCE AND FLANDERS

Third battle of Ypres—Battles of Pilckem Ridge and Langemarck
Battles of Menin Road and Broodseinde—Battles of
Passchendaele—Battle of Cambrai.

THIRD BATTLE OF YPRES

THE long drawn-out and costly operations which followed the battle of Messines had for their objects the winning of the high ground on the Passchendaele-Starden ridge, from which it was hoped a drive might be made which would loosen the German hold on the Belgian coast, and also induce the absorption of German reserves with a view to preventing any onslaught on the French Army, which was still suffering from the wholesale mutinies of May.

The Second and Fifth Armies (Chief Engineers, Major-Generals F. M. Glubb and P. G. Grant), with the co-operation of the French First Army on the left, were to develop a series of attacks, each of which had a limited objective, but were to work on a definite plan. The Germans were to be shaken and demoralized by terrific bombardments before the infantry assaulted their positions. These bombardments, however, caused great obstacles in the form of swamps and quagmires which precluded the use of tanks, and in the end made it impossible even to get the guns forward. The ground was naturally of a swampy nature, and the unusually wet weather throughout the four months, August to November, swelled the numerous little streams and filled every shell-hole to the brim. Roads no longer existed, and even if road metal could have been obtained in sufficient quantities for their repair, it would have been useless to go on sinking it in the seemingly bottomless mud.

The Germans relied on defence by a deep belt of concrete machine gun posts, manned by little garrisons who, so long as their shelters were not directly hit, seemed able to hold out until the assaulting troops literally reached their loopholes and dropped hand-grenades inside. To destroy these "pill-boxes," as they came to be called, required many rounds of heavy shell—8-in. and upwards. Even a near miss by a 12-in. shell, exploding in the soft mud outside, would only tilt the block of concrete and leave it still in occupation. A direct hit on the roof would often kill all the occupants by concussion, but the enormous expenditure of ammunition required for the systematic destruction of so many of these strong-points resulted in still further increasing the sea of mud. Time after time the assaulting infantry, after wading across the terrible ground, would find unsuspected machine-gun posts untouched by what had seemed a totally destructive bombardment.

The battle of Messines, and indeed the whole preceding three years' experience of fighting around Ypres, had shown the need for a continually increasing effort to open up roads and tracks in order to maintain the supply of guns and ammunition. It became true to say that the more shells fired in the Ypres salient the more work had to be done to restore the ground over which the assaulting infantry must pass. Thus, the R.E. problems became principally a matter of labour and materials for roads and tracks. The construction of strong-points, which had figured so largely in the engineer programmes on the Somme and at Arras, almost dropped out, and all efforts were concentrated on communications. Communication trenches in such ground became impossible, and all ways of approach had to be above ground. The roads had to be planned for the service of the batteries and ammunition dumps; the infantry had to use the narrow duck-board tracks, and the pack animals the so-called dry-weather tracks, maintained by a continuous filling of shell-holes by rubble from the shattered farmsteads. The task of the Chief Engineers was probably at its most difficult peak during the operations of "Third Ypres." Although the standard-gauge railways had been considerably increased, especially in the Second Army area, and the light

railways had become the care of a separate directorate of the Transportation Branch, it still fell to the Chief Engineers of corps to carry out the construction and maintenance of communications ahead of the D.G.T. (Director-General of Transportation) Line.

The corps troops engineers were more or less permanently quartered in corps areas, but the divisional engineers were constantly on the move and had little chance of carrying their programmes to completion. Their tasks were the duck-board tracks, the bridges over the streams, the mule tracks, the advanced dressing-stations, battle headquarters for all their divisional units, cover for field guns, screening of roads in exposed places, clearing of blocked streams, removal of obstacles in the path of tanks, and even the destruction of bogged tanks. The field companies were called upon to haul guns out of the mire and hand them over to the gunners on a road hard enough to enable the gun-teams to collect them. The laying of tapes at night to guide the infantry to their assault positions, sometimes marked by shielded lanterns improvised from petrol cans, was also their responsibility. The extension of water pipe-lines beyond the line of corps troops responsibility became impracticable, and the water had to be carried in petrol cans from the storage tanks set up at the roadsides.

The decision to use tanks in such an unfavourable terrain, contrary to the advice of the Tank Corps Commander, Brigadier-General H. J. Elles (late R.E.),* brought an additional load to the divisional Cs.R.E. The inclusion of a few tanks in attack orders meant the construction of a means of crossing, for example, the Steenbeek; the removal of fallen trees; the clearance of previously derelict tanks or the creation of a fascine-built track around them. How many tanks which might

* Later he was promoted Major-General and created a K.C.M.G. After the war he was Commander of the Tank Training Centre at Wool, Director of Military Training at the War Office 1930-4 and Master-General of the Ordnance 1934-8. At the time of his retirement he was a General and had been created a K.C.B. and K.C.V.O. in addition to his K.C.M.G.

reach the front line could be expected to overcome the mud was a question which confronted the divisions, but the attempts had to be made. The results were invariably the same.

The front line became merely a series of shell-holes in which the infantry found what cover they could, and a sheet or two of corrugated iron or a ground-sheet laid across a plank was all the protection many of them had against the incessant rain. These gallant defenders could only be reached at night-time, and finding them in the darkness became another difficulty. The line was reached by single-track duck-board paths, extending, in the case of the Fifth Army sector, for some five miles from the canal bank at Ypres. These tracks, laid on the surface, and propped up precariously between shell-holes, were, of course, the objects of constant enemy fire. The traffic over them was extremely risky at night, for a false step often meant at best a plunge into a deep hole full of water, at worst, death by drowning in horrible mud. The stretcher-bearers in particular had a gruelling task; the duck-boards tilted up, catching their feet, and relays of bearers had to accompany each case. The maintenance of such tracks therefore claimed the first priority in the programme, and many sections of the field companies were continuously employed on this work. Nightly the working parties, with a trail of borrowed infantrymen carrying the duck-boards, would set out to repair the gaps and nightly the toll of casualties mounted up. As a typical example, a young subaltern of a field company set out with a carrying party on the long trail from the Ypres canal to Poelcapelle. He had nearly reached his goal when the enemy opened a bombardment with gas-shell. The carrying party scattered in the darkness, dropping their loads, and the subaltern found himself almost alone. He made his way back to the brigade headquarters whence the carrying party had been ordered, and persuaded the brigade-major to give him another party. He led the fresh party up again, collecting duck-boards on the way, and successfully finished his task before daylight. He had covered about sixteen miles during the night.

Such were the conditions of the ground over which forty-six

British divisions and the five Australian, four Canadian and the New Zealand divisions fought during August, September, October and part of November, 1917.

The work of the Royal Engineers in this long-drawn battle, or series of battles, was the same for all the divisions and corps engaged. As divisions were relieved, their field companies remained behind to work in the forward area on roads, tracks and water supply. The Yser canal bank and the ramparts of Ypres were honeycombed with dug-outs and tunnelled shelters lined with steel arches, and became the most comfortable quarters that could be found within walking distance of the front line. Beyond these, a few timbered dug-outs with the permanent water-level above their floors, some shattered farm ruins, captured German concrete pill-boxes, a few sheets of corrugated iron across a slit in the ground, or, as a last resort, a precarious shell hole with a ground sheet for a roof, formed a diminishing scale of miserable shelter as the front line was approached. Work went on day and night upon the improvement of the communications by which alone any supplies at all could be carried forward. Each successive bombardment tore up the ground over which the infantry had to advance, and the task seemed as far from completion as ever. The engineer tasks were so much the same for all those engaged that the narrative here must be confined to an outline only, with an enumeration of the units taking part.

BATTLES OF PILCKEN RIDGE AND LANGEMARCK

The operations were divided into definite battles. First came the battle of Pilckem Ridge (31st July-2nd August). In this the Second Army attacked with the II Anzac, IX and X Corps, and the Fifth Army with the II, XIX, XVIII and XIV Corps, while the French I Corps attacked on their left. The R.E. units engaged, from right to left, were:—

SECOND ARMY

IX Corps (Chief Engineer, Brigadier-General G. P. Scholfield):—

19th Division C.R.E., Lieut-Colonel P. E. Hodgson, with
81st, 82nd and 94th Field Companies.

- X Corps* (Chief Engineer, Brigadier-General J. A. S. Tulloch):—
 41st Division C.R.E., Lieut.-Colonel E. N. Stockley, with
 228th, 233rd and 237th Field Companies.
 47th Division C.R.E., Lieut.-Colonel H. S. Christie, with
 517th, 518th and 520th Field Companies.

FIFTH ARMY

- II Corps* (Chief Engineer, Brigadier-General C. Godby):—
 8th Division* C.R.E., Lieut.-Colonel C. M. Browne, with
 2nd, 15th and 490th Field Companies.
 18th Division† C.R.E., Lieut.-Colonel C. B. O. Symons, with
 79th, 80th and 92nd Field Companies.
 24th Division‡ C.R.E., Lieut.-Colonel T. T. Behrens, with
 103rd, 104th and 129th Field Companies.
 25th Division C.R.E., Lieut.-Colonel R. J. Done, with
 105th, 106th and 130th Field Companies.
 30th Division C.R.E., Lieut.-Colonel G. W. Denison, with
 200th, 201st and 202nd Field Companies.

XIX Corps (Chief Engineer, Brigadier-General A. G.

Bremner):—

- 15th Division§ C.R.E., Lieut.-Colonel R. S. Walker, with
 73rd, 74th and 91st Field Companies.
 16th Division C.R.E., Lieut.-Colonel R. F. A. Butterworth,
 with 155th, 156th and 157th Field Companies.
 55th Division C.R.E., Lieut.-Colonel O. G. Brandon, with
 419th, 422nd and 423rd Field Companies.

XVIII Corps (Chief Engineer, Brigadier-General H. G. Joly de
 Lotbinière):—

- 39th Division C.R.E., Lieut.-Colonel H. J. Couchman, with
 225th, 227th and 234th Field Companies.
 48th Division C.R.E., Lieut.-Colonel V. Giles, with 474th,
 475th and 477th Field Companies.

* The 25th Brigade of the 8th Division was commanded by
 Brigadier-General Clifford Coffin (late R.E.).

† Commanded by Major-General R. P. Lee (late R.E.).

‡ Commanded by Major-General J. E. Capper (late R.E.).

§ Commanded by Major-General H. F. Thuillier (late R.E.).

51st Division*	C.R.E., Lieut.-Colonel J. G. Fleming, with 400th, 401st and 404th Field Companies.
<i>XIV Corps</i> (Chief Engineer, Brigadier-General C. S. Wilson):—	
Guards Division	C.R.E., Lieut.-Colonel E. F. W. Lees, with 55th, 75th and 76th Field Companies.
20th Division	C.R.E., Lieut.-Colonel E. M. Newell, with 83rd, 84th and 96th Field Companies.
29th Division	C.R.E., Lieut.-Colonel H. Biddulph, with 455th, 497th and 510th Field Companies.
38th Division	C.R.E., Lieut.-Colonel B. S. Philpotts, with 123rd, 124th and 151st Field Companies.
<i>Army Reserve</i>	VIII Corps.*

The battle went well, but not so well as had been hoped. The enemy counter-attacked strongly at noon, but by the evening the British gains amounted to about 2,000 yards on a frontage of nine miles, that is to say, round the whole perimeter of the Ypres salient. The losses were heavy, and six of the attacking divisions had to be relieved during the next few days.

Brigadier-General Clifford Coffin, commanding the 25th Brigade, 8th Division, who had been C.R.E., 21st Division, won the Victoria Cross, on 31st July, for his coolness and courage in walking from shell-hole to shell-hole, encouraging his men and showing a complete disregard of danger from heavy machine-gun and rifle fire, although in full view of the enemy.

The offensive was resumed with the battle of Langemarck, 16th-18th August, in which the following R.E. units were engaged:—

II Corps

8th Division	See above.
14th Division	C.R.E., Lieut.-Colonel D. S. Collins, with 61st, 62nd and 89th Field Companies.
24th Division	See above.

* Commanded by Major-General G. M. Harper (late R.E.).

† Commanded by Lieut.-General Sir Aylmer Hunter-Weston (late R.E.).

56th Division	C.R.E., Lieut.-Colonel H. W. Gordon, with 416th, 512th and 513th Field Companies.
<i>XIX Corps</i>	
15th Division	See above.
16th Division	See above.
36th Division	C.R.E., Lieut.-Colonel A. Campbell, with 121st, 122nd and 150th Field Companies.
61st Division	C.R.E., Lieut.-Colonel G. E. J. Durnford, with 476th, 478th and 479th Field Companies.
<i>XVIII Corps</i>	
11th Division	C.R.E., Lieut.-Colonel F.A.K. White, with 67th, 68th and 86th Field Companies.
48th Division	See above.
<i>XIV Corps</i>	See above.

BATTLES OF MENIN ROAD AND BROODSEINDE

The battle of Langemarck failed to gain the important Gheluvelt plateau, on which the Germans had massed the greater part of their artillery, and the capture of which was vital to the operations on either flank. The burden of the attack on the plateau fell on the II Corps. The Commander-in-Chief decided to transfer the II Corps to the Second Army and to give the latter the task of clearing the plateau. An interval of three weeks followed, during which fresh dispositions were made.

The II Corps was taken over by the Second Army on 3rd September, and withdrawn from the line. A fresh plan was drawn up by General Plumer for a methodical attack on the Gheluvelt plateau. The XIX Corps of the Fifth Army was relieved on 7th September, by the V Corps (Chief Engineer, Brigadier-General A. J. Craven). The coming assault by the Second Army was to be made by the X Corps and the I Anzac Corps (Chief Engineer, Brigadier-General A. C. Joly de Lotbinière) with the IX and VIII Corps (Chief Engineer, Brigadier-General G. S. Cartwright) covering the southern flank. The preparations were made with the thoroughness and

method for which the Second Army had by now become famous. The Fifth Army was to attack with the V, XVIII and XIV Corps on 20th September. A few preliminary operations were carried out earlier in the month, notably by the 42nd Division which spent a fortnight in the XIX Corps before being transferred to the XV Corps on the Belgian coast. The R.E. units were :—

42nd Division C.R.E., Lieut.-Colonel D. S. McInnes, with
427th, 428th and 429th Field Companies.

The battle of Menin Road lasted from 20th to 25th September. The X Corps attacked with the 39th, 41st and 23rd Divisions, its right flank being covered by the 19th and 37th Divisions of the IX Corps, while the 1st and 2nd Australian Divisions of the I Anzac Corps attacked on the left. The Fifth Army followed suit attacking with 9th and 55th Divisions of the V Corps on the right, the 51st and 58th Divisions of the XVIII Corps in the centre and the 20th Division of the XIV Corps on the left. The day's fighting was successful and nearly all the final objectives were secured. The battle had been carefully prepared, the assaulting divisions had been rested and were relieved by fresh troops within forty-eight hours. The Germans had been driven from most of the Gheluvelt plateau. The R.E. units in the above divisions (from right to left) were :—

IX Corps (Chief Engineer, Brigadier-General G. P.
Scholfield) :—

19th Division See above.
37th Division* C.R.E., Lieut.-Colonel H. de L. Pollard-
Lowsley, with 152nd, 153rd and 154th
Field Companies.

X Corps (Chief Engineer, Brigadier-General J. A. S.
Tulloch) :—

39th Division See above.
41st Division See above.
23rd Division.

* Commanded by Major-General H. Bruce Williams, R.E.

I Anzac Corps (Chief Engineer, Brigadier-General A. C. Joly de Lotbinière).

V Corps (Chief Engineer, Brigadier-General A. J. Craven) :

9th Division C.R.E., Lieut.-Colonel G. R. Hearn, with 63rd, 64th and 90th Field Companies.

55th Division C.R.E., Lieut.-Colonel O. G. Brandon, with 419th, 422nd and 423rd Field Companies.

XVIII Corps (Chief Engineer, Brigadier-General H. G. Joly de Lotbinière) :—

58th Division C.R.E., Lieut.-Colonel W. H. Kelly, with 503rd, 504th and 511th Field Companies.

51st Division See above.

XIV Corps (Chief Engineer, Brigadier-General C. S. Wilson) :—

20th Division See above.

The next step was the battle of Polygon Wood, which lasted from 26th September till 3rd October. The main attack was made by the Second Army with the X and I Anzac Corps. The Fifth Army co-operated with the V and XVIII Corps. The R.E. units in the attacking divisions were :—

X Corps (See above) :—

39th Division See above.

33rd Division C.R.E., Lieut.-Colonel G. F. Evans, with 11th, 212th and 222nd Field Companies.

I Anzac Corps (See above) :—

V Corps (See above) :—

3rd Division C.R.E., Lieut.-Colonel C. A. Elliot, with 56th, 438th and 529th Field Companies.

59th Division C.R.E., Lieut.-Colonel G. B. Roberts, with 467th, 469th and 470th Field Companies.

XVII Corps (See above) :—

58th Division See above.

11th Division See above.

These steps had completed the capture of the Gheluvelt plateau and the stage was set for the assault on the Passchendaele-Staden ridge. The plan for the next step—the battle of Broodseinde on 4th October—was for the Second Army to make the main assault with four divisions of the I and II Anzac Corps, while the Fifth Army attacked towards Poelcapelle with four divisions of the XVIII and two of the XIV Corps. The X Corps with three fresh divisions was to carry the advance to the eastern edge of the Gheluvelt plateau, and the IX Corps was to use the 37th Division to cover the Second Army's southern flank. All the main objectives were won and the day's fighting was an outstanding success. The R.E. units in the divisions referred to (from right to left) were :—

IX Corps (See above) :—

37th Division	C.R.E., Lieut.-Colonel H. de L. Pollard-Lowsley, with 152nd, 153rd and 154th Field Companies.
---------------	---

X Corps (See above) :—

5th Division	C.R.E., Lieut.-Colonel J. R. White, with 59th, 491st and 527th Field Companies.
21st Division	C.R.E., Lieut.-Colonel G. H. Addison, with 97th, 98th and 126th Field Companies.
7th Division	C.R.E., Lieut.-Colonel G. H. Boileau, with 54th, 95th and 528th Field Companies.

I Anzac Corps (See above).

II Anzac Corps (Chief Engineer, Brigadier-General A. E. Panet).

XVIII Corps (See above) :—

48th Division	See above.
11th Division	See above.

XIV Corps (See above) :—

4th Division	C.R.E., Lieut.-Colonel C. R. Johnson, with 9th, 406th and 526th Field Companies.
20th Division.	

On 9th October followed the battle of Poelcapelle. Again the main attack was made by the Second Army, using the I and II Anzac Corps. The latter included the following divisions who had come from the Belgian coast and now led the attack :—

II Anzac Corps (See above) :—

- | | |
|---------------|---|
| 66th Division | C.R.E., Lieut.-Colonel G. C. Williams, with 430th, 431st and 432nd Field Companies. |
| 49th Division | C.R.E., Lieut.-Colonel D. Ogilvy, with 57th, 456th and 458th Field Companies. |

The X Corps made a slight advance with the 5th and 7th Divisions, and on the Fifth Army's front the 48th and 11th Divisions attempted, unsuccessfully, to advance up the Poelcapelle spur, while the XIV Corps, with the 4th and Guards Divisions, improved the left flank.

BATTLES OF PASSCHENDAELE

The objectives of the campaign were still a long way off, but pressure had to be maintained to prevent the Germans from attacking the French. The capture of the main Passchendaele ridge, to deprive the Germans of domination over the Steenbeek valley and to improve the position which would have to be held during the winter, now became the immediate objective, and the two battles of Passchendaele brought the Flanders offensive to a close. The first battle opened on the 12th October, and the main attack was carried out by the II Anzac Corps, which employed the 3rd Australian and the New Zealand divisions, relieving the 49th and 66th. The Australians were to take Passchendaele village while the New Zealanders attacked the defences on the Wallemolen spur to the west. Neither division was able to accomplish its task. The Fifth Army co-operated with an attack by the 9th and 18th Divisions of the XVIII Corps, who failed through lack of sufficient artillery support ; but the XIV Corps, with the 4th, 17th and Guards Divisions was able to advance its line towards the Houthulst forest. The R.E. units (from right to left) were :—

XVIII Corps (See above) :—

9th Division	See above.
18th Division	See above.
63rd Division (in reserve)	C.R.E., Lieut.-Colonel S. H. Cowan, with 247th, 248th and 249th Field Companies.

XIV Corps (See above) :—

4th Division	See above.
17th Division	Lieut.-Colonel C. M. Carpenter, with 77th, 78th and 93rd Field Companies.
Guards Division	See above.
34th Division (in reserve)	Lieut.-Colonel A. C. Dobson, with 207th, 208th and 209th Field Companies.

The successive failures of all these attacks were largely due to insufficient artillery support. Ammunition supply was very difficult, and the continued bad weather since early October had even prevented the batteries from reaching their new positions and many of them had become bogged down. They could now only take up fresh sites if planked roads could be made in advance. Whole field companies became engaged in extricating guns. Wooden sledges were made for the field guns, but very substantial platforms were required for the medium and heavy artillery. All these devices required time and much labour, while every interval between assaults gave the Germans an opportunity to improve their defences.

The forward roads continued to absorb the energies of the divisional and corps engineers in both armies. Figures available for the Second Army show that the average daily labour employed on roads in the forward army area amounted to two infantry battalions, seven pioneer battalions, ten field companies, seven tunnelling companies, four army troops and two labour companies.*

The final battle was postponed until 26th October, to enable the roads to be extended and the artillery moved up. The Canadian Corps (four divisions) was brought from the First Army and on 18th October, took the place of the II Anzac

* *Official History, 1917, Vol. III.*

Corps in the Second Army. The Canadians were to capture Passchendaele in three stages and the Fifth Army was to capture Westroosbeke. Other attacks were to be made on the flanks, to give the impression of a general offensive. The first stage opened on 26th October, with an attack by the 3rd and 4th Canadian Divisions, gaining some 500 yards and establishing the Canadian front on drier ground to the south-west and west of Passchendaele. The X Corps attacked with the 7th and 5th Divisions on the Gheluvelt plateau, with the object of capturing Gheluvelt village and Polderhoek château. Some initial success was achieved, but the ground won had to be given up later in the day. On the Fifth Army front, the XVIII Corps used the 58th and 63rd Divisions in an attempt to advance up the Lekkerboterbeek valley. The mud delayed the troops, who in consequence could not keep up with the barrage, and subsequent German counter-attacks drove them back to their starting-line. The XIV Corps attacking with two fresh divisions, the 57th and 50th, was also unable to make progress. On 29th October, the XIV Corps was relieved by the XIX which took over the 35th, 57th and 50th Divisions, the R.E. units being :

XIX Corps (Chief Engineer, Brigadier-General, A. G.

Bremner) :—

35th Division	C.R.E., Lieut.-Colonel J. W. Skipwith, with 203rd, 204th and 205th Field Companies.
57th Division	C.R.E., Lieut.-Colonel H. la T. Campbell, with 421st, 502nd and 505th Field Companies.
50th Division	C.R.E., Lieut.-Colonel H. E. F. Rathbone, with 7th, 446th and 447th Field Companies.

Another attempt was made on 30th October, the Canadian Corps making further progress and reaching the outskirts of Passchendaele. The XVIII Corps, attacking again with the 58th and 63rd Divisions up the quagmire of the Lekkerboterbeek to support the Canadians' flank, was able to make only a slight advance.

On 2nd November, the XVIII Corps front again came under

command of the Second Army, and was relieved by the II Corps, which contained the following divisions :—

II Corps (Chief Engineer, Brigadier-General C. Godby) :—

- 1st Division C.R.E., Lieut.-Colonel C. Russell-Brown,
(from XV Corps) with 23rd, 26th and 409th Field Companies.
- 2nd Division C.R.E., Lieut.-Colonel P. K. Betty, with
(from First Army) 5th, 226th and 483rd Field Companies.
- 18th Division See above.
- 32nd Division C.R.E., Lieut.-Colonel G. C. Pollard, with
(from XV Corps) 206th, 218th and 219th Field Companies.
- 63rd Division See above.

On 6th November, the Canadian Corps attacked again. This time the 1st and 2nd Canadian Divisions captured the whole village of Passchendaele, and secured ground on either side of it.

This success ended the costly but very necessary Flanders campaign ; events elsewhere caused the Commander-in-Chief to close down the offensive in the north, in order to provide troops for the assistance of the Italians after their disaster at Caporetto, and for the new secret offensive which had been brewing in the Third Army. The Fifth Army was withdrawn into G.H.Q. reserve on 15th November, and its front was taken over by the Second Army.

THE BATTLE OF CAMBRAI

(20th November 3rd December, 1917)

The plan for the battle of Cambrai developed from the intentions, in April, 1917, of the Commander-in-Chief to attack the Hindenburg Line between Banteux and Havrincourt. In spite of the drain on his reserves in the Flanders campaign, far beyond his expectations, Sir Douglas Haig continued to direct preparations for a thrust in a new and unexpected sector. There were a number of influences impelling him. A sudden blow coming when the German reserves had

been heavily drawn upon and when the British themselves might be expected to pause for the winter, presented opportunities for success. The Commander of the Tank Corps, Brigadier-General H. J. Elles, and his staff were anxious that the tanks should be tried out on ground more favourable to them than the morasses of Flanders to which they had been so unfortunately committed. There was also the new method of "predicted" artillery fire (made possible by survey methods) which many enlightened officers were anxious to see tried. An attack opened by a large secret concentration of guns which would not have to open fire until zero hour, coupled with the destruction of wire entanglements by tanks instead of shell-fire, formed the basis of the plan which was worked out by the Third Army. The chalk uplands of the Cambrai area, and especially the extensive wood of Havrincourt, marked the scene of the operations.

The preparation of the plan was not made easier by the fact that the divisions which Sir Julian Byng, the Third Army Commander, wished to train were successively withdrawn from him to relieve the exhausted divisions in Flanders. All that he could do was to carry his preparations forward in the greatest secrecy without committing the troops. Then, just as the date for the assault had been settled, the Italian disaster called for emergency measures, and Sir Douglas Haig had to give up five divisions and several heavy batteries. But the Commander-in-Chief, who was convinced that the best way to help Italy was to go on attacking in France, was not the man to be turned aside from his settled purpose, and the preparations for Cambrai went on.

The evolution of predicted artillery-shooting was due to the close co-operation between the artillery and the R.E. survey units. Sound-ranging and the connexion of gun and target positions to the survey triangulation had resulted in the accurate fixing of the enemy's gun positions, and it was now proposed to complete this co-operation by pin-pointing the enemy targets all over the assault area, so that, as the artillery concentrated for the battle, every battery should know its targets and the precise ranges without having to disclose its

arrival. The story of this important development is told in Chapter XII.

As with all the projected operations of 1917, the possibility of a break-through and the exploitation of a "gap" by the cavalry was at the back of the Cambrai plan, and preparations had therefore to be made for the concentration of the cavalry divisions as well as for the great numbers of batteries which would come down from the Flanders battle.

The country was as favourable as could be found anywhere along the British front. The ground had not been cut up by shell-fire, and it was not intended that it should be. The communications were well screened, and traffic up to the front line by day was facilitated by well-drained communication trenches. The Third Army, which had taken over first the Fifth Army front in May and then the Fourth Army front in July, had been drained of its divisions for the Flanders offensive, and the work of preparation for the Cambrai battle fell heavily on the III and IV Corps.

The III Corps had three army troops and two tunnelling companies (see below). The 239th Army Troops Company was earmarked for water supply duties, and the 574th Army Troops Company for heavy bridging. The 232nd Company was held in reserve. Heavy bridging material for the crossings at Marcoing and Masnières was assembled at Fins, and packed ready on wagons on zero day. Among the preparations, arrangements were made to connect up the 60-cm. light railway from its railhead on the British side to the German light railway opposite; this was done by No. 2 Army Tramway Company, R.E., and the two systems were joined up for traffic on 29th November.

The divisions, with their R.E. units, in the line on 20th November, from right to left, were:—

VII Corps (Chief Engineer, Brigadier-General R. D. Petrie):—

24th Division	C.R.E., Lieut.-Colonel A. D. Walker, with 103rd, 104th and 129th Field Companies.
55th Division	C.R.E., Lieut.-Colonel O. G. Brandon, with 419th, 422nd and 423rd Field Companies.

III Corps (Chief Engineer, Brigadier-General A. L. Schreiber) :—

12th Division	C.R.E., Lieut.-Colonel W. Bovet, with 69th, 70th and 87th Field Companies.
20th Division	C.R.E., Lieut.-Colonel E. M. Newell, with 83rd, 84th and 96th Field Companies.
6th Division	C.R.E., Lieut.-Colonel G. F. B. Goldney, with 12th, 459th and 509th Field Companies.
29th Division (in reserve)	C.R.E., Lieut.-Colonel H. Biddulph, with 455th, 497th and 510th Field Companies.
Corps Troops	C.R.E., Lieut.-Colonel C. F. Rundall, with 232nd, 239th, 574th Army Troops Companies, 178th, 181st Tunnelling Companies and No. 2 Army Tramway Company.

IV Corps (Chief Engineer, Brigadier-General S. F. Williams) :—

51st Division	C.R.E., Lieut.-Colonel J. G. Fleming, with 400th, 401st and 404th Field Companies.
62nd Division	C.R.E., Lieut.-Colonel R. A. Gillam, with 457th, 460th and 461st Field Companies.
36th Division	C.R.E., Lieut.-Colonel A. Campbell, with 121st, 122nd and 150th Field Companies.
56th Division (in reserve)	C.R.E., Lieut.-Colonel E. N. Mozley, with 416th, 512th and 513th Field Companies.
Corps Troops	C.R.E., Lieut.-Colonel F. M. Westropp, with 142nd, 565th, 577th Army Troops Companies and 2 Siege Company R. Anglesey R.E.

V Corps (Chief Engineer, Brigadier-General A. J. Craven) :—
(in reserve)

Guards Division	C.R.E., Lieut.-Colonel E. F. W. Lees, with 55th, 75th and 76th Field Companies.
40th Division	C.R.E., Lieut.-Colonel A. C. Baylay, with 224th, 229th and 231st Field Companies.
59th Division	C.R.E., Lieut.-Colonel G. B. Roberts, with 467th, 469th and 470th Field Companies.

The attack began at 6.20 a.m. on 20th November, and was a complete surprise for the Germans. This time, the tanks advanced over more suitable ground than they had ever met

before, and closely following the barrage, they broke down the wire entanglements for the passage of the infantry. The first objectives were soon overrun, and the day's results were outstanding, but the attack at first so successful, instead of sweeping on with gathering speed to the hoped-for breakthrough, gradually lost momentum and came to a standstill.

The battle continued for ten days and resulted in a pronounced salient which the Germans heavily counter-attacked on 30th November, and 1st December, and the British line was forced back almost to where it had been at the start.

Taking the divisions in order from the right, the 24th Division took little or no part in the battle, but remained in the front line throughout, until relieved by the Cavalry Corps on 5/6th December.

The 55th Division also remained in the front line throughout. Its part on 20th November, was that of protecting the right flank of the III Corps. One of its brigades attacked and captured Gillemont Farm, but was driven out again later in the day. On 30th November, the division was heavily attacked by the Germans and the line was pressed back. The field companies were used as infantry to hold the line and for digging fresh posts for defence. At first, there were no reserves, and every available man was put in to establish and hold some sort of line. The divisional front, although forced back, was unbroken, and the division remained in the line until 2nd December.

The 12th Division made a very successful attack on 20th November, advancing nearly 5,000 yds. Several strong-points in the Hindenburg Line were captured, and their conversion gave plenty of work to the field companies for the succeeding nights. But the general situation had not developed as expected, and by the evening of 21st November, the III Corps, of which the 12th Division was on the right, was on the defensive, and great efforts were made to consolidate the gains. The field companies were allotted to the brigades and all were at work in the forward area. On 30th November, the Germans launched their big counter-stroke, intending to cut right across the base of the British salient, now dangerously inviting attack. They

penetrated the line behind the 12th Division and captured Guislain. Brigadier-General Vincent, commanding the 35th Brigade, his headquarters cut off from his troops, collected his staff, the 69th Field Company and some machine-gunners to form a little force which took up a position west of the village, and for several hours prevented the Germans from penetrating further. Reinforcements, including the 239th Army Troops Company were sent to him during the day and the sappers put Revelon Farm into a state of defence. The 70th Field Company, with the 36th Brigade, was similarly employed when Gonnelieu was captured; and the 87th Field Company took a share in holding the line east of La Vacquerie. The division remained in the battle until relieved on 3/4th December by the 61st Division.

The 20th Division, in the centre of the III Corps, had similar experiences. The field companies each had a section with the attacking brigades, and built strong-points behind the new line. In the severe fighting on 30th November all three companies manned trenches and for the next three days were used as infantry. The division was relieved on 4th December after a very long spell in the front line.

The 6th Division.—The field companies were employed almost entirely on the consolidation of captured positions. They were severely handicapped by the withdrawal of the divisional pioneer battalion in the middle of the battle, and sapper labour had to be diverted to supervise the untrained infantry borrowed to replace the pioneers. The field companies were used as infantry supports in the fighting from 30th November to 4th December, and then were engaged in building a corps defence line on Highland Ridge. The division was not relieved until 11th December.

The 29th Division, in reserve at zero hour on 20th November, was soon absorbed in the assault, its task being to secure the canal crossings at Masnières and Marcoing by which the cavalry were to advance. A detachment of the 455th Field Company cut the leads on the bridges at Marcoing and saved them. The main road-bridge at Masnières was damaged by the German demolition, but was subsequently used by the

infantry until a tank broke it down and put it out of action. There was another bridge, fit for cavalry, some 1,600 yards south-east of Masnières, but its existence was unknown to those on the spot, although it had been referred to with its map reference in the divisional operation order. A squadron of Canadian cavalry got across by a lock bridge which the infantry had used, the troopers themselves improving the crossing so that horses could get over. But the squadron became swallowed up on the other side, and few survivors returned. The preparations for crossing this canal seem to have been at fault. The intention to pass the Cavalry Corps through demanded that all means of replacing broken bridges should be pushed well forward. Even if the German bridges had not been destroyed, extra crossings to speed up the passage of the cavalry would have been necessary. But the pontoons of all three field companies, supplemented by six more from the 3rd Pontoon Park, ready loaded, were far back on the Fins Gouzeaucourt road, behind the cavalry columns. "It was hoped," says the *Official History*, "that the need for them would not arise before the following day." But the Cavalry Corps was already on the move, and its divisions were closing up to the canal. The infantry were unable to get across in sufficient strength, and the cavalry divisions were disappointed once more. The 574th Army Troops Company was sent up by the III Corps on the 21st to rebuild the bridge at Masnières, but the C.R.E., 29th Division was already repairing it to carry divisional traffic, so the 574th Company was diverted to Marcoing, where the two heavy bridges, saved from destruction by the 455th Company, were still intact. Two subsidiary bridges for tanks were then built by the 574th Company on the 24th and 25th.

When the Germans counter-attacked on 30th November, they surrounded Masnières, and the 497th Field Company had the misfortune to lose the whole of its forward sections, including the O.C. They were surprised in a tunnel under the brewery at Les Rues Vertes, while asleep after a long night's work. The other two companies, the 455th and 510th, were used to support the infantry. The C.R.E. himself took an active part by organizing the 510th Company and the Pioneers in an

improvised defence line, collecting ammunition for them and finally handing them over to an infantry brigadier. The 455th Company was with the 87th Brigade, and was responsible for the demolition of the five bridges then in Marcoing; these were successfully destroyed after the infantry of the 6th Division had been withdrawn on the night of 3rd December. The 29th Division had played a gallant part, and had been in the battle continuously from 20th November, until it was relieved on 5th December by the 36th Division.

The 51st Division had spent nearly three weeks before the battle in preparing accommodation for large numbers of additional troops in Metz village and Havrincourt Wood, and in training for the attack. On the morning of 19th November, it took over the right sector of the IV Corps. Its assault on the 20th was successful, but the village of Flesquières was not finally cleared of Germans until the night of 21st November. The 401st Field Company was then sent up to put the village into a state of defence. The other two companies worked on clearing the roads and on consolidation. The division captured Cantaing and Fontaine; the Germans recaptured the latter on the 22nd, but were again driven out by the Highlanders next day. The division was relieved by the Guards Division on 24th November. The field companies began their withdrawal but had not gone far when they were recalled for work under the Guards and 40th Divisions. On 1st December, the division was hurried back to the line, and took over from the 56th Division. The front was then receding, and eventually, by 5th December, it was back to the original line of 20th November. The field companies spent each night in wiring and strengthening the successive fronts.

The 62nd Division, like the 51st, was not brought into the line of the IV Corps until the night of 17th November, in order to conceal its arrival in the area; it relieved the 36th Division, but the latter's outposts remained in position. The division's attack on the 20th was successful, and it captured the village of Havrincourt and all its objectives for the first day. The 460th and 461st Field Companies worked on roads. Next day, the division was ordered to capture Bourlon Wood, but this

it failed to do. It was relieved by the 40th Division on the 23rd, and three days later it came back into the line to relieve the same division. Another spell of heavy fighting for the Bourlon ridge followed, but without success, and on 29th November, the division was relieved by the 47th. The Field companies and pioneers remained in the forward area to work on roads and a reserve line. On 4th December, they rejoined their division and it moved back to the XIII Corps in the First Army.

The 36th Division had only one brigade in the line at the opening of the battle. The field companies were working under the Chief Engineer, IV Corps, on the Trescault-Ribecourt road, most of which was found fit for use. Only the 109th Brigade was absorbed into the battle, and on 28th November, the division was sent north to the XVII Corps, its place in the IV Corps having been taken by the 2nd Division. On 30th November, the 36th Division was ordered back and joined the VI Corps. On 5th December, it took over from the 29th and 6th Divisions.

The 56th Division, in IV Corps reserve came into the battle on the 21st November. The field companies were employed chiefly on the Bapaume-Cambrai road. On the 23rd, the 416th Company erected a bridge for field artillery over the Canal du Nord where the main road crossed it, and next day the 513th Company erected a similar bridge close by, to supplement it. Both bridges were subjected to severe shelling. On 3rd December the division was relieved by the 51st and went northwards to join the XIII Corps.

The Guards Division, in reserve with the V Corps, was sent up to the IV Corps to relieve the 51st on the night of the 21st and for the next few days consolidated their line in front of Fontaine. An attack on Fontaine, on the 27th, was partly successful, but a strong counter-attack forced the Guards back again. The attack was stopped by the Army Commander, and on the night of the 28th, the division was relieved by the 59th, and went back into reserve at Trescault, Metz and Bertincourt. On 30th November, the division was again brought into the battle. It was sent to the III Corps, to stem the German

break-through at Gouzeaucourt. Not only did it recapture Gouzeaucourt, but it recovered the abandoned siege batteries and their dumps of ammunition. Next day, it attacked Gauche Wood and Gonnelleu, but it was unable to hold the village. The field companies had the usual tasks of road clearing and consolidation. On 5th December, the division was relieved by the 9th Division.

The 40th Division, also originally in reserve with the V Corps, was sent to the IV Corps on the 22nd, and that night relieved the 62nd in the Bourlon Wood sector. It attacked the wood next day, and gained the greater part of it. The 224th and 229th Field Companies built strong-points in the wood to strengthen the line; the 231st Company worked on the roads round Havrincourt. On 26th November, the 231st Company lost its O.C., Major F. H. Johnson, who had won the V.C. at Loos. On 25th November, the division was relieved by the 62nd, but the field companies and pioneers remained for work under the C.R.E., 62nd Division. On 4th December, the division was transferred to the VI Corps.

In addition to the divisions already mentioned, the following were brought up as reliefs or reserves, and their field companies shared in the battle honours:—

2nd Division	C.R.E., Lieut.-Colonel P. K. Betty, with 5th, 226th and 483rd Field Companies.
47th Division	C.R.E., Lieut.-Colonel H. R. S. Christie, with 517th, 518th and 520th Field Companies.
59th Division	C.R.E., Lieut.-Colonel G. B. Roberts, with 467th, 469th and 470th Field Companies.
61st Division	C.R.E., Lieut. Colonel G. E. J. Durnford, with 476th, 478th and 479th Field Companies.

The battle of Cambrai came to an end on 3rd December, with disappointing results, but a break-through at that time of the year could not have been exploited by the British Army in its exhausted state after the months of heavy fighting in Flanders. A heavy toll had, however, been taken of the Germans, and they

had been prevented from taking advantage of the weakened state of the French army.

During the winter months which followed, all the troops were heavily engaged in preparations to meet the threatened offensive which Ludendorff was to launch when he had transferred enough troops from Russia. Additional portions of the front line were taken over by the British, and a regrouping of the armies was necessary. Field companies had no rest ; they were needed to reshape and consolidate the new sectors, and to strengthen the support and reserve lines along the entire British front.

CHAPTER XIV

GERMAN OFFENSIVES OF 1918 IN FRANCE AND FLANDERS

Preparations to meet the spring offensive—The German attack in March—German attacks in Flanders—Second battle of the Aisne—Battle of Tardenois.

PREPARATIONS TO MEET THE SPRING OFFENSIVES

AS soon as the battle of Cambrai ended, on 3rd December, 1917, Sir Douglas Haig assembled his Army Commanders and impressed on them that they must give immediate attention to the organization of the zones for defensive purposes, and to the rest and training of their troops.* The troops were everywhere in need of it after the long and bitterly-contested struggles of 1917. The replacement of men, especially among the infantry, had not kept pace with the wastage, and the quality of the new troops was not as good as it had been. There was much hard work to be done during the winter to organize the defences, and the quantity and quality of the labour to do it was far below the requirements. Rest and training were equally important factors for success, and these conflicted with the need for large forces of labour for the construction of defence lines. There was no organization such as the Germans would have raised from enforced civilians, and most of the work to be done was too near the enemy's line for the employment of paid civilian gangs, even if any had been obtainable. Much of the British front line, owing to its recent conquest, was in a state of fluidity, and nearly all lacked organization in depth. Attention had been concentrated on offensive operations, and such rear lines as existed had fallen into disrepair, again from want of labour. The task, therefore, that confronted Sir Douglas Haig's engineers was very great indeed.

A memorandum on the defensive measures to be taken was issued by G.H.Q. on the 14th December, 1917.† It laid down

* *Official History*, 1918, Vol. 1, p. 37.

† *Official History*, 1918, Vol. 1, Appendix 6.

that the defences were to be organized in three zones: the Forward Zone, the Battle Zone, and the Rear Zone. Each zone was itself to be organized in depth, with several successive lines, either continuous or in groups of trenches. The forward zone roughly comprised the existing front system, with its firing line, support line, and communication trenches. The battle zone could be more deliberately chosen, and was to be sufficiently in rear of the forward zone to allow artillery fire to be brought to bear on the enemy if he broke through the former. This distance varied from 600 yards to two or three miles. The rear zone was practically a second position; it was to be from four to eight miles behind the battle zone. The forward zone became the chief concern of the divisional engineers, while the battle zone and rear zone were under the supervision of the corps. There were also other defensive lines in rear which had been prepared from time to time under G.H.Q. direction, but these were for the most part only wired, the trenches having fallen into disrepair for want of revetment.

At this period the French government became insistent upon a further extension of the British front, and so it came about that in January, 1918, a large new part of the line had to be taken over, relieving the whole of the French Sixth Army. This brought the front of the British Fifth Army as far south as the Barisis-St. Gobain railway, and gave General Gough a large new area, in which the far from adequate defences did not at all conform to the standards now to be adopted throughout the British front. Thus during the critical three months before the German attack, the programme of work was enormously increased by the extension of the Fifth Army front. In consequence, fourteen army troops companies and other R.E. units were transferred from the Fourth (late the Second) Army to the Fifth.* A preponderance of R.E. units remained, however, with the Fourth (or Second) Army which, on a front of 23 miles on 21st March, had sixty-eight companies, as against the Fifth Army's fifty-six on a front of 42 miles.*

The British XVIII Corps relieved the French III Corps on

* *Official History*, 1918, Vol. I, Table on p. 116.

† *Ibid.*, p. 116.

14th January, but the British III Corps did not complete its relief of the French XXXVII Corps until 29th January, and it then had no army troops or tunnelling company. The 4th (Siege) Company, R. Anglesey, joined it on 30th January, followed by the 365th Forestry Company on 1st February; the 182nd Tunnelling Company on 7th February; the 565th and 567th (Devon) Army Troops Companies on 11th and 14th February. The 135th and 284th Army Troops Companies were added later, but not until 7th March, a mere fortnight before the German offensive began. Thus it will be seen that the two Corps on the right of the Fifth Army were short of sappers and had very little time indeed for the preparation of the new zones of defence.

The field companies, sorely in need of rest after the long battles of the Ypres salient, were set to work on the forward zones, while the army troops companies and tunnelling companies, assisted by labour companies and entrenching* battalions, worked on the battle zones, under the direction of the Cs.R.E. of divisions in reserve or under Chief Engineers of corps.

However urgent was the labour situation on the Fifth Army front, there was no less urgency on those of the other armies. Although their fronts were not so extensive as the Fifth, their closer proximity to the vital Channel ports prevented any further diminution of their resources. The ding-dong works programme extended along the whole British line.

The rear lines of defences were merely spit-locked, or at best, excavated to a depth of one foot, but subsequent experience showed that troops retreating in the dark- or even in daylight- could not be directed to halt on a spit-locked line, if indeed they ever saw it. Much labour was expended on defence works which were never occupied. Troops, new to an area, when retiring have no knowledge of rear positions, and unless they fall back upon trenches already visibly manned by supporting troops they do not notice successive lines

* Entrenching battalions were temporary units formed from surplus drafts awaiting re-posting. In 1918, they were largely filled with the surplus arising from the reorganization of divisions on a nine-battalion basis.

scratched in the fields, even if these are accentuated by barbed wire. Yet such lines had been carefully selected with a view to the best field of fire, with positions for machine-guns, communications and so forth, and if only sufficient troops had been available in rear they could have manned these skeleton trenches and set to work to improve them, at any rate to a protective depth.

The defensive measures included the preparation of all bridges for demolition, and their numbering both on the ground and on the maps; the storing of the charges in chambers close at hand and the telling off of the firing parties. They included arrangements for felling trees across the roads. The mining of road junctions and causeways—an important part of any defence scheme—had to be omitted from the programme, because it was considered that the tunnelling companies were more urgently required for making deep dugouts.*

Inundations of certain areas were considered by G.H.Q., but the Engineer-in-Chief, Major General G. M. Heath, advised against them. He put more faith in the destruction of bridges and causeways. Inundations require time to develop; they hamper the defence almost as much as the attack, and are seldom of use except as part of a deliberately planned position. Their effects cannot be totally foreseen. Their use on the Somme front would have required a withdrawal before the attack.

THE GERMAN OFFENSIVE OF MARCH, 1918

The German offensive of 1918 was expected to be on an exceedingly large scale. The closing down of the Russian front in 1917 released huge forces, at least a million more German soldiers becoming available for the Western front. It was known in our Intelligence Branch that the first onslaught would be directed against the Fifth and Third British Armies; the date of the attack and other predictions of Brigadier-General E. W. Cox (late R.E.), the head of the Intelligence Section at G.H.Q., were fulfilled almost to the day.

The attack began in thick fog with an intense bombardment at 4.40 a.m. on 21st March. The infantry assault began at

* *Official History, 1918*, Vol. I, Appendix 18.

9.40 a.m. on the Fifth Army front, and somewhat later on the Third Army front. The attacking infantry infiltrated at a remarkable speed, but the little garrisons of the posts in the forward zone held out most gallantly, and many of them were totally destroyed.

The first action of the R.E. units was, of course, the demolition of the bridges in the forward areas, especially those in the III and XVIII Corps. The demolition parties had all been trained, and were standing by at their posts. But some confusion of responsibility occurred between the railway construction engineers, and the corps headquarters, and also between the Fifth Army and the French. The III Corps front had only recently been taken over from the French, and the latter still held responsibility for some of the railway bridges on lines operated by them. Responsibility for destruction of bridges in a fighting retreat cannot be retained far back in the army organization; it is only the officers on the spot who can judge the right moment; and so it happened that some of the bridges allocated to the railway construction branch were not demolished.

The infiltration by the enemy was so rapid that it was complained that our destruction of the bridges was incomplete, but most of the complaints were founded on ignorance of the fact that demolitions do not result in the total disappearance of a bridge; it is nearly always possible for determined infantry to get across the broken debris, especially when the water is not deep enough to cover it. The rapidity of the infiltration was due more to the fog and to the weight of numbers than to any failure on the part of the divisional or corps engineers. Another reason for the rapidity of the German advance was the fact that lock-gates were purposely not destroyed, as this would have seriously lowered the water level. "The lock just south of the Tergnier-Fargnier road had, however, been damaged by shell-fire, so that between this and the next lock 550 yds. to the northward the canal presented no serious obstacle."*

A full account of the demolitions carried out in the Fifth

* *Official History, 1918, Vol. I, Appendix 22.*

Army was published in the *Royal Engineers Journal* of March, June and September, 1933, written by the late Major-General Sir Reginald U. H. Buckland. The following outline is mainly based on his narrative.

On the extreme right of the Fifth Army, the 58th Division (acting C.R.E., Major F. G. Bywater) had thirteen bridges to demolish over the Crozat Canal. All of these were destroyed by Lieutenant Wall and 2nd Lieutenant Bilham of the 503rd Field Company by the early morning of the 22nd March.

The 18th Division (C.R.E., Lieut.-Colonel C. B. O. Symons) had seven road-bridges in its sector ; all of these were destroyed by parties from the 79th, 80th and 92nd Companies. The bridge over the railway west of Mennesis was not destroyed.

In the 14th Division (C.R.E., Lieut.-Colonel D. S. Collins), nine road bridges were destroyed in the early hours of the 22nd.

It is significant that the order delegating responsibility for destruction of bridges to divisions was not issued by Army Headquarters until late on 22nd March.* Even this delegation did not appear to go far enough. The commander of a brigade in a fighting retreat is in a better position to judge when it is wise to destroy a bridge than anyone at division, corps, or army headquarters. He is not likely to order destruction before his troops are across, and when his troops have crossed, there is no longer any need to hesitate. In such warfare it is useless to leave any bridges intact on the supposition that they may be needed for counter-attacks ; the enemy will see to their destruction in that event. There are, of course, many occasions when there is nobody to give the order at all, and then the R.E. officer or N.C.O. on the spot has to use his judgement.

In the XIII Corps, the 135th Army Troops Company and the 182nd Tunnelling Company, under the C.R.E., Corps Troops, were charged with the demolition of the bridges at Chauny and the dumps at La Motte Farm and Liez respectively. The four light railway bridges at Chauny were handed back to the 504th Field Company (58th Division) and were destroyed by them ; not without trouble, however, for the damage to one of them had not prevented the German infantry from

* Buckland. *R.E. Journal*, March, 1933, pp. 22 and 23.

crossing with comparative ease. Major W. H. Tamlyn (504th Company) on 31st March, reconnoitred this bridge and completed its destruction by personally placing combustibles on the bridge and burning it; the enemy had by then been in occupation of Chauny for some days.

In the XVIII Corps, the 36th Division (C.R.E., Lieut.-Colonel A. G. T. Cusins) had six bridges and two footbridges to destroy in and around Hamel-Seraucourt. These were all successfully destroyed during the night of the 21st and the early hours of the 22nd by 2nd Lieutenant T. V. Norman, 121st Company, without a casualty. He had an anxious time when, having destroyed the bridges north of Seraucourt by order of the 107th Brigade, he received a request from the 108th Brigade to defer the demolitions as they wanted the bridges for their own passage. Fortunately, Norman was able to guide them to another crossing-place. In the same division, the 150th Company had the Artemps group of four bridges, and the Tugny group of ten road bridges and two footbridges to destroy. One section of the 150th Company under Lieutenant W. M. W. Brunyate dealt with the Artemps bridges, while Lieutenant C. L. Knox had the Tugny group. At one of the latter, the time-fuse failed when Germans were actually on the bridge, but Lieutenant Knox, facing apparently certain death, crawled under the bridge and lit the instantaneous fuse. The bridge blew up, but he was miraculously unhurt, and was awarded the Victoria Cross for this extremely gallant act.

Another group of four road and seven footbridges around St. Simon was destroyed at about 10 a.m. on the 22nd by a section of the same company under Lieutenant Stapylton-Smith. Farther back, the 172nd Tunnelling Company had charge of the demolition of bridges in the Ollezy sector, and the 1st (Siege) Company, R. Anglesey R. Engineers those in Ham; both companies under the C.R.E., XVIII Corps Troops (Lieut.-Colonel J. E. E. Craster). These groups of bridges were taken over on the 22nd by the 30th and 36th Divisions respectively.

In the XIX Corps, the only bridges were those over the little river Omignon. Those in the forward area were prepared

by the 24th Division (C.R.E., Lieut.-Colonel A. D. Walker) and those at Villevèque, Caulaincourt, St. Martin les Prés, Tertry, Monchy Lagache, Devise, Fourques and Athies by the C.R.E., XIX Corps Troops (Lieut.-Colonel G. S. Knox), who had at his disposal the 239th, 281st, 283rd and 288th Army Troops and the 173rd, 253rd and 258th Tunnelling Companies—an unusually generous allotment of engineer units for a two-divisional front. Lieutenant A. N. Fairbourn, 103rd Field Company, 24th Division, destroyed the Vadencourt-Maissemy bridge in face of the enemy at 1 p.m. on the 21st, and also the bridge south-east of Bihécourt. Next day, he destroyed the Vermand bridges.

The VII Corps had no bridges to destroy on the 21st March.

In the Third Army, the brunt of the attack fell on the IV and VI Corps, which suffered heavy losses and had to yield ground as far back as Croisilles and St. Léger.

The situation, therefore, as regards bridge demolition, which was the chief engineering task on the 21st, was that nearly all the bridges which had been prepared had been successfully demolished by the field companies, tunnelling companies and army troops companies concerned. The exceptions were those bordering on the line of junction with the French, where the responsibility had been left with them at their request. In one or two cases, the charges had been displaced by shell-fire, or the fuses cut, and could not be replaced in time, but in every case the sapper parties told off for the work stood by their posts and carried out their orders without failure; in some cases, already referred to, most gallant efforts were made to complete destruction where the charges had not done sufficient damage.

In the light of bitter experience gained in World War II, the obstruction to the enemy caused by the demolitions of March, 1918, seems insignificant. No use was made of land mines, although these devices were considered, at any rate in the VI Corps, where divisional schemes for their use had been prepared.* There was no large-scale supply of these mines, and certainly no labour to spare for laying them. In view of

* *Diary of Chief Engineer VI Corps, 3rd March, 1918.*

the very thin line of the Fifth Army and of the mischievous fog which so favoured the enemy, it is possible that the laying of mine-fields would have proved as costly to the British as to the Germans. Mines accidentally exploded by retiring infantry are no longer there to obstruct the advancing foe.

The rest of the story of the 21st March, for the R.E. units is that of their employment as infantry soldiers. In nearly all the divisions, sections of field companies were involved in the fighting, or were actually detailed as garrisons of posts in the battle zone. In the 66th Division (acting C.R.E., Captain C. A. West) sections of the 430th and 431st Field Companies, with the Divisional Pioneers, held the village of Templeux-le-Guerard and the neighbouring quarries during the greater part of the day, and at nightfall, were cut off and lost, only a few men getting back. In the 16th Division (C.R.E., Lieut.-Colonel R. F. A. Butterworth) two sections of the 155th and 157th Field Companies fought at Lempire as part of the garrison, losing Lieutenant G. H. Baxter, mortally wounded, before falling back on Villers Faucon in the late afternoon. At Villers Faucon, the remainder of these two companies defended the village, under Major P. F. Whittall (O.C., 157th Company). The 156th Company fought at Ste. Emilie as infantry, on the right of the 49th Brigade.

In the 51st Division (C.R.E., Lieut.-Colonel J. G. Fleming) each field company had two sections in forward posts, manning the defences. The two sections of the 400th Company, under Lieutenant Watson, held their post until overwhelmed, out of fifty-four men, only fourteen getting back. In the 6th Division (C.R.E., Lieut.-Colonel G. F. B. Goldney) the officers commanding the 12th and 459th Companies, Majors A. S. Williamson and M. R. Wingate, were killed at an early hour. The casualties in the three companies on 21st March, were: 12th Company, thirty-one; 459th Company, thirteen; and 509th Company, twenty-one.

There were many other instances of the participation of the divisional engineers in the fighting, but details are lacking as war diaries were often destroyed or lost during the retreat.

22nd March.—To return to the right of the British line, in the

III Corps the 58th Division became split : the 174th and 175th Brigades were forced back in a south-westerly direction, while the 173rd Brigade with the 503rd Field Company attached, was driven north-west, and it soon happened that the whole of the III Corps passed under French command. The Germans, of course, made special efforts to break through at the junction of the British and French armies. Many of the bridges behind the 58th Division had been prepared for demolition by the 135th Army Troops Company and the 2nd Field Squadron, and these were now handed over to the field companies of the division as the line fell back.

The 14th Division was heavily attacked and its brigades were soon reduced to little more than battalions. The three railway bridges at Jussy, which were supposed to be destroyed by the French, were found to be intact, so the C.R.E. sent a section of the 89th Field Company, under Lieutenant L. T. Moore, to carry out the work. Lieutenant Moore destroyed two of them, but found a French officer in charge at the third. While Moore was destroying another wooden trestle bridge a mile away, the French officer was mistaken for a spy and was arrested before he could blow up his bridge. Moore, however, passed that way on his return and fired the Frenchman's charges, but although the piles were destroyed, the girders remained intact. He then cut the lower boom of the central girder with the one box of gun-cotton which remained with him, but he had to leave the bridge still passable for infantry.

At another bridge, the gap made by the first charges was not satisfactory, so fresh charges were laid by Captain Lyon, 89th Field Company, with great gallantry, under heavy machine-gun fire, and these completed the destruction.

Another exploit among the many connected with the bridge demolitions was that of 2nd Lieutenant R. E. Walsh, 121st Company. He was sent with his section during the afternoon to take over thirteen bridges across the Somme (prepared by the 172nd Tunnelling Company) between Ollezy and Ham. "These comprised three bridges on the Dury-Ollezy road, six at Sommette-Eaucourt, a steel railway bridge at Pithon, a wooden bridge on the Ham-Sommette-Eaucourt road, and

a pair of steel girder-bridges on the Ham-Noyon road. The Dury-Ollezy bridges were blown up at about 1.30 p.m., and the road bridges at Sommette-Eaucourt at about midnight. The two light railway bridges were set on fire; this rendered them useless as railway bridges, but left them still passable for infantry. At the time, there was some doubt as to the fate of the bridge at Pithon. This being a railway bridge, it was for the French to blow it up. Seeing that no steps had been taken to demolish it, 2nd Lieutenant Walsh put 2nd Corporal Wheeler and two sappers to do as much damage as they could to the wooden piles of the abutments. Walsh and the N.C.O. were afterwards missing, so there is no record of what was accomplished."*

In the 6rst Division (C.R.E., Lieut.-Colonel G. E. J. Durnford), which was the left division of the XVIII Corps, and was being pushed in a south-westerly direction away from its neighbour in the XIX Corps, all three field companies had been extricated from the battle zone, and were assembled at Beauvois. In the afternoon, they were moved to Voyennes and demolition parties were sent to take over the bridges at Voyennes and Offoy from the 1st Siege Company, R. Anglesey R. Engineers. At 6 p.m., German cavalry was reported to be coming down the main road, and the field companies were ordered to man the bridgeheads at both places until relieved by infantry. The 479th Company was detailed to hold Buny, just east of Voyennes, and the 476th Company to hold Offoy; the 478th was posted midway, in support. Meanwhile, the preparations for demolition went on, and at 11 p.m., the two bridges at Offoy were destroyed by Lieutenant Powell, 476th Company. During the night, the 479th Company at Buny was relieved by infantry, and as the 20th Division (C.R.E., Lieut.-Colonel E. M. Newell) had now taken over from the 6rst, the field companies were withdrawn to Nesle. The bridges at Voyennes were subsequently blown up by the 20th Division.

In the next division on the north, the 24th (C.R.E., Lieut.-Colonel A. D. Walker), the 104th Company took part in the

* Buckland. *R.E. Journal*, June, 1933, p. 196.

defence of Le Verguier with troops of the 17th Brigade. Divisional headquarters ordered withdrawal at about 11.15 a.m., but it was not until between 1.30 and 2 p.m. that the rear parties, composed of the 104th Field Company, one company of the 1st Royal Fusiliers and machine-guns of the 24th M.G. Battalion moved away.*

In the 66th Division, on the left of the XIX Corps, the C.R.E., Lieut.-Colonel G. C. Williams, had just been appointed to command the 199th Brigade in the division, and Captain C. A. West was acting C.R.E. The 432nd Field Company was heavily engaged in the defence of Jeancourt, protecting the right flank of the division.

Next in the line came the 16th Division. During this day, the 155th and 156th Field Companies moved back to Biaches and remained in divisional reserve. The 157th Company was helping the rear-guard of the 48th Brigade.

The 21st Division (C.R.E., Lieut.-Colonel G. H. Addison) still held Epehy and Peizière in the front line of the battle zone.

"The enemy sent two divisions against it. Epehy-Peizière, like other villages, was defended by a number of self-contained posts, Epehy garrisoned by the 6th and 8th Leicestershire, with the 97th and 126th Field Companies, R.E., on the right flank, and the 7th Leicestershire in Peizière. At about 9.30 a.m., as the enemy seemed to be making his main effort on the southern part of Epehy, the Brigade ordered the two field companies and the 6th and 8th Leicestershire to retire from the village and form a defensive flank on the Saulcourt-Epehy road."²

The 50th Division (C.R.E., Lieut.-Colonel J. A. McQueen), which had been in G.H.Q. reserve behind the XIX Corps, had been hurried forward on 21st March, to occupy the defences of the Péronne bridgehead. The field companies were distributed to brigades. In the evening, the enemy attacked from the north-east and east. The 7th Field Company, which had two sections working at Caulaincourt, fell back to Tertry, where the company re-formed, and was ordered by the 149th Brigade to

* *Official History*, 1918, Vol. I, p. 284.

† *Official History*, 1918, Vol. I, pp. 293 and 294.

dig and hold a series of posts on the bank of the river Omignon, covering the east of Tertry.*

The 47th, 63rd and 17th Divisions held the Flesquières salient. During the night of the 21st/22nd, the V Corps had been withdrawn some 2,000 yards, but the salient was even sharper than before, owing to the withdrawal of the 9th Division on the right. This was the junction between the Fifth and Third Armies, and the gap was widening. The 99th Brigade of the 2nd Division was put in to fill it, but contact was somehow missed.

The 51st Division, in the right sector of the IV Corps, covered the left flank of the Flesquières salient. Its field companies were scattered: the forward sections of the 401st and 404th Companies under Captain McCrone were with the 152nd Brigade, and remained in front of Lebucquière all day, digging a series of posts linking up with Beaumetz. The 400th Company, with the assistance of the 252nd Tunnelling Company made a defensive position covering Beugny from the north.

The 6th Division came next. Its field companies, which had suffered heavy casualties on the 21st, were ordered to form a defensive flank across the Vaulx-Beugny road, facing north. This position was held until 6 p.m. Enemy parties advanced against this line in the afternoon, but were driven off. At dusk, the R.E. party was withdrawn, as the division had in the meantime been relieved by the 41st Division. In the two days, 21st and 22nd March, the R.E. of the 6th Division had suffered eighty-five casualties.

The 59th Division (C.R.E., Lieut.-Colonel A. C. Howard) formed the right of the VI Corps, which had stood firm on the 21st. The division, much depleted, had been withdrawn into reserve during the night, with the exception of the 177th Brigade, and its place had been taken by the 40th Division (C.R.E., Lieut. Colonel J. G. P. Goodwin).

The 15th Division (C.R.E., Lieut.-Colonel J. M. Arthur) held the right sector of the XVII Corps, south of the Scarpe. It was not attacked during the 21st or 22nd, but it had to carry out

* *History of the 7th Field Company, R.E.*, by Major H. A. Baker, p. 52.

a withdrawal during the night of the 22nd/23rd, in order to conform with the Third Army situation. The field companies and pioneers were ordered to retire into Arras, removing as much valuable plant from the dumps as they could. A small party was left to blow up the mine at La Bergère Farm under the main Cambrai road. This meant giving up Monchy-le-Preux, a sad blow to those who had spent so much effort since April, 1917, in retaining it, for it overlooked Arras and much of the surrounding country.

North of the Scarpe the great offensive had not yet touched the British line.

On 23rd March the 58th Divisional Engineers were still occupied with the demolition of bridges over the Oise. The French were coming up, and presently the division came under French control.

The field companies of the 14th Division became so closely involved in the forward area that the C.R.E. found it impossible to organize further engineer work, and the companies assisted their brigades as infantry.

The 30th Division (C.R.E., Lieut.-Colonel G. W. Denison) still had bridges over the Somme in its area. Four of these at Ham had been prepared by the 1st Siege Company and were blown by them. Another bridge at Ham was destroyed by the 201st Field Company just as the enemy were gaining a footing upon it. A batch of three bridges over the Canal du Nord on the Ercheu-Libermont road, and two on the Ercheu-Esmery Hallon road had already been prepared by the 96th Company (20th Division) and were taken over by the 30th Division during the evening.

In the 61st Division, all the field companies had assembled by 7 a.m. at Nesle, and in the afternoon, they were made responsible for their own defence there. For this purpose they were placed under the command of Major M. Whitwill, who put an outpost line round the town. Trenches were dug, and as much as possible done to put the place into a state of defence.

The 24th Division began its retirement on Pagny at 8.30 a.m., preparatory to crossing the Somme canal. When its

rear-guard reached the crossing between Falvy and Pagny, there was confusion over the responsibility for demolishing the five bridges. These had been prepared by the 1st Siege Company, whose parties were still standing by them. When the O.C. rear-guard came upon the scene, he had no authority to order the destruction of any of these bridges, and therefore sent an orderly to headquarters, 24th Division, for instructions. Before these arrived, two of the bridges were blown up at 2.30 p.m. (apparently by shell-fire), and at 4.30 p.m., as no orders had come and the situation appeared desperate, Sergeant Crossley, R.E., in charge at the canal bridge, the most important of the five, blew it on his own initiative. The result was not wholly successful, probably on account of the displacement of the charges by shell-fire, but later a party from the 1st Field Squadron, under 2nd Lieutenant G. F. Baylay, laid fresh charges under heavy machine-gun fire and completed the destruction. Unfortunately Baylay was killed on his way back from inspecting the result. By this time the Germans were in Falvy, just across the river, and the 8th Hussars, with one squadron of the 19th Hussars, had great difficulty in getting across. Most of their horses had to be abandoned, as they could neither use the wrecked bridges nor swim across on account of the boggy banks.*

In their retirement across the Somme, the 20th Division took over from the 61st Division and destroyed a dam across the canal south-west of Oppy, and blew up six bridges there, a temporary wooden bridge over the canal north-east of Rouyle-Grand, and two more on the Voyennes-Buny road. These were all destroyed before 7.30 a.m. The division also became responsible for three bridges remaining out of the five at Bethencourt. These were blown up during the morning, but not with entire success; and a further attempt was made the same evening by a small party under Captain B. C. Davey, 1st Field Squadron, who successfully destroyed the main one; the others were found to be unfit for wheeled traffic.†

* *Official History, 1918*, Vol. I, p. 348. Buckland, *R.E. Journal*, June, 1933, p. 204.

† Buckland. *R.E. Journal*, June, 1933, pp. 202 and 203.

The 66th Division took up a line covering the Somme from La Maisonette to Eterpigny; the 197th Brigade on the left, 198th on the right and 199th in reserve. The remnants of the three field companies were amalgamated to form C Company of a composite battalion; the pioneers formed A and B Companies, and the battalion was placed under the 199th Brigade, whose commander was Brigadier-General G. C. Williams, the former C.R.E. The field company commanders remained with their respective brigade headquarters. Lieutenant Darbyshire, 432nd Field Company, attempted to complete the destruction of a bridge at the Faubourg de Paris, Péronne, but all his detonators were destroyed by a bomb. Petrol was then sprayed over the bridge, and it burned all night.

In the 16th Division, the 157th Company, acting as part of the rear-guard of the 48th Brigade, and two companies of the 11th Hants. (Pioneers) fought a valuable delaying action in Doingt. The 157th Company was under Major P. F. Whittall, who gained a bar to his D.S.O. for his conduct on this occasion. During the night, the division was relieved by the 66th and 39th Divisions and the field companies were withdrawn to west of Cappy.

The engineers of the 50th Division crossed the Somme at Brie (7th and 447th Companies) and at St. Christ (446th Company). The 7th and 447th Companies prepared a bridge-head at Brie, but were ordered back in the evening, as the 8th Division (C.R.E., Lieut.-Colonel C. M. Browne) had now come up to take over. All three field companies marched back to Foucoucourt during the night.

In the 51st Division, the forward sections of the 401st and 404th Companies still under Captain McCrone, were holding their position in front of Lebuquière. At 9 a.m., they were attacked, and as the infantry next to them were driven back, the R.E. were also withdrawn to the railway embankment south of the village. As the Germans pressed on and captured the whole village, the R.E. retired to a position in the north of Velu Wood, where they again got in touch with the 5th Scaforth's. The commanding officer ordered Captain McCrone to withdraw his men to the Green Line in front of Haplincourt.

He arrived there and started work at once on improving the defences, but once again was ordered back, this time to Bancourt. On their way, the R.E. removed as much as they could carry from the field force canteen at Haplincourt, so it is to be hoped that they obtained some satisfaction from an otherwise unsatisfactory day of moves, for they were once more ordered back after reaching Bancourt. Had these two companies remained under their C.R.E., it is likely that better use would have been made of them. The 400th Company under Major Kiggell had meanwhile been employed on strengthening the defences of Beugny, and were in some danger of being cut off when the Germans advanced from Lebucquière, but in the evening, Major Kiggell received orders to evacuate Beugny and fall back to the Green Line.

The 15th Division carried out its withdrawal successfully. Patrols commenced retiring about 10 a.m., when the enemy followed up. The mine at La Bergère was exploded about 10.30 a.m., and the R.E. party rejoined their company. The 73rd Company was detailed to work under the XVII Corps on the Ficheux-Telegraph Hill switch, while the 74th and 91st Companies worked under their C.R.E. on the Neuville Vitasse switch, with the help of the pioneers.

24th-31st March.—On the extreme right of the Fifth Army, the enemy attacked again at Vizey in the early morning of the 24th, and forced the remnants of the 58th Division farther back. The situation in Chauny became critical at 8 a.m., and the G.O.C. ordered the bridges there to be blown and the R.E. dump to be fired. This was successfully carried out by the 511th Company and by the assistant adjutant and the R.S.M. On the north side of the Oise, the 173rd Brigade with the 503rd Company retired fighting to Abbécourt. Seven bridges prepared by the 135th Army Troops Company were handed over to the 511th Company. Next day, the 173rd Brigade was relieved by the French, and retired with the 503rd Field Company to Besme to reorganize. For the next five or six days the 58th Division was sorting itself out and being relieved by French troops.

The experiences of all the field companies during the remain-

ing days of the German attack on the Fifth and Third Armies were much the same. Alternately, they formed bridgeheads at the river crossings, or defensive flanks to help the infantry ; dropping their rifles to dig or to wire, and picking them up again to repel an attack. Space does not permit here a piecing together of all the incidents referred to—often very inadequately—in the diaries, but the following account of the adventures of the engineers of a typical division will give an idea of the part they played.

At dawn on 27th March a composite battalion was formed in the 50th Division, under the orders of the C.R.E., Lieut.-Colonel J. A. McQueen), for tactical and works purposes. It was composed of the 7th and 447th Field Companies, and 350 men from the remains of the 151st Infantry Brigade. As these men were very mixed, they were organized into two companies, one under the O.C., 7th Field Company (Major H. A. Baker) and the other under the O.C., 447th Field Company (Major Chivers). The battalion was thus about 500 strong, organized in two similar wings, each consisting of a R.E. company (about eighty rifles) an infantry company (about 160 rifles) and a small headquarters section of cyclists and runners.

The battalion left Wiencourt at 7 a.m. on the 27th, with orders to take up a position to the right flank and rear of the reduced 149th Brigade, then holding the southern portion of the Vauvillers-Rosières line. Major Baker commanded the right wing, Major Chivers the left. The right wing took up a position immediately north-east of Rosières, covering the exits from the village, while the left wing was held in reserve in a railway cutting one mile in rear.

No attack on Rosières developed, and at about noon the C.R.E. was ordered to withdraw the battalion, in order to co-operate with a counter-attack about to be launched by two battalions of the 8th Division from Harbonnières on Proyart. The left wing under Major Chivers was sent off through Harbonnières before the arrival of the two battalions on Major Baker's wing, with orders to seize and hold a wood, about one mile north-east of Harbonnières, before the enemy reached

it. "It reached its position with about ten minutes in hand, and the advanced enemy lines, checked, lay down and remained inactive."*

The two battalions of the 8th Division and the right wing of the Composite Battalion under Major Baker (who was severely wounded in Harbonnières and was succeeded by Captain W. F. Baldwin) now came up, the two wings gained touch, and the Composite Battalion accompanied the attack as rear support to cover its right flank. The attack was held up about 1,200 yards west of Proyart, where an existing line of trenches was occupied and held for the night, with the 7th Company on the right, in touch with troops in the neighbourhood of Framerville, and the 447th Company on the left.

At 4.20 a.m. next morning, the C.R.E. received information that the two battalions of the 8th Division on the left were being withdrawn before dawn, and ten minutes later he was ordered to withdraw the Composite Battalion to the north-west of Harbonnières, and thence to Caix. Major Chivers was severely wounded before leaving the position, thus the commanders of both wings of the battalion were casualties.

There were one and a half miles of open country to be crossed before Harbonnières was reached, but the withdrawal of the 7th Company was effected in an orderly manner from the left, and without casualties. The troops on the right of the company were not so fortunate, and lost heavily in their retirement across the open. In consequence, they reached Harbonnières in a very mixed state. There was no time to re-form, and the Composite Battalion was ordered to continue retiring to Caix. On arrival at Caix, orders were received to re-form on the line Guillaucourt-Caix, but owing to the disorganized condition of the troops, only the two R.E. companies could be used immediately for this purpose. They proceeded to occupy a portion of the line immediately north of Caix, till retirement took place at about 2 p.m., the field companies being the last to withdraw, and suffering considerable casualties in doing so. The R.E., while forming part of the Composite Battalion, lost three officers and thirty-four other ranks.

* *History of the 7th Field Company, R.E.*, by Major H. A. Baker.

The battalion was now broken up, and the 7th and 447th Companies with the 7th D.L.I. (Pioneers) were directed to co-operate with the Composite Infantry Brigade formed under Brigadier-General Liddell. As the R.E. transport had been sent back to Aubercourt, the sappers had no tools, but managed to make small rifle pits with their bayonets. In the afternoon, the C.R.E. withdrew the 7th and 447th Companies to Beau-court, where they picked up their tool carts. All three field companies eventually retired across the Avre to Castel and on 30th March, the 50th Division was relieved.

Carey's Force.—The Germans were getting dangerously near to Amiens, the vital railway centre that the Allies wished to preserve at all costs. The Fifth Army's reserves had all been thrown into the battle, except certain units of corps and army troops, when General Gough decided to man a portion of the old French defence line some fifteen miles east of Amiens. Late at night, on 25th March, it was decided to collect all available troops possessing rifles and to place them under Major-General P. G. Grant, Gough's Chief Engineer. Grant was given three officers from the army staff, and early next morning took stock of his forces and detailed them to sectors of the line. There were available :

The 144th, 213th, 216th and 217th Army Troops Companies.

The 253rd Tunnelling Company.

The 353rd Electrical and Mechanical Company.

No. 4 Army Workshops Company, R.E.

The 5th Survey Battalion (45 officers and 650 other ranks).

Two companies of the 6th Regiment of United States

Engineers (railway construction troops), about 500 strong.

Detachments from the Fifth Army Infantry, Sniping and

Musketry Schools.

Three companies formed from the III and XIX Corps Schools.

Detachment of Fifth Army Signals.

In all, this unique force amounted to 2,900 officers and men, nearly all engineers. Some were trained soldiers, but many were almost strangers to the rifle, and nearly half had no organized means of feeding themselves. But these obstacles

were quickly overcome, and transport soon arrived from the 1st Cavalry Division.

General Grant organized his line in three sectors. The right sector, from Demuin on the Luce to Marcelcave (exclusive) was placed under the command of Lieut.-Colonel N. M. S. Irwin, Essex Regiment. He was given the 216th Company, the III Corps School detachment, two companies of the 6th U.S. Engineers, the 353rd Company, and the detachment from the 5th Survey Battalion. The centre sector, from Marcelcave (inclusive) to the Bois d'Accroche (exclusive) was under Lieut.-Colonel O. Graham, Rifle Brigade. He had No. 4 Army Workshops Company, the Fifth Army Infantry School, the Fifth Army Sniping School, and the 217th and 253rd Companies. The left sector, from the Bois d'Accroche to the river Somme was under Lieut.-Colonel R. Horne, Seaforth Highlanders. He had the 144th and 213th Companies, the Fifth Army Musketry School, the XIX Corps School, and the detachment of Fifth Army Signals. The troops took up their positions during the day, and seventy-six Lewis guns from the Army Park and sixteen machine-guns from a Canadian M.G. Company were sent up and distributed.

Major-General Grant, having organized the force and placed it in position, was relieved in the afternoon by Brigadier-General H. C. Rees, 150th Brigade, as he could not be spared indefinitely from his duties as Chief Engineer. In the evening of the same day, the command again changed, and passed to Major-General G. G. S. Carey, who was on his way to take over command of the 20th Division. Thus it came about that the force organized by General Grant and chiefly composed of technical engineer units, took the name of Carey's Force. It was a courageous effort and was a typical example of the British army's flair for improvisation in tight places. The force provided, what was so often lacking during the retreat, a visibly occupied line on which the remnants and stragglers from the worn-out divisions could rally.

The 27th March, was a day of changes in position. Some of the units got to work on the improvement of their trenches, and the making of machine-gun emplacements; others were

delayed by having to move again. The 353rd Company was transferred from the right sector to the left. The 253rd Company was shifted from the centre sector to the left. Half the 217th Company was ordered to Cerisy-Gailly, already in enemy hands, and the sections had gone barely half a mile when they came under machine-gun fire and lost both their officers. The men were ordered back to rejoin the rest of their unit, which had meanwhile been sent with the 144th Company to a hill 1,000 yards east of Hamel. The company was here shelled and machine-gunned, and withdrew to the Bois du Tailloux to reorganize. Later, it was put into the line again in the Bois d'Accroche. The 144th Company was moved at 3 a.m. to a position between Mamel and Cerisy. Twelve hours later, it was ordered to advance and to hold, with the 217th Company, the crest of the hill east of Hamel.

The XIX Corps, with six heavily depleted divisions, was being attacked by eleven German divisions, and Carey's Force was the only reserve. No counter-attack could be expected with such improvised troops, but Carey's line still held as a position on which to rally, and in the late afternoon of the 27th, troops of the 16th Division fell back to some of his trenches.*

During the night of 27th March, the 2nd Battalion, Canadian Railway Troops, about 400 strong, arrived at Villers Bretonneux as reinforcements, and came into line in a wood north-west of Marcelcave. The enemy had reached the western edge of Lamotte village during the night, and the 61st Division was ordered to make a counter-attack at 5 a.m. on the 28th. The attack did not start until midday, and was soon brought to a standstill. The XIX Corps was becoming isolated by the retirements on either flank, and a further withdrawal became necessary. The 61st Division retired on to Carey's line, and the remains of the 16th Division were in the left sector. The 253rd Tunnelling Company in the centre were heavily attacked and suffered considerable losses.

By 29th March, there was a mixture of troops from many divisions among whom Carey's Force began to lose its identity,

* *Official History*, 1918, Vol. II, p. 24.

but the original units still held, and by digging and improving trenches helped to stiffen the line, and added their quota of rifle fire to the defence.

On the 30th, the field survey detachment was withdrawn, having suffered 170 casualties (4 officers missing, 7 officers wounded, 7 other ranks killed, 56 wounded, 73 missing, 23 sick). The casualties among the army troops companies on the 30th were: 144th Company, 1 officer, 1 C.S.M. and 3 others killed, 16 wounded; 213th Company, 1 officer and 12 men wounded, 8 men killed; 216th Company, 4 men killed, 1 missing. The 253rd Tunnelling Company, in the five days 27th to 31st March, had 1 officer and 6 other ranks killed, 2 officers and 49 others wounded, and 3 officers and 30 others missing.

On the 31st March, Carey's Force was broken up, but a few of its components, the 144th, 213th and 217th Army Troops Companies and the signals detachment, remained for another two days, and were then absorbed into what was known as Whitmore's Cosmopolitan Force.* The men, totally untrained for the task that fell upon them, had acquitted themselves well, and had filled a part which certainly had its effect in rallying the broken remnants and slowing up the retirement. They rejoined their units and resumed their labours with the warm feeling of having played a worthy part in the Fifth Army's desperate battle.

The remainder of the struggle on the Somme, so far as the British army was concerned, became a battle for Amiens. For another week, the fighting at Villers Bretonneux was bitter and sustained, but thanks to the arrival of the fresh Australian divisions and to their vigorous defence, and to the part played by the remains of the 14th and 18th Divisions and the 3rd Cavalry Division, the Germans failed to reach Amiens, and by 5th April, the great battle came to an end. But another heavy onslaught was about to begin in Flanders.

* *Official History, 1918*, Vol. II, p. 95.

THE GERMAN OFFENSIVE IN FLANDERS, 1918

Ludendorff's next blow fell on the First Army line between Bethune and Armentières. Here, the British divisions, with the exception of the 55th, had all been through the severe fighting in the Fifth and Third Army areas. They had been hastily rebuilt with reinforcements from England—mere youths, some of them too young to be placed in the battle line.

The disposition of the divisions on 9th April, was as follows:—

XI Corps (Chief Engineer, Brigadier-General H. J. M. Marshall) :—

55th Division C.R.E., Lieut.-Colonel O. G. Brandon, with 419th, 422nd and 423rd Field Companies.

2nd Portuguese Division.

51st Division C.R.E., Lieut.-Colonel J. G. Fleming, with (in reserve) 400th, 401st and 404th Field Companies.

XV Corps (Chief Engineer, Brigadier-General C. W. Singer) —

40th Division C.R.E., Lieut.-Colonel A. C. Baylay, with 224th, 229th and 231st Field Companies.

34th Division C.R.E., Lieut.-Colonel A. C. Dobson, with 207th, 208th and 209th Field Companies.

50th Division C.R.E., Lieut.-Colonel J. A. McQueen, with 7th, 446th and 447th Field Companies.

The XI Corps headquarters had returned from Italy on 15th March, to resume command of the same sector of the front which it had had before leaving, and in which it had remained ever since its formation in August, 1915, with the exception of the four-months' Italian break. The staff was therefore thoroughly acquainted with the country.

The Portuguese Corps stood between the XI and XV Corps, but only one of its divisions was in the line, and this had recently been placed under the XI Corps, and its withdrawal on the evening of 9th April had already been decided upon. The fact that these three Portuguese brigades were holding much the greater part of the XI Corps front, and the knowledge that they were on the point of relief did nothing to stiffen the

Portuguese troops for the massive assault which was hurled against them in the fog on 9th April.

The engineers of all the divisions, except the 55th, which had not been in the fighting farther south, and had had time to refit since the battle of Cambrai, but were themselves much weakened, and their losses had not yet been made up.

The defence lines were numerous, and distributed in depth; they were also backed up by the canalized rivers Lys and Lawe, and by several small streams, but the low-lying and watery nature of the country made it necessary to use breastworks instead of digging trenches, and these had suffered during the long months of winter, as the pulling out of divisions to reinforce the Fifth and Third Armies had left little or no labour for repairs. The sorely tried British divisions were again called upon to withstand the attacks of more than double their numbers of fresh troops, this time on a front where there was still less room for strategic retirement without jeopardy to the Channel ports.

The Germans were again favoured by a thick mist. The weather conditions of 9th April were exactly the same as those of 21st March; the defending troops were tired, the reserves were few, and the prospects of the enemy were rosy in the extreme. But he succeeded no better than on the Somme.

A heavy bombardment by gas shell on Armentières during the night of 8th April had caused many casualties and, as we have seen, a rearrangement of the line held by the Portuguese was in process of execution when the Germans attacked. The whole of the Portuguese 2nd Division was to have been withdrawn during the night of 9th April, and its place taken by the 50th Division from XI Corps reserve, and by the 166th Brigade of the 55th Division. The 51st Division was to take the place of the 50th in corps reserve. This was unfortunate, as the 50th had already reconnoitred the ground and the defences which it was to have manned in the XI Corps area.*

All the bridges over the rivers Lawe and Lys had been prepared for demolition, the greater number of them by the

* *Official History*, 1918, Vol. II, p. 149, footnote.

145th, 552nd and 556th Army Troops Companies, and a rehearsal of the duties of the demolition parties was carried out on 8th April.

The main strength of the British line lay in the 55th Division's sector at Givenchy. The Division itself was strong and had had time to organize its defences, and the infantry had been training strenuously, especially at musketry. The 251st Tunnelling Company had been at work for many months improving the deep dug-outs, making concrete machine-gun posts, and extending the system of tunnels. In the heavy fighting which followed, the hold of the 55th Division on Givenchy proved to be the rock on which the German attack was broken.

The engineer companies, except those of the 55th Division, were all very weak in numbers, and those which had received reinforcements had not yet had time to reshape themselves. For the next ten days they were continually on the move or taking part as infantry in the fighting.

The easy break-through on the Portuguese front soon caused a gap between the 55th Division and the next British division (the 40th) on its left. The XI Corps cyclists and the corps cavalry (1st King Edward's Horse) were hastily sent up to fill it, followed by a brigade of the 51st Division. As in the south during March, divisions soon became split up, and the brigades, with field companies attached, had to fight separate actions. The 50th and 51st Divisions both had to enter the battle in the wide gap left by the Portuguese without any reconnaissance of the positions and with no previous knowledge of the bridges prepared for demolition.

The 51st Division, on the morning of 9th April, was in corps reserve, with its brigades around Busnes. As soon as the German attack began, its 152nd Brigade was sent up by bus to help to stop the Portuguese rush. The 401st and 404th Field Companies were moved up to L'Écluse, while the 400th Company reconnoitred the bridges over the La Bassée canal near Hinges. The 552nd Army Troops Company was at Rue Déléannoy, with demolition parties scattered along the river Tawe from Béthune to Lestrem. On the 10th, the Germans exploited their success by widening the gap to the north.

The 51st Division held a line along the Lawe Canal from the south of Vielle Chapelle to Lestrern. The field companies reconnoitred the crossings over the Clarence river behind, and a position running from Hinges through Pacaut, Epinette and Grand Pacaut. A pontoon bridge was put across the La Bassée canal south-west of the Hinges bridge, and all demolition parties stood by to destroy or remove their bridges. On the 11th, the 3rd Division (C.R.E., Lieut.-Colonel W. C. Cooper) which had come up on the day before to reinforce the XI Corps, took over part of the line of the 51st Division and relieved the C.R.E. of responsibility for some of his bridges. On the 12th, the enemy broke through the centre of the 51st Division at Pacaut, captured the brigadier and staff of the 152nd Brigade, and nearly reached Robecq. The 400th Field Company was ordered to defend Robecq, and later in the day a composite force about 1,700 strong, made up of reinforcements, machine gunners, Canadian railwaymen, and two gas companies, R.E., was placed under the C.R.E., 51st Division, with the title of Fleming's Force. It took over the defence of the village, which was now at the apex of the German salient on the Lys. The 51st Division was now practically squeezed out by the closing in of the 4th Division on its right and the 61st Division on its left, and the field companies were withdrawn to Busnes.

The 40th Division was also given a hard task when its right flank became exposed by the rout of the Portuguese. It was holding a two-brigade front from Bois Grenier to Rue Déleval, with a region of wet ditches and small streams behind it. A number of cork float footbridges had been prepared for the river Lys, and as soon as the German attack began, these and the pontoon bridges were swung into position to facilitate retirement or counter-attack. The bridgeheads were heavily shelled all day, and the enemy pressed the division back, its right flank in the air. It became necessary to demolish the bridges, twenty-three pontoon and emergency cork-float bridges being successfully destroyed. The field companies, the 224th, 229th and 231st, continued to defend the north bank of the Lys, but the permanent bridge at Saily was only partially destroyed, and the demolition of the permanent bridge

at Estaires completely failed owing to the primers refusing to detonate. On 10th April, the enemy pressure became heavier. The field companies were concentrated at their transport lines at Douliu, and moved forward to support the 119th Brigade. They were ordered to defend Le Verrier, now in the front line, with the 88th Brigade (29th Division) on their left. The 145th Army Troops Company, from the XV Corps, was also placed under the C.R.E. and helped to man the line with the infantry. On the 11th, the R.E. remained in the line all day, forming a defensive flank to a counter-attack by the 31st Division. At nightfall, they were relieved by infantry and withdrawn to their transport lines at Strazeele. On the 12th, the companies dug and wired a chain of posts in front of Strazeele with the infantry, the enemy having attacked along the whole front. On the 13th, the 40th Division was withdrawn from the battle, and the R.E. companies assembled west of Staples. Next day, they marched to Cornette, and the division was transferred to the VIII Corps, now out of the line, and charged with organizing new defence lines in rear. The casualties among the field companies of the 40th Division from 9th to 14th April, amounted to: killed 2 officers and 8 other ranks, wounded 1 officer and 82 other ranks, missing 28 other ranks: total 121.

The 24th Division had only reached the Lys area from the Fifth Army at the beginning of April. It was at once faced with the problem of a flank defence in the expected event of the Portuguese failure. On the night of 8th April, when the Germans heavily bombarded Armentières with gas-shell, causing nearly 1,000 casualties, the 207th Field Company was almost entirely incapacitated by the gas, and next morning the company's transport lines were severely shelled, so the unit had to be completely withdrawn. On 9th April the division was holding the line on a two-brigade front curving round Armentières from Bois Grenier to Hemplines. The 208th and 209th Field Companies were at Pont Nieppe and Les Trois Tillouls; they had demolition detachments at all the bridges. On the 10th the enemy made even more progress. He had secured several crossings over the Lys, including the important one at Bac St. Maur, and the field companies were ordered

to blow up all bridges as soon as the infantry had withdrawn. Complete retirement of the 34th Division across the Lys was ordered to begin at 3 p.m., and thereafter the field companies passed out of the control of the C.R.E. For two days they had to act independently, attaching themselves to the nearest brigade. That evening, the 209th Company found itself on the left flank of the Worcesters (25th Division) who were defending Steenwerk station. The 208th Company was still farther detached, and on the 11th, was at Neuve Eglise. Messages from the companies, however, kept the C.R.E. informed of their whereabouts, and on the 13th, as soon as the situation permitted, the companies were re-formed, and the division was withdrawn and transferred farther north to the IX Corps.

The 50th Division had come up from the Somme on 4th April, to the Robecq area, where it was in reserve to the XI Corps. It had reconnoitred the line it was to man in case of attack, but on 8th April it was transferred to the XV Corps, and had to move again. On 9th April the divisional headquarters were at Merville. The three field companies were in billets immediately east and north-east of Nieppe forest, but were moved forward during the morning to positions of general readiness, immediately west of the Lys canal, between Merville and Estaires. All demolition arrangements for the bridges over the canal were in the hands of the XV Corps, and the 40th and 34th Divisions were still in the line. On the 10th, the G.O.C. ordered the preparation of a defensive line, about three and a half miles long, running roughly from the east corner of Estaires through Neuf Berquin to Vierhock. The C.R.E. reconnoitred the line, and all the available sappers—the 7th and 447th Companies and three sections of the 446th—were set to work on it. The pioneers were employed in keeping Merville and Estaires clear of debris. In the afternoon, the bridges in La Gorgue and Estaires were blown up successfully with the exception of the drawbridge east of Estaires. A section of the 446th Company was sent after dark to complete the destruction, but owing to the darkness and the semi-shattered state of the bridge, it was impossible to do more than

place a few bulk charges, which were not entirely successful in rendering the bridge impassable. In the evening, the 556th Army Troops Company was placed by the XV Corps at the disposal of the C.R.E. It moved up to Merville, and took over the bridges in the town. The 455th and 510th Field Companies of the 29th Division (C.R.E., Lieut.-Colonel R. K. A. Macaulay), now coming from Ypres, were also placed at the disposal of the C.R.E., 50th Division, and were sent to help dig posts at the outer ends of the rallying line.

On the 11th, the work was continued, and the line of posts was completed by about 10 a.m. The infantry, falling back, began to man them, and the field companies were withdrawn to the north of Neuf Berquin. By the afternoon, the Germans had reached the outskirts of Merville, and the 556th Army Troops Company was ordered to destroy the bridges in the town. The heavy bridge over the Lys Canal at the southern entrance to the town was not entirely destroyed, but during the night, when the Germans tried to rush it, a section of the 446th Field Company, under Lieutenant Williams, blew it up while ten Germans were in the act of crossing. Williams was killed by machine-gun fire a few moments later. In the evening, troops of the 29th Division were beginning to arrive in support of the 50th. The field companies of the latter division were withdrawn to La Rue du Bois at the north east corner of Nieppe forest. On the 12th, all three field companies were in action. The situation east of the Nieppe forest appeared critical. The 7th and 447th Companies were sent to help the infantry north and south respectively of the La Motte-Merville road, and remained in action until the evening, when the situation was eased by the arrival of the 5th Division (C.R.E., Lieut.-Colonel J. R. White) recently returned from Italy. The 446th Company had meanwhile been in action with the 149th Brigade near Vieux Berquin. On the 13th, the companies were withdrawn and concentrated at Le Parc, a hamlet on the north edge of the Nieppe forest. For the next three days they worked on a line of breastworks and trenches from La Motte through the Bois des Vaches, under the C.R.E., 5th Division. The 50th Division, once more reduced to the strength

of little more than a brigade, gradually withdrew from the battle, and was finally taken out on the 17th April.

The 25th Division (C.R.E., Lieut.-Colonel R. J. Done) forming the right of the IX Corps, had only arrived on the Lys front on 1st April. It took over the Lys-Douve sector. Its losses had been made good, and the command of the field companies had been overhauled. When the battle began on 9th April, the divisional front was not immediately assailed; but when the situation on the right became critical, owing to the enemy's capture of Fleurbaix and Laventie, and his crossing of the Lys at Bac St. Maur, the 74th Brigade, from the 25th Divisional reserve, was sent up to retake Croix au Bac and form a defensive flank. As the 75th Brigade was too weak to hold the whole line from Le Bizet to Ploegsteert Wood, the three field companies (105th, 106th and 130th) and the pioneers were sent up at 10 p.m., under Lieut.-Colonel Fitzpatrick, R.E., who commanded the pioneer battalion, and placed under the orders of the 75th Brigade. They took up a position along the Lys 500 yards from Vanne, forming a defensive flank, and sent out patrols. Next morning, 10th April, an intense bombardment of the divisional front started at 4.30 a.m., and under cover of fog, the Germans crossed the Lys and reached Le Touquet station. Lieut.-Colonel Fitzpatrick was ordered to counter-attack with the R.E. and pioneers. He took one company of pioneers and pushed up as far as Lys Farm, where he found that the situation at Le Touquet had been restored by the troops on the spot. Meanwhile, the 75th Brigade had ordered the rest of his troops back to the Gravier area, as the enemy were in Ploegsteert and were threatening the Romarin road. Lieut.-Colonel Fitzpatrick rejoined his battalion and the field companies, who had taken up another position in front of Romarin. At 4.30 p.m., Colonel Fitzpatrick was ordered to retake Ploegsteert in conjunction with a party of R.E., some Australians and two companies of the South Lancashire Regiment. The attack was launched at 5.30 p.m., but owing to machine-gun fire from the right and heavy fire from the village, it failed, and the remnants were obliged to fall back, after getting within 200 yards of their objective.

On 11th April, the field companies, who had spent the night near Romarin, rejoined the pioneers near Dou Dou Farm. At about 10 a.m., as the troops on their right were falling back, the R.E. and pioneers were withdrawn to the army line near Romarin. The 105th Company shot down two enemy aeroplanes with their Lewis gun, one falling behind our lines, and the other in the enemy's. The R.E. and pioneers made an attempt to regain Romarin, but only succeeded in winning about half the village, and the 75th Brigade ordered them back at dusk. The 134th and the 1st Australian Army Troops Companies, who had been placed at the disposal of the C.R.E., were sent to dig on the army line across the Neuve Eglise spur.

Next day, after a heavy artillery preparation, the enemy attacked at 2 p.m. By 6 p.m., the situation south of Bailleul became critical, and all available R.E. at the transport lines, about 140 all told, were sent up under Major J. W. Lloyd (O.C., 105th Field Company) to take up a position on Asylum Hill under the 7th Brigade. The R.E. under Major Lloyd remained in action as infantry for the next seven days, forming part of Brigadier-General Wyatt's Force. On the 15th, when the Germans took Ravelsberg Ridge, Lieutenant Cooper and Rice, R.E. went forward to ascertain the situation. Finding a gap in our line, they collected fifty stragglers and some ammunition and made a counter-attack, under cover of which some of the infantry who were being surrounded were able to withdraw, and the situation was restored at this point. Two days later, Lieutenant Cooper again distinguished himself, but was unfortunately killed. He attempted to rush an enemy machine-gun which had taken up a position on his right flank, but was shot by a sniper from a shell-hole when he had nearly reached his objective. On the 19th, the R.E. with Wyatt's Force were relieved by infantry and were withdrawn to their transport lines.

The 25th Divisional R.E. had been fighting almost continuously from 10th to 18th April. The C.R.E.'s diary records: "For the first three days, there was a good deal of straggling; that is to say, men in considerable numbers found their way to their transport lines, both R.E. and pioneers. In the fog,

and in the confused infantry fight, small parties became separated and lost ; not knowing what else to do, they either made their way to their transport lines or reported to Divisional Headquarters where they were fed, rested, equipped with ammunition and sent up again to their units. These men were not real stragglers. They came in in good order, generally very exhausted, but with their rifles and kits complete. Their work in face of the enemy was marked by a steady and effective use of their rifles, and by orderly retirements when ordered to withdraw. Their casualties during these nine days were : officers, 2 killed (Captain E. P. D. Cator, acting O.C., 106th Company and Lieutenant Cooper), 2 wounded and 1 missing ; other ranks, 27 killed, 93 wounded and 3 missing ; total 128."

The 19th Division (C.R.E., Lieut.-Colonel P. E. Hodgson) had taken over the Messines sector from the 2nd Australian Division at the end of March ; on 6th April it also took over the Wytshaete sector. The 81st and 82nd Field Companies were forward with the right and left brigades respectively, and the 94th Company was at work behind. No attack was made on the divisional front on the 9th, but the division was ordered to be prepared for relief on the next night in case the Second Army shortened its line. On the 10th, however, the enemy attacked at dawn. The 81st and 82nd Companies were sent to occupy strong points in the IX Corps defence line, and the 94th Company was ordered to consolidate a reserve line. The 81st Company suffered severe casualties, losing its O.C., Major Smith, severely wounded, one officer killed, and thirty-two other casualties. The division successfully held its positions in the battle until it was relieved by French troops on 17th April. The R.E. had the usual tasks of destroying bridges and culverts, and digging and wiring successive lines.

The 3rd Division (C.R.E., Lieut.-Colonel W. C. Cooper) was in reserve south-west of Béthune, and on 9th April the 9th Brigade was sent up to help the 55th Division. On the 11th its other two brigades, the 8th and 76th, were moved up to help the 51st Division and on the 12th, the whole division was in the line, between the 55th and 51st.

The 4th Division (C.R.E., Lieut.-Colonel C. R. Johnson) was hurried up from Arras on the 12th, and that night relieved

part of the 3rd Division along the La Bassée canal, from Pacaut Wook to Robecq. On 18th April, the enemy made a heavy attack on that part of the line held by the 1st, 3rd and 4th Divisions, but was repulsed after heavy fighting. At the time of the attack, a party of sappers of the 406th Field Company (4th Division), about thirty-eight strong, under 2nd Lieutenant R. Brand, was engaged in wiring a bridgehead south of Pacaut Wood on the La Bassée canal. When the German barrage opened at 1.45 a.m., the party was obliged to cease work and to take cover in the trenches on both sides of the bridge along the south bank. They were joined by eight sappers of the 9th Field Company under 2nd Lieutenant D. F. McKay. At 4 a.m., the barrage lifted on to the new line behind the canal. There was then an interval of five to ten minutes before a party of seventy Germans with three machine-guns made a rush for the bridge. They hesitated, collecting in a bunch, and very effective rifle fire was opened on them by the sappers. Some tried to dash across the bridge, others were mown down on the opposite bank and the remainder disappeared. About twenty Germans then dashed over the bank carrying a specially-made assault bridge, which they launched intact, but it failed to reach across. Some of the Germans dashed on but were shot down to a man. After this, a corporal of the 9th Company rushed on to our bridge and destroyed the off-shore bay with hand grenades, and the bridge was pulled across to our side. At about 6 a.m., a party of the Seaforth and King's Own appeared on the northern bank. A whole pontoon was lying adrift in the canal, so 2nd Lieutenant Brand swam out and secured a line to it, by which he ferried over about twenty-five of the infantrymen. At 7 a.m., one of the Germans on the north bank waved a white handkerchief; then others put up their hands, and finally between 200 and 300 surrendered. During the ferrying of prisoners in the pontoon, some machine-gunners opened fire on the sappers, and several were hit. This renewed the fighting, but eventually nearly 150 prisoners were got over. The sappers were withdrawn about 10.30 a.m., having lost one officer (Lieutenant R. Findon, 9th Company) and one other rank killed and

fourteen wounded. 2nd Lieutenant Brand, 406th Company, was unfortunately killed on 9th May.

The 5th Division arrived in France from Italy on 8th April. It was originally intended to relieve the 2nd Canadian Division on the Vinny front, but owing to the situation on the Lys, it was sent up on the 12th to Steenbecque, and assembled near Thiennes. As soon as it had arrived, it was ordered to establish two of its brigades east of Nieppe Forest. The 13th Brigade, with the 527th Field Company, and the 95th Brigade, with the 59th Field Company, were sent up, and the 15th Brigade followed in support. The 491st Company was ordered to secure the bridges on the canal east of Aire. The division was quickly established in the line, with the 61st on its right and the 35th on its left. During the night, the field companies constructed a series of strong-points, and "the direct road to Hazebrouck through Nieppe Forest was for the moment securely blocked."* During the remainder of April, the 5th Division stood firm and was very successful in repelling numerous German attacks.

The 61st Division (C.R.E., Lieut.-Colonel G. E. J. Durnford) detained at Merville on 10th and 11th April and its units were sent up piecemeal as they arrived. The first two battalions went to help the 51st Division, now very hard pressed, and took up a position covering Pacau. The rest of the division began to arrive during the night of the 11th on the Clarence river, between Robecq and Merville. The field companies were sent off to prepare the pontoon bridges for destruction. The charges on a minor bridge north of Calonne failed to explode, and orders were sent to the 458th Company that every effort must be made to demolish the bridge at once; but this was found to be impossible as the enemy had meanwhile obtained possession. It transpired that the battalion commander on the spot had not allowed the bridge to be destroyed at the right moment, and had ordered the R.E. section to man posts some distance away. Lieutenant Roberts had visited this commander several times to ask if he might destroy the bridge, but on his last visit, the battalion headquarters had gone, and the enemy was in possession. Lieutenant Roberts had one man

* *Official History*, 1923, Vol. II, p. 226.

killed and several wounded in making the final attempt. This is an illustration of the difficult position in which an officer responsible for bridge demolitions may find himself. The 61st Division remained in action for the rest of April, and also during the whole of May and June, until relieved in the middle of July by the 74th Division (C.R.E., Lieut.-Colonel W. R. Izat).

The 29th Division (C.R.E., Lieut.-Colonel R. K. A. Macaulay) had been in the Ypres sector since January, 1918. On 7th April, it was relieved by the 59th and 41st Divisions with a view to moving to St. Pol, but it was more urgently required to stem the assault near Neuf Berquin, and at midnight on 9th April received orders to embus for Merville. The 455th and 510th Field Companies moved with the 87th and 86th Brigades, but the 497th Company remained with the 88th Brigade at Ypres. April 10th was spent in getting into position about Neuf Berquin and reconnoitring the situation. On the 11th, the two companies, 455th and 510th, in conjunction with the 50th Divisional R.E., were digging a line of posts when the enemy broke through in front, and the sappers had hastily to man their works. After this the companies became scattered and the C.R.E. lost touch. Two sections of the 455th Company got back to their billets in the evening after losing four killed and seven wounded; the other two sections were still on the left of the 50th Division line; while there was no news of the 510th Company in front of Merville. Divisional headquarters were moved back to La Motte au Bois, and again next day to Caestre. The C.R.E. sent out his assistant adjutant to try to get into touch with his two companies, but he was only able to locate the 455th Company's headquarters. The line was now constantly moving back. In the meantime, the 88th Brigade had become attached to the 34th Division, and the 497th Company was fighting at La Crèche, north of Bailleul. Its O.C., Major H. W. Webster, was severely wounded, and died of his wounds later. On the evening of the 13th, the 455th and 510th Companies were assembled near St. Sylvestre Cappel, and the division was relieved by the 1st Australian Division. It was moved up behind the French troops holding Kemmel on the

19th, but did not go into action during the remainder of April. The R.E. casualties from 10th to 15th April were: 455th Company, eight killed, seventeen wounded and one missing; 497th Company, three killed, one officer died of wounds, twelve other ranks wounded and three missing; 510 Company, three killed, three officers wounded, and one officer and four other ranks missing.

The 31st Division (C.R.E., Lieut.-Colonel F. L. N. Giles) had only just moved to the Villiers Chatel area, north-west of Arras, in G.H.Q. reserve, when it received orders on 10th April, to prepare to move at one hour's notice. The 223rd Field Company embussed at 4 p.m. with the 93rd Brigade, the 211th Company with the 92nd Brigade, and the 210th Company at 11 p.m. with the 4th Guards Brigade, moving up to Strazeele and Outtersteene behind the 29th Division. From 12th to 17th April, the division was in action in front of Hazebrouck, the field companies taking their part with the infantry. On the 17th, the division was withdrawn, but remained near Hazebrouck in reserve.

The 33rd Division (C.R.E., Lieut.-Colonel G. F. Evans) at the beginning of April was in the Passchendaele sector. It was relieved by the 29th and 59th Divisions, and moved down to the Third Army on 7th April assembling near Hauteville. On 11th April, it was moved up at short notice to Caestre, and next day was put into the line in front of Meteren. On the 16th, the 11th Field Company distinguished itself in action which is thus recorded in the *Official History*: "about 4.30 p.m., two sections of the 11th Field Company, R.E., in support of the left of the 4th King's, made a counter-attack on a farm half a mile west of Meteren, bayoneting thirty Germans and capturing eighteen with three machine-guns. This brilliant little episode stabilized a situation which was becoming dangerous."* Lieutenant S. Feary, the officer in command, was wounded; he was subsequently awarded the D.S.O. On the 19th, the division was relieved by the 1st Australian Division, and for the remainder of the month was employed in digging rear lines.

* *Official History, 1918*, Vol. II, p. 332.

The operations in Flanders continued until the end of April, chiefly round Kemmel and the Scherpenberg, south-west of Ypres, where the XXII Corps took part. The Germans made several heavy attacks, but their troops were exhausted, and gradually the great battle came to an end, with the failure of Ludendorff to break the British line and reach the Channel ports.

THE BATTLE OF THE AISNE, 27TH MAY-2ND JUNE, 1918

As part of the arrangements made with General Foch, the British IX Corps (Lieut.-General Sir Alexander H. Gordon) was transferred on the 27th April to what was considered to be a quiet part of the front—the Chemin des Dames sector of the French Sixth Army—in order that some of the divisions which had had a heavy share in the fighting of March and April might be given a rest, and so release French divisions for Foch's reserve. The divisions selected were the 8th (C.R.E., Lieut.-Colonel C. M. Browne), the 21st (C.R.E., Lieut.-Colonel G. H. Addison), the 25th (C.R.E., Lieut.-Colonel R. J. Done) and the 50th (C.R.E., Lieut.-Colonel J. A. McQueen). They had lost nearly all their more experienced officers and N.C.Os., and had recently received a large number of young recruits. They therefore needed a considerable period for reorganization and training.

The VIII Corps, commanded by Lieut.-General Sir Aylmer G. Hunter-Weston (late R.E.), had also been withdrawn from the line, and was under orders to move to Chalons-sur-Marne, to join the French Fourth Army, with the same object of relieving French divisions. Only one division, the 19th (C.R.E., Lieut.-Colonel P. E. Hodgson), had been allotted for the time being to the VIII Corps, and had arrived in the neighbourhood of the Chalons on 18th and 19th May. It was destined to be drawn into the IX Corps' battle on the Aisne.

British G.H.Q. had a strong impression that the Germans intended to launch an attack on the Chemin des Dames, and were uneasy about the fitness of the tired divisions to withstand another attack so soon after their heavy work on the Somme and the Lys. The French were convinced, however, that there

would be no object in a German attack in that sector, as it would lead to no important strategic result. Thus when the IX Corps took over from the French XXXVIII Corps on 17th May, the troops settled down in their beautiful surroundings to a routine of static warfare and mild raids. But signs of unusual activity on the German side were soon noticed, and the IX Corps reported obvious preparations for an attack. The Germans had, in fact, mustered twenty divisions and 1,036 batteries for an assault between Berry au Bac and Soissons.* Information from prisoners, taken on 26th May, gave clear warning of the impending attack, and troops were hurriedly moved into battle positions.

The IX Corps had the 21st, 8th and 50th Divisions in the line, while the 25th was held back by the French Sixth Army Commander, General Duchêne. The disposition of the R.E. companies varied. The 21st Division kept all three companies (97th, 98th and 126th) and its pioneers in divisional reserve. The 8th Division placed the 490th Company at Berry-au-Bac in support of its 25th Brigade, and kept the 2nd and 15th Companies, and the pioneers, to garrison the defences of Gernicourt. The 50th Division placed the 447th Company with the 150th Brigade in the front line, and the 7th and 446th Companies in reserve in the Bois de Gernicourt. All three divisions had R.E. demolition parties standing by at the bridges over the Aisne and its canal.

The opening bombardment, which began at 1 a.m. on 27th May, was terrific : it covered a front of 36 miles and reached to a depth of nearly twelve miles. Very many casualties were incurred among troops moving to their positions, the 2nd, 7th, 15th and 447th Field Companies, in particular, suffering heavy losses, even before daylight.

The 25th Division, from army reserve, was handed over to the IX Corps on the night of the 26th, and moved up to supporting positions early on the 27th, but its brigades were quickly absorbed into the battle, and by 1 p.m. they were fighting under the orders of the other three divisions, the experiences of whose engineers are described below. The

* *Official History*, 1918, Vol. III, p. 44.

R.E. companies were all severely handicapped by the heavy losses suffered in the initial bombardment, and their diaries were largely written by surviving subalterns, often quite ignorant of what befell the bulk of their units. The narrative which follows is, therefore, far from complete.

The 8th Divisional Engineers.—The 2nd Field Company (Major J. R. Grant) was aroused in its billets at 10.40 p.m. on 26th May, and at 11.45 p.m. three sections, under the O.C., marched off to man the emergency trenches, leaving the remaining section to follow. At 1 a.m., when the company had almost reached its trenches, the enemy barrage came down. The men dispersed, and most of the officers and N.C.Os. became casualties. With a few sappers the O.C. reached the position at about 2 a.m., and, about an hour later, was joined by the fourth section, which had made its way through the woods. The trench was held until 9.15 a.m., when the party, about thirty strong, was forced back about 200 yards to another trench east of Gernicourt. At 12.30 p.m., it was found that the Germans were occupying the same trench on both flanks, and the little party was ordered to withdraw. Only seven men made their way back to the transport lines. Major Grant and 2nd Lieutenant Gardner were missing, 2nd Lieutenants Clarke and Brummel were wounded, and of the three sections which Major Grant led forward at midnight, only twenty-four men returned during the morning. The transport lines, meanwhile, had been subjected to a gas-shell bombardment, and had moved back at 5 a.m., first to Ventelay, and then in the afternoon to a wood south of Montigny. At 10 p.m., what was left of the company marched back to Serzy, halting at 7 a.m. on the 28th. This was another day of marching, and the company arrived near Jönquery at 5.30 p.m. Next day, Lieutenant Miller and forty men were attached to the 23rd Brigade, and moved forward as infantry to Champlat, while the transport crossed the Marne at Pont à Binson, near Chatillon, and moved to Oeuilly. The Divisional Commander then decided that the R.E. were not to be used as infantry, so Lieutenant Miller and his party, after helping to regulate traffic and collect stragglers, returned to the company lines on the 29th. For

the next ten days, the company was continually on the move, but took no further part in the fighting.

The 15th Field Company (Major E. C. Hillman) was in dug-outs on the Aisne Canal a short distance west of Gernicourt, with one section, under 2nd Lieutenant H. C. Garbutt, detached near Berry-au Bac. All sections had parties told off for bridge demolitions. As soon as news of the impending attack had been received, orders were issued that the bridges were to be blown at the discretion of the field company commanders on the spot. Accordingly, when he received the warning order from the C.R.E. at 8 p.m. on the 26th, Major Hillman went along the canal to verify the readiness of all his bridge-demolition parties. He was at Berry-au-Bac when the German bombardment opened at 1 a.m., and returned at once to his headquarters to order immediate packing-up and readiness to move. He sent out Lieutenants E. H. Jacobs-Larkcom and C. Sutton with written orders to blow their bridges as soon as it became evident to them that the enemy was advancing, and that the blowing of the bridges was necessary to prevent him from crossing the river. The canal bridges were to be blown after the river bridges. Shortly after this, all telephonic communication was cut, and no further instructions were received from the C.R.E., but at about 4.30 a.m., Major Hillman was handed a message from the 25th Brigade stating that the enemy had penetrated the right flank of the Rifle Brigade. Stragglers and wounded coming along the canal bank reported that the Germans were advancing rapidly. At 6 a.m., 2nd Lieutenant Strong was sent out to his bridges. At 6.15 a.m., Lieutenant Garbutt came in with his section and reported that he had blown all his six bridges at Berry-au-Bac, and that the enemy was being prevented from working along the canal by some gunners. At 7 a.m., Lieutenant Jacobs-Larkcom returned to company headquarters, wounded in the face, and was evacuated. Major Hillman, who had by now collected a number of stragglers and three infantry officers, disposed his little force for the defence of the canal bank.

At 10 a.m., he was visited by Brigadier-General R. H. Husey, commanding the 25th Brigade, and ordered to take his men

back across the canal and endeavour to hold the front edge of the Bois de Gernicourt. In the village itself were the 22nd D.L.I. (Pioneers) and some of the 490th Field Company. At 11 a.m., Major Hillman received word that the Germans were well across the river at Pontavert and were working round behind the Bois de Gernicourt. He was becoming more and more isolated, and there was a gap of 1,000 yards on his right between him and the East Lancashire Regiment, who were south-west of the village of Gernicourt. About midday, when it became obvious that the Germans were in the wood, he sent Captain A. D. Black, of the 490th Field Company, with twenty-five sappers, southwards to do what he could to prevent the enemy coming out of the wood. Captain Black evidently went too far, for at 12.30 p.m., the Germans suddenly appeared within a few yards of Major Hillman in his trench. They threw bombs, but the sappers had none to throw back. Hillman, seeing that the position was hopeless, passed the word down to retire towards the East Lancashires. Hillman was the last out, and following a trench that he thought would lead him to the infantry, came upon the remains of Captain Black's party, Captain Black having been killed. He told them to follow him, as he intended to get through the wood if possible, although groups of Germans could be seen on all sides. Crossing a clearing one by one, the little party managed to get into the wood and discovered a track leading southwards. On this track Hillman found an abandoned 18-pounder gun and removed the breech-block. At the end of the track, they saw a group of men whom they took to be British, but soon found that they were Germans, making signs to them to surrender. Hillman shouted to his men to follow him, but they were evidently too close to the enemy to do so. Hillman, now left by himself, doubled through the wood, but came upon six Germans talking together. He made a rush towards a trench but it turned out to be a cul-de-sac, and he was taken prisoner.*

The 490th Field Company (acting O.C., Captain A. D. Black), which was working in the front line and was billeted

* From Major Hillman's personal account, written in February, 1919, after his release.

at Le Cholers farm, turned out at 1 a.m. on the 27th to go into support under 25th Brigade arrangements, leaving bridge demolition parties under Lieutenant P. Burr and 2nd Lieutenant W. C. Leslie-Carter. Heavy casualties were incurred in moving up, but the company manned their trenches until daylight, when Germans appeared in the trench fifty yards to their left. Black gave orders to retire to 25th Brigade headquarters. Before these were reached, the company, now much reduced in strength, met some men of the Rifle Brigade, whom they joined and assisted to hold their position until a tank bore down on them. They then retired past Brigade headquarters and reached Le Cholers farm. Here Captain Black sent out Burr and Leslie-Carter to blow up their bridges, while he took his own party to Gernicourt, where men were being collected in a trench to make a stand. After some four hours, word was passed along that Germans were massing on the left, and a party of thirty R.E. and infantry was sent to hold up their advance. By this time, Major Hillman, O.C. 15th Field Company, had taken over command, and Captain Black with some twenty-five sappers and infantrymen, was ordered to man a trench on the left, but found it occupied by Germans. He gave orders to retire, and word was passed along to Major Hillman asking for orders. The reply was to get forward, as the enemy were killing men in the rear. Captain Black then led the way over the top of his trench, but was immediately shot. Lieutenant Otway followed safely, gathered the men together in another trench, and then, as ammunition had been exhausted, and there were no organized troops left in sight, he returned by stages with ten other ranks to the company's transport lines.

The 50th Divisional Engineers.—The field companies of the 50th Division had similar experiences. Cut off from telephonic communication and overwhelmed by the bombardment, the R.E. units were left to their own devices. Apart from the demolition of bridges, there was no opportunity to do any work. Sections became scattered, and companies reduced to skeletons.

The 7th Field Company (Major W. F. Baldwin) was under warning orders to occupy a strong-point in the reserve line

in the event of the enemy penetrating the front, but before the messenger from the C.R.E., carrying the order to move forward, reached the company, the heavy concentration of gas shell had put a large number of men out of action. Major Baldwin, waiting for orders to move up, sent 2nd Lieutenant H. G. Pottle to reconnoitre, and while parading his three sections (the fourth was at Beaurieux working at divisional headquarters) he was killed by shrapnel. By this time, the Germans were advancing through the woods on all sides and the company had to retire without being able to reach its battle-position. Pottle was wounded and sent back; the company sergeant-major and many others were killed, and the sections were overwhelmed. Captain F. J. Slattery, who had taken over the command when Major Baldwin was killed, and Lieutenant H. F. Sharpe were wounded and captured, together with all the survivors of the three sections except a few men under 2nd Lieutenant M. H. King who got back to the company lines. Only No. 2 section under Lieutenant W. H. Rebbeck, clearing roads at Beaurieux, remained intact. This section received orders to retire with the infantry to Maisy, south of the Aisne.*

The 447th Field Company (Major A. G. Rainsford-Hannay) fared even worse. It was in the forward area, on the Craonne plateau, when the bombardment began, and was overwhelmed and cut off when the Germans penetrated on the eastern side. Only one man got back during the day to report himself at the headquarters of the C.R.E.

The 446th Field Company (Major McClellan) was disposed along the river bridges on the Aisne. Out of sixteen bridges, fourteen were destroyed, but not without casualties amounting to four officers and forty-six other ranks.†

The total R.E. casualties on the 27th May, in the 50th Division alone amounted to thirteen officers and 281 other ranks, more than two-thirds of their strength at the beginning of the day.

The 25th Division (C.R.E., Lieut.-Colonel R. J. Done) had been held back in army reserve until the evening of the 26th,

* *History of the 7th Field Company, R.E.*, pp. 60-1.

† *Official History*, 1918, Vol. III, p. 58.

when it was handed over to the IX Corps just before the German attack began. The field companies were placed at the disposal of the infantry brigades for work on the second line of defence. The brigades were moved up in succession, and by 1 p.m., on the 27th they were fighting under the orders of the 8th, 50th and 21st Divisions. The field companies were then placed at the tactical disposal of the brigadiers and the C.R.E. ceased to have control over them; all that he could do was to see to the successive moves of their transport lines. For all practical purposes, even divisional headquarters ceased to operate. For the next six days the R.E. were used as infantry and it was not until 2nd June that the companies could be reassembled. Their casualties had amounted to about one third of their strength.

The 19th Division (C.R.E., Lieut.-Colonel P. E. Hodgson) which was intended to form part of the VIII Corps in reserve was directed to the IX Corps, but did not come into the battle on the Aisne until 29th May, by which time the French right shoulder of the salient was stiffening. The division relieved the remnants of the 8th, 25th and 50th Divisions on 30th May and for the next six days, offered a stubborn resistance. Although still being forced back, the front was beginning to crystallize, and the R.E. companies were able to work on various defence lines. They suffered a number of casualties during a German attack on 6th June; Major K. B. Godsel (82nd Company) was wounded, seven other ranks killed and eleven wounded. Four days later, the 82nd Company again lost its O.C., Captain Gorringer, killed by shell-fire.

The divisions of the IX Corps were gradually relieved by French troops, and during June they returned to the British area.

THE BATTLE OF TARDENOIS, 20TH-31ST JULY, 1918

In spite of the heavy load borne by the British armies during March and April, 1918, the French High Command still nursed the idea that they should render more help in carrying the burdens which had been weighing on French troops for

three and a half months.* When the German attack on the French front from the Argonne to Château Thierry seemed about to fall, Foch became anxious about the position of his reserves. He himself was preparing his counter-offensive against the western flank of the German salient which had resulted from the attack of 27th May to 2nd June, and he, therefore, now called for the British XXII Corps, disposed near Amiens, to be moved behind the French Fourth Army. Sir Douglas Haig was of the opinion that another heavy attack against the British front was equally probable, and was against a premature move of his reserves, but while on a visit to England, his Chief of Staff was persuaded to set the XXII Corps in motion towards the Reims front on 12th July. The XXII Corps at this time consisted of the 51st, 62nd, 8th, 15th and 34th Divisions.

On 16th July, while the 51st and 62nd Divisions were concentrating in the French Fourth Army Area, the XXII Corps was ordered back westwards by General Pétain to support the Fifth Army. Some confusion ensued, not only owing to the counter-order, but also because the assembly places of the two divisions were changed. It was not until 18th July (the date on which Foch launched his counter-stroke) that the 51st and 62nd Divisions were concentrated east and south-east of Epernay, the leading units marching from the original de-training stations, and later ones being brought up by lorry. They were then allotted to the French Fifth Army. The other two divisions, the 15th and 34th (the 8th had been withdrawn from the XXII Corps), were directed to the French Tenth Army. The 15th Division, while en route on 17th July, was directed to detain at Clermont, forty-one miles west of Soissons, and completed its concentration next day. The 34th Division concentrated around Senlis on the same day. Thus the XXII Corps was split in halves on the eastern and western side of the Château Thierry salient.†

As soon as the great counter-stroke began on 18th July, the Italian Corps, which held one of the Fifth Army sectors

* *Official History*, 1918, Vol. III, p. 223, footnote.

† *Official History*, 1918, Vol. III, p. 235.

south of Reims, suffered heavy casualties and was badly shaken. It had to be relieved, and General Berthelot, the commander of the Fifth Army, asked that the XXII Corps should be placed at his disposal. Accordingly, during the night of 18th July, the 51st and 62nd Divisions crossed the Marne at Epernay and, after an arduous march, concentrated in the southern part of the Montagne de Reims forest, moving up in the evening to a preliminary position.*

The 51st and 62nd Divisions were put into the attack on 20th July. The fighting was hard and the wooded country difficult. The work of the R.E. was restricted to clearing roads and tracks for the horse transport; but the 404th Company of the 51st Division was left behind at Moussy with the bridging equipment of both divisions, and placed under the orders of the French I Cavalry Corps for bridging the Marne. A bridge of two trestles and ten pontoons was built on 27th July at Troissy.

The attacks were successful, and the line was carried forward on successive days. The salient was flattened out, and the British divisions were withdrawn on 1st August. On the western side of the salient, the 15th and 34th Divisions were brought up to relieve the American 1st and French 38th Divisions on 21st July, but they were separated from each other by two French divisions. During the sharp fighting which followed, the 15th Division distinguished itself on the 28th by the capture of Buzancy village, but had to yield again to a heavy German counter-attack. A section of the 91st Field Company under 2nd Lieutenant Arbutnot accompanied the 44th Brigade in the attack, for the demolition of cellars and dug-outs. The officer was severely wounded when starting off from the position of assembly, but the section carried on under Sergeant Colman and reached the old château of Buzancy. Lance-Corporal Brazier and four sappers helped to rush a cellar from which two German officers and a hundred men were captured. The diaries of this period are scanty, and give but few details of the work of the field companies during the advance, which continued till 5th August, when the 15th and 34th Divisions were withdrawn and returned to the British area.

* *Official History*, 1918, Vol. III, p. 242.

The great German offensive of 1918 had been resisted and the tide had turned. The foregoing chapter has dealt with the experiences of the R.E. units during these very difficult months of repeated withdrawals and heavy fighting. We have seen how often the divisional and even many other R.E. units were called upon to act as infantry, acquitting themselves with credit in a rôle that was unavoidable during some of the critical stages of the battle. We have also seen the difficulties in keeping control of scattered units during the disorganization of a retreat, and especially the complicated situations which are liable to occur during the demolition of bridges, when there is doubt or delay in delegating authority for firing the charges.

CHAPTER XV

THE FINAL PHASE ON THE WESTERN FRONT

Operations of the Fourth Army—The Hindenburg Line—Passage of the Sambre—Oise Canal—Operations of the Third Army—Operations of the First Army—Operations of the Fifth Army—Operations of the Second Army.

OPERATIONS OF THE FOURTH ARMY

SIR Douglas Haig's final offensive began on 8th August, and the opening blow was struck by the Fourth Army, which held the front from the Amiens-Roye road on the south to Morlancourt on the north, where it joined the Third Army front. It was composed of the Australian Corps and the III Corps holding the front line, with the Canadian Corps, secretly moved down from the First Army, in reserve until just before the attack began. The American 33rd Division was attached to the III Corps. The main attack was to be carried out by the Canadian and Australian Corps, with defensive flanks formed by the First French Army on the south and by the III Corps on the north. In army reserve were the 1st, 2nd and 3rd Cavalry Divisions, and in G.H.Q. reserve, the 17th, 32nd and 63rd Divisions, concentrated respectively behind the Australian, Canadian and III Corps.

The R.E. units concerned in the opening phase were therefore those belonging to the British divisions in the III Corps. These were :—

III Corps (Chief Engineer, Brigadier-General A. Rolland) :—

12th Division	C.R.E., Lieut.-Colonel A. T. Shakespear, with 69th, 70th and 87th Field Companies.
18th Division	C.R.E., Lieut.-Colonel C. B. O. Symons, with 79th, 80th and 92nd Field Companies.
47th Division	C.R.E., Lieut.-Colonel A. B. Carey, with 517th, 518th and 520th Field Companies.

58th Division	C.R.E., Lieut.-Colonel A. J. Savage, with 503rd, 504th and 511th Field Companies.
74th Division	C.R.E., Lieut.-Colonel W. R. Izat, with 5th R. Anglesey, 5th R. Monmouth and 439th Field Companies.
Corps Troops	C.R.E., Lieut.-Colonel C. F. Rundall, with 221st, 283rd and 288th Army Troops Companies, No. 1 Siege Company, R. Anglesey R.E., 180th, 253rd and 256th Tunnelling Companies.

The corps had been employed for the previous four months on strengthening the defences of Amiens; it was now called upon to form the left flank of the Fourth Army attack until 30th September, when it was withdrawn and its place taken by the XIII Corps.

The whole of the Amiens outer defences were gained in the first three days' fighting, and the III Corps consolidated the northern defensive flank of the army. There followed a period of preparation for the next phase until 21st August, when the advance on Péronne began. The river Ancre lay on the III Corps front and was crossed by the 18th Division between Albert and Dernancourt without much difficulty. During the next few days, the troops were fighting over the old Somme battlefield, stripped of all cover, and ploughed up by mine craters and old trenches. For many days the fighting was close and bitter. The Germans had had plenty of time to build machine-gun emplacements by the hundred; but step by step the Fourth Army made progress, and at intervals launched heavier attacks as soon as the communications and conditions of supply permitted them. The III Corps remained with the Fourth Army until the outer defences of the Hindenburg Line had been taken and was then withdrawn to the First Army.

The R.E. units had the usual programme of road reconstruction, clearance of obstacles, booby traps and mines, and the carrying forward of water supplies. The only bridges required were those over the Ancre and Hallue rivers. The spans were twenty feet or less and the divisions were only responsible for

those required for horse transport. The roads in the recovered area were found to be in surprisingly good condition, and the weather remained fine. The forward work on roads was done by the tunnelling companies and divisional pioneers; these were followed up by the siege companies and labour companies. Horse traffic was kept off the roads as much as possible by the provision of tracks quickly made by the pioneers.

The water supply was organized under the Corps Water Supply Officer, who was given the 288th Army Troops Company and a section of the 353rd Electrical and Mechanical Company. Captured wells were cleaned and worked by the divisional engineers. As soon as the attack on 8th August cleared the area, the Corps installed a high-speed pump on a good well in Sailly-le-Sec and ran a pipe-line thence to the Bray-Corbic road. A mobile section of the Fourth Army Water Column was allotted to the corps and worked directly under the Chief Engineer. As the advance progressed, pumps and other water equipment were dismantled from rear areas and carried forward. The work had now become so extensive that a Water Supply Group was formed, commanded at first by Major D. A. MacDougall (O.C., No. 1 Siege Company, Royal Anglesey R.E.) and later by Lieut.-Colonel G. R. Hearn (late C.R.E., 9th Division). It was composed as follows: 144th and 288th Army Troops Companies, No. 1 Siege Company R.A.R.E., 136th Labour Company, the III Corps Water Column and No. 2 section 353rd Electrical and Mechanical Company. The successful advance of the Fourth Army over the desolated battlefields of the Somme, already twice fought over, was very largely due to the rapid opening of communications and the carrying forward of the vitally necessary water supply.

THE HINDENBURG LINE

The IX Corps (Chief Engineer, Brigadier-General G. S. Cartwright) came into the Fourth Army from G.H.Q. reserve on 11th September, and took over the right front from the Australian Corps, which moved farther north. The IX Corps took over the 32nd Division from the Australians, the 6th Division from

army reserve, and the 1st Division, which was now arriving by rail from the First Army, and on 19th September, the 46th Division came from III Corps reserve. These four divisions remained with the IX Corps until the Armistice. The Divisional engineers were :

IX Corps (Chief Engineer, Brigadier-General G. S.

Cartwright) :—

1st Division	C.R.E., Lieut.-Colonel C. E. P. Sankley, with 23rd, 26th and 400th Field Companies.
6th Division	C.R.E., Lieut.-Colonel G. F. B. Goldney, up to 23rd September, then Lieut.-Colonel H. A. L. Hall, with 12th, 459th and 509th Field Companies.
32nd Division	C.R.E., Lieut.-Colonel G. C. Pollard, with 206th, 218th and 219th Field Companies.
46th Division	C.R.E., Lieut.-Colonel H. T. Morshead, wounded 25th September, then Lieut.-Colonel W. Garforth, with 465th, 466th and 468th Field Companies.
Corps Troops	C.R.E., Lieut. Colonel Traill, with 648th Field Company (ex 73rd Division, broken up) 216th, 221st, 567th and 574th Army Troops Companies, No. 4 Siege Company, R. Anglesey R.E., 253rd, 254th and 256th Tunnelling Companies.

The two months spent by the IX Corps in the Fourth Army were very strenuous; there was much hard fighting, with the crossing of the river Selle and the Sambre-Oise canal to vary the R.E. programme. When the Corps arrived, the Fourth Army was preparing to renew its attack on a large scale with the object of gaining the outer defences of the Hindenburg Line, and of allowing the enemy no respite. The storming of the Hindenburg Line itself would have been far too formidable an undertaking without the previous capture of its outer defences, containing the observation and artillery positions necessary for our main assault.

The attack on the outer defences began on 18th September.

the IX Corps attacking with the 6th Division on the right and the 1st Division on the left. The 409th Field Company put footbridges across the Omignon river, and these were later converted for horsed traffic by the 26th Company. Not much progress was made in face of the still opposition, and several determined counter-attacks against the 6th Division stopped its advance. Operations were resumed on 24th September, when the 46th Division had also come into the line. Opposition was again very strong, and not all the objectives were gained.

The preparations were, however, now sufficiently complete for the storming of the main Hindenburg Line. The chief obstacle on the front of the IX Corps was the St. Quentin canal, which ran underground between Bellicourt and Le Catelet. The main attack of the corps was against Bellenglise and the canal north of it, and was to be made by the 46th Division with the 32nd Division in support. The canal was fifty to sixty feet wide, with a depth varying from ten feet of water down to a few shallow pools. The water on the front of the 46th Division was almost at normal level, and the banks were high and steep. The artillery bombardment, however, had broken the sides of the canal in many places, and the debris formed useful ramps up which the infantry were able to scramble. Three thousand lifebelts had been sent up, and a number of rafts and light portable boats were prepared. Existing crossings consisted of the Riqueval bridge on the left, a narrow brick structure carrying an unmetalled farm road about fifty feet above the water, and on the right a low and narrow concrete dam. Between these there were several German foot-bridges just above water level. The enemy outposts were about 500 yards west of the canal.

The 46th Division advanced to the storming of the canal and the capture of Bellenglise with the Staffordshire Brigade (137th) in front, supported by the Lincoln and Leicester Brigade (138th) in its right rear, and by the Sherwood Brigade (139th) in its left rear. After seizure of the crossings by the Staffordshire regiments, the other two brigades were to follow through and to capture the remainder of the Hindenburg defences and the village of Bellenglise. The Staffordshire

Brigade, equipped with a ship's lifebelt per man, was prepared to force the crossing without any bridges. Attached to the brigade was the 466th Field Company (Major H. M. Fordham) with orders to give all practical assistance with portable footbridges etc. The 465th and 468th Field Companies (Majors Hardman and Lowbridge) were to follow up the leading brigade, to construct footbridges for the use of the supporting infantry, and to convert the narrow concrete dam into a crossing for horsed transport. The high and conspicuous Riqueval bridge was not expected to remain usable or repairable. On the right of the 46th Division the field companies of the 32nd Division were to build a girder bridge for lorries at the site of the main road-bridge.

Zero hour was at dawn on 29th September. There was thick mist with visibility sometimes as low as twenty yards, and it was not until the afternoon that it reached more than 200 yards. The 6th South Staffordshire Regiment crossed the canal north-west of Bellenglise, where it was almost dry. They took the enemy by surprise and swiftly overran the village, securing the tunnelled entrance to the extensive deep dug-outs and capturing many prisoners. The 5th South Staffordshire and 6th North Staffordshire Regiments, in the centre and on the left, found a considerable depth of water in the canal, and the banks were steep. They also, however, surprised the Germans and gave them no time to destroy their bridges, but these had been much damaged by the British bombardment. The first waves of infantry swam over, led by their officers with ropes; succeeding waves crossed on rafts and light portable boats, or scrambled over the damaged German bridges. The Riqueval bridge had been considerably damaged, and the Germans were in the act of blowing it up when it was rushed by a section of the 466th Field Company, and was quickly repaired and made temporarily passable for field guns; a most timely feat at a critical moment. When the 465th and 468th Companies arrived on the canal bank, they found that their cork-float bridges were not wanted, so they concentrated on the repair of the damaged German footbridges and converted the concrete dam for use by wheeled transport. The

138th and 139th Brigades soon followed, and the crossings were secured. The 32nd Division opened the Bellenglise road-bridge for motor traffic during the next day.*

The 1st Division did not reach the canal that day, but the 32nd Division, leap-frogging through the 46th, made good progress and captured Le Tronquoy. The artillery then moved forward to take up positions within reach of the main Hindenburg Line.

The Hindenburg Line was broken into between 30th September and 2nd October; and the Beaufort Line between 3rd and 5th October. Behind these, the Germans had no organized defence line, and the success of the Fourth Army was to be exploited by a general attack, fixed to start on 8th October, to carry the army forward to Le Cateau and across the river Selle.

The Selle was not a very formidable obstacle, but the ground on its eastern bank was closely hedged and broken with orchards; it afforded the enemy very good cover and protection for his innumerable machine-guns. On the western bank, the approaches were open to view and fire. The little river rises beside the village of Molain, south of Le Cateau, and flows in a northerly direction to the Scheldt at Denain. Its width, between St. Souplet and Le Cateau, is from fifteen to eighteen feet, and its depth from three to four feet, but it was at the time bordered by watery meadows extending from 100 to 200 yards on either side. In Le Cateau, it was about twenty feet with bricked-up banks.* "A topographical feature of special importance, as affecting the operations, was the high spur running in a south-westerly direction from Forest towards Montay. From this spur, excellent observation could be obtained up the valley of the river, and over the plateau east of it, and from it enfilade fire could be brought to bear on any troops attacking across the river."†

* From an account by Major Hardman, acting C.R.E., 46th Division; and from *The Story of the Fourth Army*, by Major-General Sir Archibald A. Montgomery, p. 759.

† *The Story of the Fourth Army*, p. 203.

‡ *Ibid.*, p. 205.

The crossing of this part of the Selle was the task of the II American and XIII British Corps, the latter having taken over the left wing of the Fourth Army from the III Corps. It contained the following R.E. units :—

XIII Corps (Chief Engineer, Brigadier-General C. A. Elliott):—

18th Division	C.R.E., Lieut.-Colonel C. B. O. Symons, with 79th, 80th and 92nd Field Companies.
25th Division	C.R.E., Lieut.-Colonel R. J. Done, with 105th, 106th and 130th Field Companies.
50th Division	C.R.E., Lieut.-Colonel P. de H. Hall, with 7th, 446th and 447th Field Companies.
66th Division	C.R.E., Lieut.-Colonel O. S. Davies, with 430th, 431st and 432nd Field Companies.
Corps Troops	144th, 283rd and 288th Army Troops Companies, No. 1 Siege Company, R. Anglesey R.E. and 180th Tunnelling Company.

The 50th Division was the only one in the line on 1st October; the other three were in corps reserve. It fell to the 50th Division to make the crossing of the St. Quentin canal at Vendhuile; farther south the canal had already been passed by the III Corps' operations. The 38th Division of the V Corps had already crossed the tunnel defences and were moving northwards through Gouy and Le Catelet. The 283rd A.T. Company under the C.R.E., 50th Division, erected an Inglis bridge at Vendhuile, while the 7th Field Company put over two foot-bridges and a medium pontoon bridge in the same village. The 446th and 447th Companies built a heavy bridge near the same spot.

The XIII Corps now made rapid progress over the open country between the St. Quentin canal and the river Selle. The 10th October found the 25th Division up to the western bank at St. Benin, and the 66th Division on the outskirts of Le Cateau. The 25th Division was now relieved by the 50th, and the passage of the Selle on the XIII Corps front was made by the 50th and the 66th Divisions on 17th October.

The 50th Division had all three field companies engaged

on the bridging; twenty infantry bridges were put across at St. Benin and St. Souplet. Of these, twelve were launched by the 446th Field Company, and four each by the 447th and 7th Companies. Favoured by a ground mist and covered by the smoke of the artillery barrage, the infantry quickly passed over the river. Le Cateau was to be encircled by the 66th Division from the north and by the 50th Division from the south, the troops meeting at the eastern exit of the town. The South African Brigade of the 66th Division was to cross by eight bridges thrown over the river immediately north of the town. In order to conceal this intention, feints were made to cross in the town itself.* The eight footbridges were put across by the divisional engineers and pioneers by 2 a.m. The South African Brigade formed up along the western bank, and as soon as the bridges were placed, sent patrols over to lie up in the enemy's wire entanglements on the opposite bank. In this forward position and covered by the mist, the brigade escaped injury from the enemy's barrage. As soon as it was known that the 50th Division had crossed higher up, the South Africans went over. The first waves met a succession of belts of wire entanglement and very strong opposition, but they found or made gaps, and fought their way up to the railway cutting. Meanwhile, the 198th Brigade cleared up the town of Le Cateau, and the bridgehead was firmly established.

On 21st October, the II American Corps was taken out of the line, and the IX and XIII Corps closed inwards. The 50th and 66th Divisions of the XIII Corps were now in reserve, and the 25th and 18th Divisions led the way. The 25th Divisional engineers had been employed on putting four heavy bridges across the Selle after the passage of the 50th and 66th Divisions. The sites were still under fire and a considerable number of casualties were incurred, especially by the 106th Field Company, which had two officers wounded, two other ranks killed and fifteen wounded. Since 3rd October, the field companies of the 25th Division had had seventy casualties.

The 25th Division now held a front facing north-east, from the eastern outskirts of Le Cateau to the north-eastern edge

* *The Story of the Fourth Army*, p. 222.

of Bazuel. Its task was to improve the roads and tracks up to the Le Cateau-Bazuel road, and to prepare for the next phase of the operations, which would include the crossing of the little brook Richemont, and the construction of bridges for artillery over the railway. The brook was narrow enough to be jumped in some places, but the fourteen footbridges prepared were carried forward and nine of them were put in place. The 130th Company had two men killed and eleven wounded in getting these across. The 105th Company built a trestle bridge near the Moulin du Garde, put two artillery bridges over the brook, and made two horse-watering points near by. The 106th Company cleared a block on the Le Cateau-Bazuel road where the railway bridge had been blown. The 18th Division crossed the Richemont brook farther north and pushed on towards Bousies.

There was no further big advance until the passage of the Sambre-Oise canal was made on 4th November, and the XIII Corps swung through the southern portion of the Mormal forest.

SAMBRE-OISE CANAL

To return to the IX Corps. They had further stiff fighting through Riqueval wood and Andigny forest before reaching the Sambre-Oise canal. The axis of the advance was now running in an E.N.E. direction with the canal and the forest of Mormal ahead. The canal ran east of several large villages, all of which formed strong centres of German resistance. Of these, Catillon and Ors lay in the path of the IX Corps.

Another general attack, embracing the Fourth, Third and First Armies was ordered for 4th November. The Fourth Army was now up to the Sambre Oise canal, and its passage was included in the first objective. The canal formed a considerable obstacle, "being some seventy feet in width from bank to bank and thirty-five to forty feet in width at water-level, except at the locks, which were only seventeen feet. It contained at that time from six to eight feet of water, and was nowhere fordable. The bridges had either been demolished or were prepared for demolition. The low ground on both sides of the canal had been

inundated by the Germans, and much of it had been transformed into a swamp. In some places the water (of the swamps) was only ankle-deep, but north and south of Ors, there were small streams parallel to the canal, swollen to a width of about fifteen feet and a depth of two to three feet; similar streams existed south of Catillon. Along each side of the canal between Oisy and Lock No. 1 there were wide reservoirs; at their northern end they are more than twice the width of the canal, and at that time contained a fair depth of water, but they were narrower and shallower farther south. South of Catillon, the enemy had felled the trees along the western bank of the canal for the double purpose of improving the field of fire and of forming an abattis.*

The IX Corps' frontage of attack extended for about seven and a half miles from Petit Cambrésis (south-east of Le Cateau) on the south to La Folie on the north. The 1st Division was on the right, and the 32nd on the left. Reconnaissance of the bridge sites and accumulation of materials had been going on since 23rd October. The following account of the preparations and launching of the bridges by the 1st Divisional engineers may be taken as typical of the work done in other divisions:—

The portion of the canal allotted to the 1st Division was that between Petit Cambrésis and Catillon. Several reconnaissances of this stretch were made by officers and N.C.Os. of the three field companies, and two localities for the crossings were selected; one at the lock about 2,000 yards north-west of Petit Cambrésis, the other at the bend in the canal about 1,200 yards farther north. At the lock site the span was 17 ft., with solid abutments, and there was a length of about 180 ft. available for the bridges. At the other site, the width of water was about fifty feet, with masonry walls on either bank. A brigade was detailed for forcing the passage at each of these places and the resulting bridgehead would be about 5,000 yards in perimeter.

The two sites each required a different treatment, but at both the bridging operations were to comprise first-wave infantry assault bridges, supplementary infantry bridges, bridges for pack

* *The Story of the Fourth Army*, p. 242.

transport, and finally, bridges for horsed transport and field artillery. In addition, a bridge for motor transport up to an 8-ton axle load was to be built close to the site of the demolished road bridge at Petit Cambr sis, and a bridge for tanks at the lock crossing. The 1st Divisional Engineers thus had a very full programme.

The first-wave infantry bridges for the lock were single-span wooden footbridges, as light as possible, to carry four to six men at a time. They were fitted with a lever and a pair of wheels so that they could be launched from the near abutment with no assistance from the far side. The supplementary infantry bridges were similar in design, but of stouter construction, and without the special launching device. The bridges for cavalry and pack transport were also similar in design, but were made in two longitudinal portions for convenience in carrying. The bridge for horse transport at the lock site was of simple single-span design, and would only be necessary if the site for the tank bridge was unsuitable for use in conjunction with the horse-transport route. The horse-transport bridges at Petit Cambr sis were to be made of standard pontoon equipment. The infantry assault bridges were to be carried up bodily from the assembly positions to the sites, so that no construction work should be necessary on arrival.

The infantry bridges at the northern crossing were floating bridges carried on German steel floats, of which eighty had been found in the pioneer park at Bohain, and were enough for four bridges. These floats were very light, and their shape was well adapted for sliding over mud. The bays of each bridge were hinged so as to give the maximum vertical flexibility in transit, and the head of each bridge was fitted with a ladder to enable the far bank to be scaled with ease. The supplementary infantry bridges had piers made of cork bales, petrol tins or barrels. Eighteen cork floats were provided by the IX Corps, from which two bridges were made; 700 petrol tins were supplied by the division, and made two more bridges; enough barrels, of various sizes from 26-gallon upwards, to make four bridges, were collected from neighbouring villages. There

was no shortage of timber, wire, rope, steel joists, wheels etc. As the bridges were completed, they were carried forward by night to the assembly positions. The tank bridge for the lock site was of the simplest design, and consisted of only two types of members, 10-in. by 5-in. steel joists and 9-in. by 3-in. decking. The only constructional work required at the site was the removal of the coping stones of the lock and the spiking down of the ribands.

The 2nd Brigade, with the 409th Field Company (Major G. de C. E. Findlay) was detailed to make the crossing at the lock site; the 1st Brigade, with the 23rd Field Company (Major W. G. Smith) to cross at the northern site; while the 3rd Brigade, with a section of the 26th Field Company (Major W. Shanks) was to capture Catillon and form a subsidiary bridgehead there. The remainder of the 26th Company was to build the horse-transport bridges at the lock site and at Petit Cambrésis. For the tank bridge, a section of the 1st Australian Tunnelling Company was allotted to the C.R.E. At the lock crossing, there were small streams on both sides of the canal. Preparations had been made for crossing them, and the necessary parties and bridges had been told off.

Zero hour was at 5.45 a.m. on 4th November. At that hour when the artillery barrage fell on the canal and its western bank, the 409th Field Company was carrying forward:—

8 footbridges for the subsidiary stream on the near side.

4 first-wave infantry bridges for the lock.

4 supplementary infantry bridges for the lock.

6 pack transport bridges (2 for each of the subsidiary streams and 2 for the lock).

8 footbridges for the subsidiary stream on the far side.

The leading bridge-carrying parties under Captain Rhind and Sergeant McLaren were well away at zero, and were some fifty to a hundred yards ahead of the infantry. As soon as the barrage had lifted from the canal, these parties moved forward, but Captain Rhind almost immediately fell severely wounded, and two or three other men were hit. For about half a minute

the area was unshelled. Then the enemy's barrage came down on a line about fifty to eighty yards west of the canal, with some shells falling on the canal bank.

The small stream west of the canal bank proved to be more of an obstacle than had been anticipated. Barbed wire had been entangled on the farther bank, roots and fallen trees obstructed the sites that had been selected and withering machine-gun fire from a ruined house near the lock caused heavy casualties among the carrying parties and the assaulting infantry. Some of the bridges intended for the lock had to be used for the smaller stream, and only one bridge finally reached the lock. This was successfully laid across by Major Findlay and two of his N.C.Os., the rest of the bridging party having become casualties. Major Findlay himself had been wounded, but he carried on and was the first to cross the lock; his efforts and coolness under heavy fire having steadied all who were near him. Lieut.-Colonel Dudley Johnson, commanding the 2nd Royal Sussex, the leading assault battalion, came forward as soon as the delay occurred, and personally collected men to help the sappers. As soon as the first bridge was over the lock he led his men across. The fine example and bravery of these officers gained for both of them the Victoria Cross.

The leading infantry now silenced the machine-guns in the lock-house, and the whole of the 2nd Royal Sussex crossed over, followed by a large part of the 2nd King's Royal Rifles. Meanwhile, a second assault bridge was brought up and successfully laid, followed a minute or two later by two of the supplementary bridges; and the bridges for the little stream east of the lock were then carried over. By 6.35 a.m., there were six footbridges over the lock, and at 7.45 a.m., the two bridges for pack animals arrived, together with some forty pack mules of the 2nd Royal Sussex. These bridges were completed by 8.30 a.m., including screens, and the pack animals crossed. Meanwhile, the section of the 1st Australian Tunnelling Company had come up with the materials for the tank bridge, and by 10.30 a.m. this was also completed. Finally, the horse-transport bridge was completed by 4.30 p.m.

Major Findlay, in spite of his wound, remained on the site till 10 p.m.

The 409th Company had suffered thirty-five casualties: one officer killed, three officers wounded, eleven other ranks killed, and twenty wounded. The officer casualties were 100 per cent of those present, and the other ranks were 45 per cent—grim evidence of the gallant performance of this fine company.

At the northern crossing, the 23rd Field Company met with less opposition. Their bridges reached the canal five minutes after zero. There was no enemy shelling, and practically no resistance except from one machine-gun post on the west bank. Sergeant E. Cook, of the 23rd Company, with Sapper G. F. Daycock, rushed this post, killing three Germans and capturing the other two. The sergeant then laid his bridge nine minutes after zero, and the 1st Cameron Highlanders began to cross. A minute later, the three remaining first-wave bridges were in position. Each bridge carried two sappers, who placed the storming-ladders on reaching the far bank, and went ashore to fix the anchorage. These leading sappers captured two enemy posts behind the east bank. The casualties of the 23rd Company were light: one sapper killed, and one officer, Lieutenant J. C. Pocock, and eight sappers wounded.

The 26th Field Company was divided up. One section accompanied the 3rd Brigade in its attack on Catillon, another was sent to reinforce the 409th Company at the lock after their heavy casualties, and the other two sections went to Petit Cambrésis to build the pontoon bridges for horse transport. In the evening, the company took over the maintenance of the bridges at the lock as well as their own at Petit Cambrésis.

These bridging operations were the last actions of the 1st Divisional engineers, for next day the division was withdrawn to rest.*

* This account is based on the C.R.E.'s report; an article in the *R.E. Journal*, August, 1922, by Lieut.-Colonel C. E. P. Sankey; *History of the 23rd Field Company, R.E.*, by Captain R. L. Bond; and *The Story of the Fourth Army*, by Major-General Sir Archibald A. Montgomery.

North of the 1st Division, the 32nd Division had to make the crossing of the canal between Catillon and La Folie, which included an awkward elbow in the canal close to the eastern end of the Bois de l'Evêque. The 14th Brigade was ordered to cross just south of Ors, and the 96th Brigade immediately south of the elbow. The crossings were to be covered by a powerful artillery barrage and a smoke screen. The 206th Field Company was to put the bridges across for the 14th Brigade, and the 218th Company for the 96th Brigade.

As soon as the attack began, the enemy put down a heavy barrage on Ors, but in spite of this the 206th Company succeeded in getting two petrol-fin footbridges across twenty-five minutes after zero. The company also built a horse-transport bridge by 10 a.m. This enabled the 1st Dorsets to cross. The 96th Brigade met with very severe artillery and machine gun fire, and the bridge detachments suffered heavy casualties. Two footbridges on cork floats were put across, but were almost immediately smashed. Two of the 218th Company's officers, Lieutenants Oakes and Barker, were killed, and two others wounded. Major A. H. S. Waters, who commanded the company, took charge, and by his personal efforts, backed up by Sapper Adam Archibald, succeeded in restoring one of the bridges under almost point blank machine-gun fire in addition to the heavy artillery barrage. Both were awarded the Victoria Cross. The rest of the detachments were all killed, wounded, or gassed. So hot had been the fire at this crossing, that the 96th Brigade had had to break off the attempt, and make use of the crossing effected at Ors by the 14th Brigade.* They began to cross at 8.30 a.m., and soon both brigades were making headway on the eastern bank.

The day's operations were a brilliant success. The IX Corps had completed its crossing, and the Fourth Army's bridgehead over the canal was some three miles deep on a front of fifteen. By this time, supply difficulties were becoming acute, but a few more days of pursuit brought the corps to near the Avesnes Maubeuge road, where their operations came to a victorious conclusion.

* *The Story of the Fourth Army*, p. 251.

Meanwhile, preparations had been going on in the XIII Corps for the passage of the canal. These included, on the front of the 25th Division, the clearance of the block at Bazuel (just east of Le Cateau), where the Germans had blown up a railway bridge. This entailed work by day and night, shared by the 106th Company of the 25th Division and the 7th Company of the 50th, both assisted by a company of pioneers. The heavy girders of the bridge, weighing about 400 tons, had fallen lengthwise in the road, and the abutments had fallen on the top, presenting a formidable task for the lightly equipped field companies. It was decided to cut up the girders with explosives, and to remove them piecemeal. Calculated cutting charges were quite ineffective, and far larger ones had to be used, with the object of blowing whole segments of the bridge out of the way. Even so, the remaining pieces weighed about two tons, and had to be hoisted from the road with a derrick and tackle. The work took four days, using 10,000 lb. of gun-cotton and German perclite. It was an unusually heavy obstruction, and it would seldom happen that two whole field companies could be spared for one such task, but it proved what could be done with very little means.*

The XIII Corps was to cross the canal with the 25th Division on the right, and the 50th Division in the centre, while the 18th Division on the left advanced through the Mormal forest. The 66th Division, in reserve, was to pass through the 25th Division when the latter had captured Maroilles. The 25th Division was to cross opposite Landrecies, capture the town and push on to capture Maroilles. The 50th Division was to clear the southern corner of the Mormal forest, then cross the canal and advance eastwards in conjunction with the 66th Division. The chief problem would be the crossing at Landrecies, as a bridgehead there would facilitate the passage by the 50th Division.

An account of the crossing by the 25th Division is given in some detail, as it was the last R.E. operation of magnitude in the XIII Corps.

The canal at Landrecies was known to be about fifty-five

* Account based on the report by the C.R.E. 25th Division.

feet wide, with a depth of water of six to seven feet. There was a lock in the town, which had the normal width of seventeen feet. According to the air photographs, the main bridge was still intact, but it was reported to be mined. North-east of the lock, the Germans had built a wooden horse-transport bridge, and south of the lock they had three single-plank infantry bridges. The ditches outside the canal bank were said to be up to nine feet wide, three feet deep and very muddy. They did not appear to have much water in them, but it was possible that they would have to be bridged, and material would have to be carried up for them. The course of the old river running on the north-west side of the canal presented an additional obstacle. This was twenty feet wide and four or five feet deep. The ground between it and the canal was said to be marshy and unfit for wheeled traffic, thus restricting sites for pontoon bridges.

It was decided that the only way to put the first waves of infantry over quickly was by using rafts. The only available equipment seemed to be a limited number of cork bales. These had been tried by the 46th Division at their crossing of the St. Quentin canal at Bellenglise, but had been found very heavy, requiring eight men per raft. To carry enough of these over one and a half miles of difficult ground did not seem feasible where speed and surprise were necessary. Trials had been made elsewhere with petrol tins, and it was, therefore, decided to make up rafts with these. Three thousand tins were indented for, and the 105th Field Company (Major F. W. Richards) was detailed to make a pattern. It was proposed to put 200 infantrymen across in each wave, and eighty rafts were ordered, in the hope that forty or fifty would survive the journey to the canal, and by working these backwards and forwards as ferries, enough men would be carried to secure a footing on the opposite bank. In order to be able to use the rafts subsequently as a bridge, a light superstructure was made up in bays of five feet so that the weight of not more than one man would come upon each raft. A raft consisted of two floats, each of eight tins. The weight, with superstructure, was 95 lb., with an available buoyancy of 220 lb.; there was thus a margin

to allow for two tins being perforated by bullets. Each raft carried a wooden paddle and a pair of lashings. A preliminary trial was made at Honnechy, and a demonstration, made on the river Selle at St. Benin on the afternoon of 2nd November, when an infantry platoon was successfully ferried across, proved that the project was feasible, and gave the infantry confidence. Although such a type of assault bridge is now commonplace, it must be remembered that at the time the equipment was an entire novelty, and much of the subsequent success of the operation was therefore, due to the careful preparations and rehearsal.

The 75th Brigade was to make the crossings at Lambocies. The 105th Field Company was to provide three separate bridging parties :

No. 1 party to bridge the old river with three floating bridges (fifteen rafts).

No. 2 party to bridge the canal between the lock and the divisional right boundary (thirty rafts).

No. 3 party to bridge the canal between the lock and the divisional left boundary (thirty-five rafts).

Each raft had two pioneers to carry it, and one sapper with a hand-axe to cut gaps in hedges, to assist in carrying and to paddle the raft on its first journey. Each bridging party was in the charge of an R.E. officer, and was subdivided into groups of five rafts, each group under a sapper N.C.O.

On nearing the canal, the groups were to spread out so that the rafts would be about twenty yards apart along the whole front of the crossing. The rafts would then be launched, the sapper on each raft would paddle himself across and the pioneers ashore pay out the rear line. On reaching the opposite bank the sapper would make fast the front lashing, and then the raft would be pulled backwards and forwards with an infantryman on each trip. As soon as the first wave of 200 men was across, the rafts were to be collected and formed into complete footbridges.

The 106th Field Company (Major C. G. Lynam) was detailed

to make two pontoon bridges for field artillery, one on each side of the lock and to act as reserve under the C.R.E.

All the materials were ready by 2nd November, and during the night were carried forward and dumped in three separate places near the assembly positions. The night was very dark, with heavy rain, and there was considerable shelling. One wagon was hit and the three drivers wounded, but only five of the rafts were damaged. These were replaced, and the three dumps were completed at 4 a.m.

On 3rd November, the 105th Field Company with three companies of the divisional pioneers, moved up to the village of Pommereuil. After dusk, they moved to their assembly positions, and distributed their rafts from the dumps. The two portable bridges for the lock made by the 106th Company were also brought up by their carrying parties of six sappers each.

As late as 2nd November, it was known that the German bridges over the canal were intact. The road bridge at Landrecies was known to be mined, and probably the others were as well, but it was worth while making an attempt to save them. For this purpose, the C.R.E. decided to use his section of the 182nd Tunnelling Company. Two parties of three sappers each were to rush the horse-transport bridge and the footbridges north-east and south-west of Landrecies respectively; and one N.C.O. and ten sappers were to rush the main bridge. These parties took up their assembly positions with the others, and all was in readiness by midnight.

The attack started at 6.15 a.m. on the 4th in a thick fog. The R.E. and pioneers were assembled close behind the infantry, the intention being that as the advance proceeded, these parties should drop back to about 300 yards behind the leading wave, but owing to the fog and to the numerous hedges that were encountered, many of the carrying parties became mixed up with the leading infantry, and they even took some German prisoners. The sappers with their hand-axes were found to be very useful in clearing gaps in the hedges. On the right, the 5th Gloucesters advanced well up to the barrage until they arrived at the railway, but here they met much opposition until two tanks arrived and drove the enemy out. The advance

then went on without a check. The old river was reached and the bridge over it was found to be intact but mined. Sergeant Wood, R.E., and a sapper were the first to reach it, and they withdrew the charges. No. 1 bridging party (under 2nd Lieutenant A. L. Armstrong, 105th Field Company) put two of their floating bridges across, in addition to the German bridge, keeping the third as spare. These floating bridges were used by the infantry in preference to the existing bridge, because they were lower and therefore less exposed to machine-gun fire. The 5th Gloucesters crossed the river and reached the canal, to which Armstrong's party carried the twelve rafts not wanted on the river. On arrival at the canal, one of the three single-plank bridges was found intact, but the other two had been smashed by the Germans. The 5th Gloucesters started to cross, and Lieutenant Armstrong seeing that rafting would not be unnecessary, proceeded to build his bridges.

No. 2 bridging party (under 2nd Lieutenant C. S. Wells) reached the canal soon after No. 1 party, with seventeen rafts intact. These were boomed out and two floating bridges were quickly made. No. 2 party also repaired one of the two broken bridges. The 5th Worcesters now crossed and the Bridgehead began to take shape. The infantry advanced towards their objective, outflanking Landrecies on the south-west.

Meanwhile, the main road-bridge in Landrecies was still standing. The party of tunnellers tried to save it, but were delayed by the enemy who were holding the houses on the north-west side of the canal. At 10.30 a.m., the bridge blew up, and the German who fired the charge galloped off on a horse. The tunnellers immediately attacked the garrison, killing several and taking fifteen prisoners. When the lock was reached it was found to be intact, and the parties of the 130th Company put their two footbridges across.

On the left, the 8th Warwicks had a longer advance over very difficult ground, and could not keep up with the barrage, but, in time arrived near to the canal. Here 2nd Lieutenant J. M. Petty, R.E., 105th Company, in charge of No. 3 party, had a difference of opinion with an infantry company commander concerning the best line of approach, but he obtained

from him a platoon without an officer. These he took straight to the railway embankment, and leaving the infantry platoon to cover his advance he led his own party to the canal bank. One of his groups of five rafts had gone astray and did not arrive till later, but he had thirty rafts with him, of which four were unserviceable through bullet holes. His party was the first to reach the canal, and the rafts were quickly launched. The sappers paddled them across under machine-gun fire from the houses in Landrecies with only two casualties. As soon as the infantry arrived, they were ferried over, the first company crossing in ten minutes. As soon as there appeared to be no more infantry ready to cross, 2nd Lieutenant Petty collected his rafts and formed two footbridges, which were used later by the rest of the 8th Warwicks. The horse-transport bridge near Landrecies was found to be intact but damaged, and three sappers of the 182nd Tunnelling Company withdrew the demolition charges. The advance then continued and many more prisoners were taken in Landrecies. In due course the whole objective was captured and consolidated, and an outpost line established in front of it.

Meanwhile, the 106th Field Company was waiting for orders to bring up the two pontoon bridges for the lock, but as no reports had reached the C.R.E. by 10 a.m., the C.O., Major Lynam, went forward to see for himself. He found that pontooning was possible, and sent back orders for his bridging parties. This message also went astray but the parties eventually received orders to start. The sappers soon reached the bridge sites, but as the wagons met heavy shelling on the approach roads and were delayed, work did not start till about 4 p.m. The two bridges each required two trestles and three pontoons, and were completed for traffic by 8.30 and 10.30 p.m. The 106th Company also repaired the German horse-transport bridge at the same time. The bridge for tanks at the lock was built by the XIII Corps troops, and was completed about 2 p.m. next day.

The foregoing account, taken from a report by the C.R.E., 25th Division, gives another example of the success which attends careful preparations and rehearsal. It also shows

the initiative and good leadership of the junior R.E. officers concerned. The operations were typical of the work of divisional engineers during the final stages of the great advance.

There was more bridging ahead of the 25th Division in order to cross the Petite Helpe and Grande Helpe rivers. The C.R.E. borrowed the pontoon equipment of the 66th Division, with which the 130th Company built a bridge over the Petite Helpe near Maroilles. Two cork float footbridges were also put across at the same place on 5th November. On 6th November the 105th Company bridged the Grande Helpe at Taisnières with pontoons, and afterwards replaced them with a trestle bridge. On 7th November the 106th Company, with the 283rd A.T. Company, built an 84-ft. span Inglis bridge at Maroilles. The 106th Company also built a heavy A-type bridge at the same place on 9th and 10th November.

The Fourth Army operations had provided the R.E. field units with a wide variety of works, the chief of which were the rapid opening up of roads and bridges, and carrying forward the water-supply. That the advance maintained its pace and vigour was as much due to the success of the bridging operations and the clearing of roads as to the regular supply of rations and ammunition, which itself depended upon the work of the engineers.

OPERATIONS OF THE THIRD ARMY

To the north of the Fourth Army, the Third Army played a large part in the victorious operations which led up to the Armistice. It held the front from the Fourth Army's left flank on the Ancre up to the river Scarpe. It did not take part in the battle of 8th August, but as soon as the battle of Amiens was over, Sir Douglas Haig decided that a successful attack between Albert and Arras in a south-easterly direction would turn the line of the Somme south of Péronne. Preparations were therefore made for a thrust by the Third Army towards Bapaume.

The Army consisted at this time of the V, IV and VI Corps, from south to north. The R.E. units in these corps were:—

V Corps (Chief Engineer, Brigadier-General A. G. Stevenson):—

38th Division	C.R.E., Lieut.-Colonel T. E. Kelsall, with 123rd, 124th and 151st Field Companies.
21st Division	C.R.E., Lieut.-Colonel G. Master, with 97th, 98th and 126th Field Companies.
17th Division	C.R.E., Lieut.-Colonel F. A. Ferguson, with 77th, 78th and 93rd Field Companies.
Corps Troops	147th, 280th and 559th Army Troops Companies, 175th, 178th and 183rd Tunnelling Companies.

IV Corps (Chief Engineer, Brigadier-General C. M. Carpenter):—

37th Division	C.R.E., Lieut.-Colonel R. D. Jackson, with 152nd, 153rd and 154th Field Companies.
42nd Division	C.R.E., Lieut.-Colonel J. G. Riddick, with 427th, 428th and 429th Field Companies.
5th Division	C.R.E., Lieut.-Colonel E. E. F. Homer, with 59th, 491st and 527th Field Companies.
63rd Division	C.R.E., Lieut.-Colonel J. A. Graeme, with 247th, 248th and 249th Field Companies.
Corps Troops	142nd, 149th and 7th R. Monmouth Army Troops Companies. 179th and 252nd Tunnelling Companies.

VI Corps (Chief Engineer, Brigadier-General R. N. Harvey):—

Guards Division	C.R.E., Lieut.-Colonel E. F. W. Lees, with 55th, 75th and 76th Field Companies.
2nd Division	C.R.E., Lieut.-Colonel P. K. Betty, with 5th, 226th and 483rd Field Companies.
3rd Division	C.R.E., Lieut.-Colonel R. P. Pakenham-Walsh, with 56th, 438th and 529th Field Companies.
52nd Division	C.R.E., Lieut.-Colonel L. F. Wells, with 410th, 412th and 413th Field Companies.
56th Division	C.R.E., Lieut.-Colonel E. N. Mozley, with 416th, 512th and 513th Field Companies.

59th Division	C.R.E., Lieut.-Colonel L. J. Coussmaker, with 467th, 469th and 470th Field Companies.
Corps Troops	546th and 547th Field Companies (ex 73rd Division), 132nd, 232nd and 565th Army Troops Companies, No. 2 Siege Company, R. Anglesey R.E., 174th, 177th and 181st Tunnelling Companies.

On 21st August, the battle of Albert began. This was a limited attack by the Third Army, in conjunction with the left wing of the Fourth, to gain the general line of the Albert-Arras railway. The assault was delivered by the 42nd, New Zealand and 37th Divisions of the IV Corps, and the 2nd and Guards Divisions of the VI Corps. These divisions soon carried the enemy's foremost defences, and the 5th and 63rd Divisions of the IV Corps and the 3rd Division of the VI Corps then passed through and continued the advance. They reached the line of the railway on practically the whole front, capturing Achiet-le-Petit, Logeast Wood, Courcelles and Moyenneville, while the 21st Division of the V Corps cleared the north bank of the Ancre about Beaucourt. On 22nd August, Albert was captured by the 38th Division working in conjunction with the III Corps, and the line was advanced well to the east of the Bray-Albert road.

These preliminary attacks cleared the way for the main operation which began on 23rd August, and engaged both the Third and Fourth Armies. The 38th Division, as before, worked in close co-operation with the III Corps, and the other divisions of the Third Army (17th and 21st of the V Corps; 42nd, New Zealand, 5th and 37th of the IV Corps; and the 2nd, 3rd, Guards, 56th and 52nd of the VI Corps) attacked at different hours during the morning along the whole front north of Albert. They met with immediate success. The 17th and 21st Divisions made progress along the left bank of the Ancre north of Thiépval. Farther north, the 3rd Division took Gomicourt. The attack spread along the IV Corps front. The enemy's main line of resistance was stormed, Bihucourt,

Ervillers, Boyelles and Boiry-Bocquerelle were captured, and the troops were closing down on Bapaume from the north and north-west.

Next day, the 24th, the same divisions again moved forward and pressed the enemy back rapidly. The 38th Division captured Thiépval ridge, wading breast-high through the Ancre; the V Corps gained Pozières, Courclette and Martinpuich; The 42nd Division took Pys and Miraumont; The 5th Division having captured Irlès, cleared Loupart Wood; The New Zealand Division took Grevillers and assisted in the capture of Bielvillers by the 37th Division. Farther north, the Guards Division gained St. Leger; the 56th Division had heavy fighting about Croisilles; and the 52nd Division took Henin-sur-Cojeul and obtained a footing in St. Martin.

In all these operations the work of the field companies was of the usual type: road clearing, discovery and cleaning of wells, and clearing of mines and booby traps. There was no bridging to be done. The companies were continually on the move. After the first day's attack, a series of strong-points was built and wired as a reserve line in case of counter-attack, but strong-points were at last beginning to drop out of the programme.

On 29th August, Bapaume was evacuated by the Germans, and promptly occupied by the New Zealand Division. The second stage of the British offensive was brought to a close on 1st September and the Third Army had twelve days' respite. On 12th September, the IV and VI Corps attacked in the Havrincourt sector, with the New Zealand, 37th, 62nd and 2nd Divisions. Truseault and Havrincourt were taken.

On 27th September, the battle of the Canal du Nord* began. On the First and Third Army fronts the enemy still held strong positions covering the approaches to Cambrai between the Nord and Scheldt canals, including the section of the Hindenburg Line itself north of Gouzeaucourt. At 5.30 a.m. the Third and First Armies attacked with the IV, VI, XVII and Canadian Corps in the direction of Cambrai from Gouzeaucourt and Sauchy-Lestrée. The northern portion of the canal was too

* Not marked on 1/250,000 map. It ran north and south, passing west of Havrincourt and east of Mœuvres and Inchy.

great an obstacle to be crossed in the face of the enemy. It was therefore necessary for the attacking divisions to force a passage on a narrow front about Mœuvres, and thereafter turn the line of the canal farther north by a divergent attack developed fanwise from the point of crossing.*

The attack proceeded according to plan from the start. On the right, strong resistance was encountered at Beaucamp and several counter-attacks were made, but the 5th and 42nd Divisions of the IV Corps established the right flank between Beaucamp and Ribecourt. The 3rd Division moved forward with the Guards Division and forced the crossings of the canal in face of heavy machine-gun fire. In the centre, the 52nd Division, crossing the dry bed of the canal below Mœuvres, gained the high ground overlooking Graincourt. On the left, the 63rd Division and the 4th and 1st Canadian Divisions had similar success. The 57th Division passed through and carried the line forward east of Anneux to Fontaine.

The XVII Corps had meanwhile been transferred from the First to the Third Army. The R.E. order of battle in this corps was :

XVII Corps (Chief Engineer, Brigadier-General W. D.

Waghorn) :—

52nd Division	C.R.E., Lieut.-Colonel L. F. Wells, with 410th, 412th and 413th Field Companies.
57th Division	C.R.E., Lieut.-Colonel H. La T. Campbell, with 421st, 502nd and 505th Field Companies.
63rd Division	C.R.E., Lieut.-Colonel J. A. Graeme, with 247th, 248th and 249th Field Companies.
Corps Troops	549th Field Company (ex 73rd Division), 232nd Army Troops Company, No. 2 Siege Company R. Anglesey R.E., 177th and 178th Tunnelling Companies.

At the end of the day, the divisions had reached the general line Beaucamp-Ribecourt-Fontaine Notre Dame, with the First Army continuing the line to Oisy. The next obstacle to be crossed was the Scheldt (Escaut) canal, running just

* Sir D. Haig's Dispatch of 21st December, 1918.

west of Cambrai. On 28th September, the Third Army captured Masnières and secured the crossings of the canal between there and Cambrai. The 63rd Division, with its bridging equipment supplemented by that of the 57th Division, had built bridges for infantry and pack transport across the canal and the old river during the previous night, and crossed east of Canraing. The bridges were then supplemented by the rapid repair of the old road bridge a mile south-west of Fontaine, by a pontoon bridge close by, and a heavy timber bridge (to carry 60-pounder guns) across the two locks near the road bridge.

The C.R.E. 57th Division, deprived of his bridging equipment, was ordered to put a bridge for field guns across the canal, north of the 63rd Division's bridges. An old barge was found, road bearers were cut from the wood close by, and planking for the deck was taken from neighbouring houses. The sappers (two sections of the 502nd and 505th Field Companies) worked until 1 a.m., and the bridge was ready for the guns. The XIII Corps had meanwhile ordered up the bridging equipment of the 52nd Division to help the 57th Division, and with this the 502nd Company built two pontoon bridges east of Fontaine Notre Dame.

By 13th October, the Third Army had reached the river Selle at all points between Le Cateau and Haspres, and had established bridgeheads at a number of places. On 20th October seven divisions, the 38th, 17th, 5th, 42nd, 62nd, Guards' and 19th, from right to left, attacked the river line, and after heavy fighting about Neuville Amerval, Solesmes and Haspres, forced the crossings and established a line east of the river. The crossings were made on infantry assault bridges, followed by pontoons or trestles for the field artillery and horse transport. Very few details of these operations are available, but all preparations for the work were completed in time, and the portable bridges, from thirty-five to forty feet in span, were placed in position by the field companies during the night.

As a typical account of the R.E. work done in the Third Army during these final weeks, the experiences of the 37th Divisional Engineers are given here at some length.—

For the attack on 23rd October the field companies were

north-west of Le Cateau, disposed as follows: the 152nd Company at Béthencourt; the 153rd at Viesly; the 154th at Briastre. C.R.E.'s headquarters were at Briastre. There were two small rivers, the Harpies and the St. Georges, within the divisional objectives. They ran north-west, between Solesmes and Le Quesnoy. The task of crossing these and making approaches for infantry and field guns was allotted to the 152nd and 154th Companies, who were also to erect watering troughs and tanks along the rivers. The 153rd Company was to bridge the St. Georges with a double bridge for heavy guns, strengthened to take tanks on one half only—a curious variation from the usual type. Portable bridges were collected from those used on the river Selle, and cork bales for assault crossings were drawn from the corps reserve. The divisional dump was moved forward to Briastre.

When the bridging parties arrived at the Harpies, they found two brick bridges only slightly damaged, but a trestle bridge was built by the 154th Company and twenty footbridges were also put across. The St. Georges river was not reached until later in the day, and the main road crossing was not clear of the enemy until later still. A few footbridges were put across that night. The main bridge was still standing but was badly shaken. However, a few field guns and some R.E. bridging wagons were passed over it next morning.

The next day's advance included the little river Ecaillon. This had been reported as a considerable stream with bridges from twenty-seven to thirty-three feet span. It was, in fact, found to be insignificant, and the spans were 2.7 and 3.3 metres respectively: an instance where the little decimal point and the confusion of units might have meant a serious calamity had the mistake been the other way round. The lighter bridges over the Ecaillon were the task of the 154th Company; the 152nd Company went forward with the 112th Brigade, while the 153rd Company had the tank and lorry bridges to build over the St. Georges and Ecaillon streams. As quickly as possible, the Weldon trestle bridges were replaced by trestle bridges made from tree trunks, beech slabs and salvaged mining timber, and the Weldon trestles were recovered.

By the evening of the 24th, the division had gained a line to the north and east of Ghessignies, and it was decided to consolidate this before continuing the advance. A series of small posts was dug by the pioneers and wired by the 152nd Field Company. Work in the valley of the Ecaillon was under heavy gas and shell-fire, and had to be carried out almost entirely in respirators. Much work was done to make the troops more comfortable, and it is interesting to note that in the midst of these active operations, bath-houses were improvised in Salesches, Neuville and Hirson. Improvements in billets and gas-proofing of dug outs were in the programmes of all the companies.

On 1st November, preparations were begun for the next, and final, stage of the advance. Light portable bridges were made and existing ones collected, water supply equipment and Weldon trestles were mobilized, and notice boards and other stores for marking out tracks were prepared. Girder suits for heavy bridging were found and arrangements made for collecting them. The river crossing at Vendegies-au-Bois was doubled by the construction of a plank and brick deviation. The country was now becoming more closely set with hedges and orchards, and the great forest of Mornel lay in front. Arrangements for the clearing of tracks for the infantry and artillery therefore became of the first importance.

The new attack was fixed for 4th November. The 152nd Company was charged with clearing tracks for the 112th Brigade during the attack; the 153rd Company had to clear two roads forward for the field artillery; the 154th Company were to build the light footbridges and any heavy bridges that might be required. No heavy bridge was known to be necessary, but a railway bridge was reported destroyed on the road to Le Quesnoy, and a demolition party from the 154th Company was attached to the pioneers for any clearing work which might be required. Sections from the 153rd and 154th Companies were detailed for water supply; and a section of the 252nd Tunnelling Company was available to search for mines.

The 152nd Company carried out its programme, working continuously from 5 a.m. on 4th November to 7.30 a.m. on the

5th, when the troops of the 5th Division passed through the forest of Mormal right up to the outpost line.

The 154th Company found that the destroyed railway bridge on the Ghisignies-Le Quesnoy road was a heavier task than had been anticipated. The gap was fifty feet but the abutments were sound. Some extra long timber was demanded from the IV Corps and was received the same night. The chief difficulty was the removal of the debris to allow trestles to be erected. The abutments had also to be carefully searched for delay-action mines. But the bridge was passable for traffic by 10 a.m. on 7th November. All the available pioneers were employed on a temporary diversion for lorries through Louvignies. On 8th and 9th November the field companies moved forward to build a heavy bridge for lorries at Baussières. The C.R.E.'s report ended with the note: "the pre-war organization and equipment of the field companies was proved sound, and entirely stood the test of the class of operations for which it was intended."

One of the last V.C.s. of the war was awarded to Major B. M. Cloutman, commanding the 59th Field Company, 5th Division. On 6th November, after reconnoitring the river crossings at Pont-sur-Sambre, Major Cloutman found the Quartes bridge almost intact but prepared for demolition. The bridge and its approaches were swept by artillery and machine-gun fire at close range. Leaving his party under cover, he went forward alone, swam across the river, and having cut the leads swam back again. Unfortunately the Germans managed to blow up the bridge later in the day by other means, but the abutments remained sound.

OPERATIONS OF THE FIRST ARMY

The First Army came into the general scheme of the final offensive on 26th August, when it began the battle of the Scarpe (26th to 30th August). At that date, the Army consisted of: the Canadian Corps (4th and 51st British Divisions, and 1st, 2nd, 3rd and 4th Canadian Divisions); the XXII Corps; and the VIII (formerly the XVIII) Corps. The R.E. Order of Battle was as follows:

Canadian Corps

- 4th Division C.R.E., Lieut.-Colonel C. R. Johnson, with 9th, 406th and 526th Field Companies.
- 51st Division C.R.E., Lieut.-Colonel N. W. Napier-Clavering, with 400th, 401st and 404th Field Companies.

XXII Corps (Chief Engineer, Brigadier-General A. E. Panet):—

- 11th Division C.R.E., Lieut.-Colonel F. A. K. White, with 67th, 68th and 86th Field Companies.
- 51st Division Transferred from Canadian Corps on 29th August.
- Corps Troops 217th Army Troops Company, 172nd and 176th Tunnelling Companies.

VIII Corps (Chief Engineer, Brigadier-General H. G. Joly de Lotbinière):—

- 8th Division C.R.E., Lieut.-Colonel C. M. Browne, with 2nd, 15th and 490th Field Companies.
- Corps Troops 282nd, 290th and 560th Army Troops Companies, No. 1 Siege Company R. Monmouthshire R.E., 185th Tunnelling Company.

The Army had recently transferred the XVII Corps to the Third Army and the XIII Corps to the Fourth Army. It now attacked with its right wing with a view to turning the enemy's position on the Somme by a drive eastwards from Arras cutting the German railway communications.

At 3 a.m. on 26th August, the Canadian Corps attacked astride the Scarpe with the 2nd and 3rd Canadian Divisions and the 51st Division. By noon, Wancourt and Guémappe had been taken, and also the prominent hill and village of Monchy-le-Preux, which had for so long been the scene of fierce struggles in 1917. North of the Scarpe, the 51st Division pushed forward towards Roeux and captured Greenland Hill. The First Army followed up its success next day by the capture of several more villages, and at the end of the month, had cleared the area between the Scarpe and Sensée rivers as far as the Trinquis brook. This success brought the troops within

assaulting distance of the Drocourt-Quéant Line.* The British Divisions engaged were the 4th, 8th and 51st.

The storming of the Drocourt-Quéant Line (2nd and 3rd September) was carried out by the First Army and by the XVII Corps of the Third Army. The Canadian Corps included the 4th British Division (which was relieved on 3rd September by the 1st British Division) : the XXII Corps had only the 11th Division. "The attack was a complete success; by noon, the whole of the elaborate system constituting the Drocourt-Quéant Line on the front of our advance was in our hands."†

The next operation on the Army front involved the crossing of the Canal du Nord,‡ between 27th September and 1st October. The canal had not yet been completed and parts of the bed were dry, but everywhere it formed a serious obstacle, which the Germans had made the most of with their machine-guns and wire. The attack was made with the Canadian Corps, which again included the 11th Division, and the XXII Corps (4th and 56th Divisions). The Canadians crossed near Moeuvres, and with the 11th Division, turned north-eastwards and took Haynecourt, Epinoy and Oisy-le-Verger. The 56th Division, waiting until the Canadians had passed Marquion, made its crossing between that village and Sauchy-Cauchy. Beyond the canal and running parallel to it there was the little river Agache, which had to be bridged. These operations were successfully carried out by the 416th, 512th and 513th Companies, using cork rafts and their own pontoon equipment. During the next three days, the First Army made further good progress, and ended the month of September with the Canadians close up to Cambrai.

The Second Battle of Cambrai (8th and 9th October) involved the Canadian and XXII Corps of the First Army, but

* Sir D. Haig's Dispatch of 21st December, 1918. This line ran from a point in the Hindenburg line about eleven miles west of Cambrai, passing about seven miles west of Douai and joining the main front east of Armentières.

† Sir D. Haig's Dispatch of 21st December, 1918.

‡ Not shown on 1/250,000 map. It runs roughly north and south, passing about eight miles west of Cambrai.

it was the progress of the Third and Fourth Armies which caused the Germans to evacuate the town; the Canadians and the 57th Division entered it on the 9th.

The Victoria Cross was posthumously awarded to Corporal James McPhie, 416th (City of Edinburgh) Field Company, 56th Division, who was in charge of a small party maintaining a cork-float bridge across the Senece canal, near Aubencheu-aux-Bains, on 14th October. Just before dawn, the troops crossing the bridge were met with close machine-gun fire and became so crowded that the bridge began to sink and break up. Accompanied by a sapper, Corporal McPhie jumped into the water and attempted to hold the cork and superstructure together, but was unable to do so. McPhie then swam back, and having reported the broken bridge, obtained materials for repair. It was now daylight, but although he knew that the bridge was under close fire and that the far bank was in German hands, he led the way on to it, axe in hand. He was at once severely wounded, falling partly into the water, and died after receiving several further wounds. His magnificent example ensured touch with the patrol on the enemy's bank.

On 20th October the First Army crossed the Selle north of Haspres, the 4th and 51st Divisions (XXII Corps) attacking the river line north of Le Cateau, and making the crossings. These two divisions made further progress on the 24th, carrying the line northward to the Scheldt. A further blow was struck at the enemy on 1st November, when the First Army attacked on a front of six miles south of Valenciennes with the XXII and Canadian Corps. During 1st and 2nd November, the 49th and 4th Divisions of the XXII Corps crossed the Rhonelle river, capturing Maresches and Préseau. Passage over the next rivers, the Aunelle and the Honnelle, encountered stiffer resistance, and the 11th and 56th Divisions were pressed back slightly. On 6th November the opposition was overcome and the First Army continued its advance. On 11th November the 3rd Canadian Division captured Mons, and the First Army had reached its starting point of the war.

During the period 8th August to 11th November, the

divisional R.E. units engaged in the First Army, in addition to those already mentioned were as follows :—

VIII Corps

- | | |
|---------------|--|
| 20th Division | C.R.E., Lieut.-Colonel E. M. Newell, with 83rd, 84th and 96th Field Companies. |
| 58th Division | C.R.E. Lieut.-Colonel A. J. Savage, with 503rd, 504th and 511th Field Companies. |

XXII Corps

- | | |
|---------------|---|
| 4th Division | See above. |
| 11th Division | See above. |
| 56th Division | C.R.E., Lieut.-Colonel E. N. Mozley, with 416th, 512 and 513th Field Companies. |
| 49th Division | C.R.E., Lieut.-Colonel D. Ogilvy, with 57th, 456th and 458th Field Companies. |

OPERATIONS OF THE FIFTH ARMY

The Fifth Army had been reconstituted on 23rd May, under the command of Lieut.-General Sir William R. Birdwood. On 1st July, it took over the left wing of the First Army, between Béthune and Estaires, with the XIII Corps (3rd and 4th Divisions) and XI Corps (5th and 6th Divisions). The 74th Division, newly-arrived from Palestine, was in Army reserve.

The XIII Corps was transferred to the Fourth Army on 27th September, and was replaced in the Fifth Army by the III Corps on 7th October. The I Corps, with the 15th, 16th and 55th Divisions, was transferred from the First to the Fifth Army on 20th September.

The rôle of the army in the general plan was to exercise continual pressure on the enemy and to take advantage of any opportunity for exploitation which offered itself, rather than to stage any major attack. The effect of the larger operations of the Fourth, Third and First Armies to the south, and of the Second Army to the north, was to compel the Germans to give up their Lys salient, and to fall back continuously until the line of the Scheldt was reached.

The Fifth Army, with active patrols, advanced its line first

to the Lawe river, and then by stages to the thickly-populated area of Lille, Tourcoing and Roubaix. There was little heavy engineering work required beyond clearing the roads, but a number of minor bridges were built by army troops companies and tunnelling companies. Lille itself was not badly damaged and the bridges that were destroyed were not over rivers which caused any delay. The bridges over the Haute Deule Canal on 15th October were put across by the 15th and 16th Divisions (I Corps).

The field companies were almost continually on the move, for open warfare had by this time become fully established. Bridges over the Scheldt were put across at Pecq and Tournai. At the latter crossing, the largest bridge was an 85-ft. Class "A" span in the centre of the town. The Germans had wrecked the old bridge and much time was needed to remove the twisted debris. The site was restricted by the narrow street approach, and the proximity of the houses made anchorages and hold-fasts difficult. The bridge was built by the joint efforts of the 284th and 552nd A.T. Companies of the XI Corps, starting on 10th November.

The R.E. troops engaged in these operations were :—

I Corps (Chief Engineer, Brigadier-General H. W. Gordon) :—

15th Division	C.R.E., Lieut.-Colonel J. M. Arthur, with 73rd, 74th and 91st Field Companies.
16th Division	C.R.E., Lieut.-Colonel F. Summers, with 155th, 156th and 157th Field Companies.
55th Division	C.R.E., Lieut.-Colonel O. G. Brandon, with 419th, 422nd and 423rd Field Companies.
Corps Troops	133rd, 135th, 290th and 560th Army Troops Companies, 3rd Australian Tunnelling Company, 170th Tunnelling Company.

III Corps (Chief Engineer, Brigadier-General A. Rolland) :—

3rd Division	C.R.E., Lieut.-Colonel R. P. Pakenham-Walsh, with 56th, 438th and 529th Field Companies.
4th Division	C.R.E., Lieut.-Colonel C. R. Johnson, with 9th, 406th and 526th Field Companies.

Corps Troops 42nd, 148th and 215th Army Troops Companies, 251st Tunnelling Company.

XI Corps (Chief Engineer, Brigadier-General H. J. M. Marshall) :—

5th Division C.R.E., Lieut.-Colonel E. E. F. Homer, with 59th, 491st and 527th Field Companies.

61st Division C.R.E., Lieut.-Colonel G. E. J. Durnford, with 476th, 478th and 479th Field Companies.

Corps Troops 239th, 281st, 284th and 552nd Army Troops Companies, 250th and 257th Tunnelling Companies.

Other Divisions (whose allotment to corps varied) :—

19th Division C.R.E., Lieut.-Colonel P. E. Hodgson, with 81st, 82nd and 94th Field Companies.

25th Division C.R.E., Lieut.-Colonel R. J. Done, with 105th, 106th and 130th Field Companies.

47th Division C.R.E., Lieut.-Colonel A. B. Carey, with 517th, 518th and 520th Field Companies.

57th Division C.R.E., Lieut.-Colonel H. La T. Campbell and later Lieut.-Colonel P. O. L. Jordan, with 421st, 502nd and 505th Field Companies.

59th Division C.R.E., Lieut.-Colonel L. J. Coussmaker, with 467th, 469th and 470th Field Companies.

66th Division C.R.E., Lieut.-Colonel O. S. Davies, with 430th, 431st and 432nd Field Companies.

74th Division C.R.E., Lieut.-Colonel W. R. Izat, with 5th, R. Anglesey R.E., 5th R. Monmouthshire R.E., and 439th Field Companies.

OPERATIONS OF THE SECOND ARMY

The general plan of the final offensive included an attack to be made in Flanders under the command of the King of the Belgians. His force consisted of the Belgian Army, a few

French divisions and Sir Herbert Plumer's Second Army (II, X, XV and XIX Corps).

The Second Army attacked on 28th September with the XIX Corps and the II Corps on a front of about four and a half miles south of the Ypres-Zonnebeke road, while the Belgians continued the attack as far as Dixmude. It was a brilliant success, and the line was advanced far beyond the limits of the farthest advance in 1917, and the whole Ypres salient was cleared.

The R.E. troops engaged were :—

II Corps (Chief Engineer, Brigadier-General C. Godby) :—

9th Division	C.R.E., Lieut.-Colonel H. C. B. Hicking, with 63rd, 64th and 90th Field Companies.
29th Division	C.R.E., Lieut.-Colonel R. K. A. Macaulay, with 455th, 497th and 510th Field Companies.
36th Division	C.R.E., Lieut.-Colonel R. H. Mackenzie, with 121st, 122nd and 150th Field Companies.
Corps Troops	20th, 138th, 289th and 556th Army Troops Companies, 255th Tunnelling Company.

X Corps (Chief Engineer, Brigadier-General G. H. Boileau) :—

30th Division	C.R.E., Lieut.-Colonel P. F. Story, with 200th, 201st and 202nd Field Companies.
34th Division	C.R.E., Lieut. Colonel A. C. Dobson, with 207th, 208th and 209th Field Companies.
Corps Troops	411th and 550th Field Companies (from 65th and 72nd Divisions broken up), 167th Army Troops Company, 173rd Tunnelling Company.

XV Corps (Chief Engineer, Brigadier-General C. W. Singer) :—

31st Division	C.R.E., Major A. S. Mansel (acting), with 210th, 211th and 223rd Field Companies.
40th Division	C.R.E., Lieut.-Colonel W. R. Wilson, with 224th, 229th and 231st Field Companies.
Corps Troops	136th, 145th, 214th and 235th Army Troops Companies, 3rd Canadian Tunnelling Company.

XIX Corps (Chief Engineer, Brigadier-General E. N.

Stockley) :—

14th Division	C.R.E., Lieut.-Colonel D. S. Collins, with 6rst, 62nd and 89th Field Companies.
35th Division	C.R.E., Lieut.-Colonel J. W. Skipwith, with 203rd, 204th and 205th Field Companies.
41st Division	C.R.E., Lieut.-Colonel A. C. Howard, with 228th, 233rd and 237th Field Companies.
Corps Troops	134th and 245th Army Troops Companies, No. 6 Siege Company R. Monmouthshire R.E., 184th Tunnelling Company.

The initial assault was delivered by the 14th and 35th Divisions of the XIX Corps, and the 29th and 9th Divisions of the II Corps. Following these up were the 41st Division (XIX Corps) and the 36th (II Corps). South of this attack the X Corps (30th and 34th Divisions) carried its line forward to St. Yves and the old Wytschaete-Messines ridge. By 1st October, the bank of the Lys from Comines southwards was reached. Then followed a pause, while the communications were improved.

On 14th October, the Second Army resumed its offensive, attacking with the X Corps (30th and 34th Divisions), XIX Corps (41st and 35th Divisions) and II Corps (36th 29th and 9th Divisions). Great progress was made, and the Lys was crossed in several places. As an example of the bridging carried out in this operation we may take the account of the C.R.E. 36th Division, whose field companies built the crossings at and near Courtrai. On the afternoon of 16th October, under cover of a smoke screen, the 122nd Company, having ferried across a small covering party, built a pontoon bridge at Courtrai. The bridge was nearly completed—in fact, a few infantry had already used it—when intense machine-gun fire was opened on the sappers from a flank, and the smoke did not completely hide the work. At 2.45 p.m., after three officers, one of whom was killed, and twenty-four men, including most of the senior N.C.Os., had become casualties, the party was ordered to withdraw.

The 121st Company was ordered to put a light pontoon bridge across for the 107th Brigade. Half-pontoons were used, and the necessary materials were collected and put under cover at night among farm buildings. Two boats were first rowed across with riflemen, then in spite of flares sent up by the enemy and heavy machine-gun fire, two companies of infantry were ferried across safely and the building of the bridge began. But it was found that the width of the river was eight feet wider than had been estimated. The O.C. tried to fill the gap with a Weldon trestle, but before this could be assembled, a gas-shell fell among the party, killing four men and wounding several others. Several men on the bridgehead were also hit. The two R.E. sections in reserve were called up, and while the wounded were being removed, Captain Knox decided to draw upon the reserve pontoons of the 150th Company, instead of launching the trestle. A pontoon was brought along at the gallop, and the bridge was successfully completed. The 107th Brigade then crossed without a casualty. At 4 a.m., on 20th October, more shelling damaged the bridge, but repairs were effected before the next battalion was due to cross at 6 a.m. A more permanent footbridge was put across during the day by the same company.

The 150th Company had already, on 14th October, built light bridges over the Heulebeke, south-west of Ledeghem, for the 109th Brigade and cleared the roads for its advance. On 19th October, the company's pontoons were sent up in reserve, in case the 121st and 122nd Companies needed extra equipment. Casualties from shell-fire were suffered while the sections were under cover. On the 20th, in addition to helping the 121st Company to complete their bridge, the 150th put a medium bridge across the Lys near Oyghem, with extra pontoons from the 7th Pontoon Park.

On the 23rd, the 121st Company built a trestle bridge over the river with timber cut locally. The river was a hundred feet wide, with thirteen feet of water and a very soft uneven bottom. The larger trestles were made with ledgers in the form of a box. They were then floated into position and held there by ropes. The boxes were then filled with stones and the trestles

sunk. Further adjustment was made by the simple process of a section of sappers jumping on a temporary decking until the required settlement had been reached. This bridge was completed in two and a half days by a party of twenty sappers and a platoon of pioneers, everything except the logs and nails, having been collected locally. On 25th October, a large convoy of French 3-ton lorries passed over the bridge, two at a time, without any effect on its stability.

The bridging work of the 36th Division on the Lys was a striking example of good preliminary reconnaissance, careful organization and placing of equipment, and gallant behaviour of all ranks under fire. The initiative of the junior subalterns contributed much to the success, and the special message of appreciation sent by the Army Commander to the division was a well-deserved tribute to the field companies.

The 30th Division built a super-heavy pontoon bridge on 19th to 21st October, about a mile west of Halluin, employing the 201st and 202nd Field Companies. There were not many examples of these heavy pontoon bridges during the war, chiefly owing to the difficulty of ensuring articulation without damage to the baulks or decking. An 8-in. howitzer crossed this one, with about nine inches of free-board. Another good example of this division's work was a heavy trestle bridge built by the 202nd Field Company over the Scheldt near Bossuyt. A reconnaissance for this bridge was made at 4 a.m. on the 9th November, work on the timber trestles was begun at the R.E. dump at Knokke soon after 9 a.m., and the bridge with its road diversions was completed by 2.30 a.m. on the 10th.

The Second Army had advanced well beyond the Scheldt when the Armistice came. Its engineers had all shared in the arduous work of crossing the rivers and rapidly opening fresh communications. The few examples given above are typical of all the others. In no case was the advance of the army delayed for want of bridges. The pace was increasing towards the close, but the supply of equipment met the demands. The companies in rear dismantled the pontoon bridges as soon as they had been replaced by more permanent structures,

and sent the equipment forward. The exhilaration of open warfare heartened the troops, and brought a reward for so many weary months of toil and disappointment, but the break-away from static warfare found them well prepared for new problems.

In these chapters the author has mainly confined himself to recording the work of divisional engineers and some corps units, but during the retreats of March to June, 1918, all the numerous types of R.E. units, however specialist they were, found themselves employed on the construction of defences, on demolitions or as infantry. It should be specially noted that from March to November 1918, the fighting was mainly mobile; the long period of three and a half years of static warfare had been broken up, and was succeeded by a war of manœuvre on large parts of the front. The result was the release of a considerable quantity of R.E. man-power employed in the tunnelling companies, who now became available for general R.E. work, both offensive and defensive. Mention has been made in these chapters of the very valuable and competent work done by these tunnelling companies, who were welcomed wherever they went by the Chief Engineers of Corps, but for further information the reader is referred to Chapter XVIII.

CHAPTER XVI

WORK OF THE FIELD SQUADRONS IN FRANCE

Operations during 1914—Operations during 1915-16—The Indian Cavalry Corps—Operations during 1917—Operations during 1918.

OPERATIONS DURING 1914

IN August, 1914, the British Expeditionary Force included five cavalry brigades, of which four were formed into a cavalry division, while the fifth was an independent brigade.

The cavalry division had a field squadron, R.E., consisting of a headquarters and four troops, each troop having an establishment of one officer and about forty N.C.Os. and men. The 5th Cavalry Brigade had its own field troop with three officers and seventy-five N.C.Os. and men, formed into two half-troops.

The officers with the 1st Field Squadron on the outbreak of the war were: Major E. S. Sandys, Captain P. O. Jordan and Lieutenants G. E. H. Sim, T. H. Foster, R. R. Egerton and R. G. W. H. Stone.

In September, 1914, the 2nd Cavalry Division was formed, the 5th Cavalry Brigade and its field troop being absorbed, with an additional troop on loan from the 1st Field Squadron. In October, 1914, the 2nd Field Squadron (Captain L. C. Trench) which had been formed in England with a headquarters and 2 troops, arrived in Belgium, and absorbed the old 5th Brigade Field Troop, returning the troop borrowed from the 1st Squadron. Both the 1st and 2nd Field Squadrons were now organized with a headquarters, four troops and a small bridging train. A third squadron (Captain C. E. P. Sankey), formed in England in September, 1914, for the 3rd Cavalry Division, arrived in France in October. At first, it had only two troops, but in March, 1915, it was expanded to the same establishment as the other two squadrons. Thus each of the three British, and also the two Indian cavalry divisions (who arrived in

France in November and December, 1914, eventually had its own field squadron, and at Cavalry Corps Headquarters a C.R.E. (Major E. S. Sandys) was appointed for their technical control. The establishment of a field squadron was 225 men and the same number of horses.

Shortly afterwards two cavalry corps were formed in the B.E.F.: the British Cavalry Corps (1st, 2nd and 3rd Cavalry Divisions) and the Indian Cavalry Corps (1st and 2nd Indian Cavalry Divisions).

The Indian cavalry divisions at first differed in organization from the British; they each had a C.R.E. and a number of Field and Assistant Field Engineers, drawn from the regular R.E. officers serving in India, but on the formation of the Indian Cavalry Corps in December, 1914, the British system was adopted and, by May, 1915, the 1st and 2nd Indian Field Squadrons had arrived in France with all-British personnel. Thus the story of the Indian Field Squadrons belongs to that of the regular Royal Engineers. The officers commanding these squadrons were Major A. G. Bremner and Major S. D'A. Crookshank respectively. The Indian Cavalry Corps existed until March, 1916, when it was broken up. Later, its two divisions formed part of the reorganized Cavalry Corps, formed in September, 1916, from the five divisions then in France, with Lieut.-Colonel W. H. Evans as C.R.E. The 1st and 2nd Indian Field Squadrons were redesignated the 4th and 5th Field Squadrons. When the 4th and 5th Cavalry Divisions were withdrawn in March, 1918, and sent to Egypt, the 4th Squadron was broken up, and the 5th remained in France until April, when it also became dispersed.

A field squadron was not an economical unit. From a whole squadron it was impossible, even under favourable conditions, to provide a dismounted working party of more than seventy N.C.Os. and men, and this left the remainder of the squadron practically immobile, and quite unproductive.

From the beginning of trench warfare to the end of the war, it was hoped by all, and believed by many cavalrymen, that one day a gap would be broken in the German lines and the cavalry would pour through to spread havoc and confusion

in the rear. No such gap was in fact ever made. Even if the cavalry had had their chance, it is difficult to imagine any probable circumstances in which their engineers, if carried in motor transport, could not have served them far better than if mounted on horses. Moreover, during those periods when the cavalry were either acting as infantry or withdrawn to rest, it is obvious that there was still less a case for a horsed engineer. Throughout almost the whole of the war this was, in fact, the fate of the cavalry, and a close examination of the work of the field squadrons discloses no occasion on which their horses were anything but an encumbrance.

From their landing in France in the middle of August, 1914, the Field Squadron, and the detached 4th Field Troop, accompanied their respective cavalry formations throughout the retreat from Mons and the advance to the Aisne.

During the battle of Mons, on 23rd August, the Squadron destroyed the bridges over the Sambre river and canal between Pommerehne and St. Aybert. Next day, all wheeled transport was sent to the rear, and the squadron acted as mounted infantry. The only R.E. work done consisted in the cutting of fences for the passage of the cavalry. They were in the firing line at Audignies on the 24th, retiring to Joulain: they helped to hold Solesmes on the 25th, and retired via Beaumont, Ligny, Ronssoy, Rouy le Grand, reaching Flavy le Meldeux near Ham, on the 28th. On the 29th, they fought a delaying action with the 2nd Cavalry Brigade round Guiscard and Criselles, reaching Ourcamp in the evening.

The same day, the 4th Field Troop (Captain L. C. Trench) had to prepare for demolition the bridges over the Oise at Chauny. There were three bridges, two of which were close together while the third, carrying a metric-gauge light railway, was about three-quarters of a mile away. The two bridges in Chauny carried the main road, and the standard-gauge railway. The actual destruction of these bridges was not to be completed without orders. Sufficient time and material were available to do the work, which presented no technical difficulty, and was finished by noon on the 29th. The light-railway bridge was left in charge of an N.C.O. with orders to blow it up when

he heard the demolition of the others. The main railway bridge was to be dealt with by a party of French sappers, while the main road bridge, an important and solid structure, was manned by a detachment of the field troop, under Lieutenant T. A. S. Swinburne. During the afternoon, the destruction of the bridges was ordered and counter-ordered until the French decided, with or without orders, to blow theirs. The destruction was not complete, but the explosion had the effect, fortunately as it happened, of causing the N.C.O. in charge of the light-railway bridge to fire his charges, which he did with complete success at 3 a.m. on the 30th. Late at night, Lieutenant Swinburne received an order from the I Corps to remove the charges from the main road bridge and drop them in the river. As everyone had disappeared and all seemed quiet, he did so, and the bridge presumably fell intact into the hands of the enemy.

The general retreat carried the Field Squadron back to Gournay near Paris. When the advance was resumed, it moved up via Marmand, Jouvilly and La Honte to Sablonnière where, on 8th September, it reconnoitred the bridges over the Marne and strengthened a bridge at La Ferté Gauche for lorries. On the 9th, the Cavalry Division was ordered to seize the crossings over the Marne at Charly and Saulcherry. The Squadron prepared to bridge the river, but the existing bridges were found to be intact, which was fortunate, for the two bridging trains were at this time as far back as Le Mans. The advance was continued to the Aisne, via Mont de Bonneil, Griselles and Cramaille to Braisne, where on 12th September, preparations were made for bridging, but one bridge was found intact. After severe fighting, the advance was continued to Vauxcerc and Oeuilly, where the squadron was employed from 14th September to 2nd October on improving and strengthening the bridges over the Aisne. One of these was a girder bridge which had been partially destroyed during the retreat; its repair was completed just in time to replace the field bridge when the latter was put out of action by a flood.

On 3rd October the transfer of the British army to Flanders was begun. The 1st and 2nd Field Squadrons marched with their cavalry divisions, and enjoyed the exhilaration of movement

and the apparent success of the wide outflanking operation, but resistance began to stiffen and, in fact, soon became an enemy advance.

A crossing over the Ypres-Comines canal was made near Hollebeke by the simple method of filling it with earth, helped by about fifty Belgian workmen under the city engineer of Ypres. The bridge carrying the main road over the canal near the same spot, was found to be wrecked, and the R.E. were complimented by the cavalry on the thoroughness of its destruction. The Belgian engineer, however, explained that the collapse of the bridge had been due to a failure in the design of the abutments.

Before the end of October, all three field squadrons were very fully occupied in helping their divisions to prepare defensive positions, and sometimes in helping to hold them. During the first battle of Ypres, the cavalry were extensively employed as infantry to relieve the latter, or to fill some threatening gap. The 1st Squadron worked from the south of Messines to about halfway along the ridge to Wytschacte, the 2nd from there to Hollebeke Château, and the 3rd farther north. The shortage of tools and wire made it very difficult to accomplish more than the most elementary defences. The cavalryman had no entrenching tool, and at first did not perhaps fully appreciate the value of a shovel which might be issued to him by a field squadron ; but he soon learned to do so, and then the difficulty was to recover it. Villages and farms were searched for any sort of tool from a hoe to a coal shovel, with which a man could dig a little cover, and the fences for miles around were stripped of their wire and posts in order to erect some sort of obstacle. Three strands of wire were considered good, but to get material for even this it was necessary to send out collecting parties well in advance. The arrival of the first issue of three coils of barbed wire in a staff car from St. Omer was a great event. When the battle had died down, towards the end of November, the cavalry divisions and their field squadrons were withdrawn to billeting areas close behind the line. The 1st Squadron was billeted at Thieshouk, the 2nd at Vieux Berquin and the 3rd at Hazebrouck.

From then until the end of the war, work consisted of one or other of the following tasks, upon which field squadrons were employed from one end of the British line to the other.

Acting as field companies when their divisions were dismounted and sent into the line. A cavalry division could produce about 1,200 rifles, and a field squadron at most seventy men to go with them. Small though these numbers may appear, they meant that each man left behind had at least four horses to look after. It was on one of these occasions, at Ypres in March, 1915, that the 1st Field Squadron dug and blew what must have been one of the first, if not the first, of the mines laid by the B.E.F. in France. It was only 14 ft. deep, with a gallery of 25 ft., and was charged with 150 lb. of gunpowder. This did no great execution, but it was a beginning.

Digging parties.—Dismounted cavalry working parties were in great demand, and as sappers were required to accompany every party, the field squadrons spent many months in this way at various parts of the line.

Preparing for the "Gap."—Every large-scale attack raised hopes that a practicable gap would be broken in the German line. The field squadrons' share in the preparation for a gap consisted in making and teaching the use of trench bridging devices; practising in the use of their own bridging equipment; installing water-points for the very large numbers of animals which were brought up close behind the front of attack; preparing camps for Cavalry Corps Headquarters, which were never used, except by exhausted infantrymen coming out of the line; clearing and marking 30 ft. wide cavalry tracks through our own trench system up to the front line; and lastly, producing the squadron complete and keyed up to concert pitch at the right time and place on the day of battle.

Working, dismounted, when not required by their own divisions, on front and rear defence systems for other formations.

Improving the billeting accommodation of the cavalry divisions. This was, naturally, an endless task.

Instructing cavalry regiments in field engineering and defence work of all kinds. In the early part of the war, the manufacture and use of bombs and hand-grenades was an important feature of this work.

An important item in the equipment of a field squadron was the 3 ton lorry allotted in 1915 for the transport of the divisional reserve of entrenching tools 500 picks and 500 shovels. At times, unfortunately only for short periods, up to thirty dismounted sappers would be attached to a squadron. These men could be moved, by dumping the reserve tools from the lorry, and it was thus possible to increase the effective value of the squadron by about 50 per cent. Even with this example of the results to be obtained from their mechanical transport, the squadrons still kept their horses, though in none of the tasks on which they were employed, as given above, were horses of any use. The man it was who became the slave of the horse.

Each time the stage was set for a "gap" high hopes were raised that now, at last, cavalry would show what it could do. The higher the hopes, the deeper the disappointment felt in marching away from the battlefield, and leaving the infantry still fighting, or passing others on their way forward. On the other hand, as the war went on, the cavalry, owing to their comparatively light losses, almost certainly contained the best material of the army.

OPERATIONS DURING 1915-16

After the first battle of Ypres, the Cavalry Corps spent the winter of 1914-15 round La Motte, in the forest of Nieppe. It stood by for the battle of Neuve Chapelle, and on 10th March, one brigade of the 2nd Cavalry Division was engaged.

On 22nd April, when the Germans made their first gas attack at Ypres, the Cavalry Corps went up in support of the left of the British line, from Ypres to the right of the Belgian army. The 1st Field Squadron, on the 23rd, helped the 1st and 2nd Cavalry Brigades on the line Woesten-Elverdinghe-

Brielen, the 2nd Squadron helped the 4th Cavalry Brigade to entrench in front of Boesinghe and the 3rd Squadron was at Vlamertinghe with its division in reserve.

"Later, the field squadrons were employed on trench work east of Ypres, under the C.R.E., 28th Division, and continued work in this neighbourhood until the end of May, sometimes working with their divisions in the line about Hooze and Wieltje and sometimes on the G.H.Q. Line east of Ypres. Between 17th and 28th May the squadrons worked together under the C.R.E., Cavalry Force (Major Sandys). During the second gas attack, on 24th May, the 1st Squadron had to abandon their dug-outs and man the Menin Gate trenches. This squadron was withdrawn on May 28th to Esquelbecq; the 2nd Squadron on 29th May to Ebblinghem; and the 3rd on 5th June to Renescure. On 30th June the Corps went up to work, dismounted, on rear-line trenches in the Ypres area; the 1st Squadron to Vlamertinghe under VI Corps; the 2nd to Dickebusch on the Kemmel defences under V Corps; and the 3rd on trenches from Hill 63 to Neuve Eglise, later going on to the Elverdinghe defences under VI Corps, handing over these to the 1st Squadron on 7th August, and then working from 16th August on trenches east of Armentières, where on 30th August, Lieutenant Theodore Smith was killed. The squadrons were withdrawn about 5th September, respectively to Esquelbecq, Roquetoire and Vincly (near Fruges) and the divisions started training for the battle of Loos."*

"For the battle of Loos, the 3rd Cavalry Division was placed at the disposal of the First Army. It proceeded to the Bois des Dames on 20th September, and the field squadron was employed in making cavalry tracks. On the 26th it assisted the 6th and 8th Cavalry Brigades to consolidate the position they had won on the east side of Loos, and was withdrawn on the 28th, Lieutenant R. D. Pank being slightly wounded during the action. Meanwhile, the Cavalry Corps moved to Noeux les Mines for the battle. The 1st Cavalry Division reached Vaudricourt on the 25th, and held and put in order the old German line behind Loos, afterwards working on the trenches under the XI Corps. It was withdrawn on 6th October, its

* *Brief History of R.E. with Cavalry.* R.E. Journal, March, 1926, p. 47.

field squadron going to Serny, and on 20th October, to Clarques. The 2nd Cavalry Division arrived in the neighbourhood of Perlay on 29th September, whence a dismounted party with the field squadron went up to Vermelles for work on the old German line until 17th October.*

The Cavalry Corps was withdrawn towards the end of October, and the divisions settled down for the winter in the rear areas. The cavalry was employed on G.H.Q. defence lines, and the field squadrons were distributed among the working parties. This went on throughout the winter of 1915-16, but on 31st December the Cavalry Corps formed a dismounted division for work in the trenches.

"The composite division proceeded to La Philosophie and worked on second-line trenches in the Hohenzollern Redoubt, east of Vermelles, until its return to the corps on 15th February, 1916. Major C. R. Johnson was appointed C.R.E., and Lieutenant G. E. Grimsdale, Adjutant R.E. of the division. During this period, Lieutenant R. D. Pank, 3rd Field Squadron, was again wounded on 22nd January, 2nd Lieutenant Chappell, 3rd Squadron, was killed on 3rd February, Lieutenant Greathed, 1st Squadron, wounded on 8th February, and in the 2nd Squadron, Lieutenant Wise was slightly wounded and Lieutenant K. M. Carnduff killed early in January.

"Towards the end of March, 1916, the British Cavalry Corps was broken up, the 1st Cavalry Division being allotted to the First Army, the 2nd to the Second Army; and the 3rd held in G.H.Q. reserve. The 1st Field Squadron, at the end of March, sent up a detachment to Vedrel to work on the Estrée Cauchie Verdrel line, under IV Corps. On 26th June, the 1st Cavalry Division arrived at Querrien for the Somme offensive, the field squadron having to construct several bridges. During July, they stood to and moved up on several occasions, and on 24th July, proceeded dismounted to Fricourt for work with the cavalry on trenches at Montauban and Bernafay Wood, under XIII Corps; this work was continued until the re-formation of the Cavalry Corps at the beginning of September, 1916"†

* *Brief History of R.E. with Cavalry. R.E. Journal*, March, 1926, p. 48.

† *Ibid.*, p. 48 et seq.

The 2nd Field Squadron was similarly employed in the Second Army area until September, when it returned with its division to the Cavalry Corps.

The 3rd Squadron went up to Querrieu with its division on 24th June for the Somme offensive, and took part in trench work with the dismounted cavalry in front of Contalmaison and Mametz Wood. In August, it moved to Le Quesnoy, west of Amiens, and sent up a party to help the divisional machine-gunners in the Leipzig Redoubt.

"On 5th August the squadron moved to Dompierre, and another party was sent to Aveluy for work under II Corps, when Captain Cobb and Lieutenant Hay were wounded. On 9th September the parties rejoined and the 3rd Division marched to Querrieu to join the Cavalry Corps."*

The new Cavalry Corps, formed at Daours in September, 1916, had five cavalry divisions. These were concentrated in the Fourth Army area, waiting for the long-hoped-for gap. Lieut.-Colonel W. H. Evans was appointed C.R.E. of the corps, with Captain G. E. Grimsdale as adjutant. The field squadrons were employed on the usual work of making and maintaining cavalry tracks in the forward area. The renewed attack did not result in any opening for the cavalry, and at the end of September the corps was withdrawn for the winter. The R.E. squadrons were billeted respectively at Doudeauville, Douriez, Les Puits Berrault, Boismont and Embreville. Hutting and stabling formed the chief items of the winter's work. Officers were sent to the courses at the bridging school at Aire and the field company commanders' course at Hesdin.

THE INDIAN CAVALRY CORPS

As already mentioned, the two field squadrons attached to the 4th and 5th Indian Cavalry Divisions were purely British units, and their story therefore belongs to this history.

The first cavalry formations to arrive from India were accompanied by two Indian field troops, drawn from the 2nd and 3rd Sappers and Miners, but with the arrival of the 2nd

* *Ibid.*, p. 49.

Indian Cavalry Division. in December, 1914, it was decided to form an Indian Cavalry Corps, to abolish the Indian organization of R.E. with cavalry, and to reorganize with British R.E. personnel.

The 1st and 2nd Indian Field Squadrons were formed in France at Wittes and Ermy St. Julien in May, 1915, under the command respectively of Major A. G. Bremner and Major S. D'A. Crookshank. The two Indian field troops were broken up in July, 1915, and their personnel sent to the Indian (infantry) Corps.

There was also a Canadian field troop, raised at Aldershot in September, 1915, under Captain R. F. Mainguy, composed entirely of British R.E. personnel. This troop joined the Canadian Cavalry Brigade in October. It served for a time with the Canadian Corps, and was then attached to the 2nd Indian Cavalry Division. Finally, in January, 1917, it was merged into the 2nd Indian Field Squadron, which was then renamed the 5th Field Squadron, the 1st Indian Squadron becoming the 4th. Both these squadrons were broken up in 1918, after their divisions had been transferred to Egypt.

"From February till the end of April, 1915, the Indian Cavalry Corps was employed on constructing G.H.Q. defences in the neighbourhood of St. Venant and the forest of Nieppe. During the early part of 1915 the corps moved up on several occasions in support of attacks, returning always to the Aire neighbourhood. On 11th March they went to Auchel for the Neuve Chappelle battle; at the end of April into Belgium for the first gas attack at Ypres; on 17th May to east of Lillers for the Festubert attack; and on 27th May to Ypres for the second gas attack. On this occasion the 1st Indian Cavalry Division was put into the trenches at Hooge, and both the 1st Indian Field Squadron and the 2nd Indian Field Troop did much front-line work there and at Railway Wood, Captain J. C. Wickham, R.E., being severely wounded. From the end of June to the end of July, 1915, dismounted men from the 1st and 2nd Divisions were employed on the reserve trenches and strong points in the Laventie and Noeux les Mines areas.

"At the end of March, 1916, the Indian Cavalry Corps was

broken up. The 1st Indian Cavalry Division moved northwards to the Auxi-le-Château area, where the field squadron was employed on the construction of the Third Army School, and later a divisional school at Vaucqueriette. On 30th June the division marched to the Doullens area for the Somme battle, moving back to the Auxi-le-Château on 2nd July and to Aubigny on 20th July. The field squadron was employed under XVII Corps north of Arras on front-system redoubts, concrete field-gun emplacements and dug-outs for the corps heavy artillery. On 3rd September, the division marched to the St. Ricquier area, and on 13th September, reached the Allonville area near Querrien, where it joined the newly re-formed Cavalry Corps.

"Except for a training period at St. Ricquier, the 2nd Indian Cavalry Division stayed in the Alloncourt area until 1st July, 1916, when it proceeded to Bussy-les-Daours for the Somme offensive. The field squadron went on to Meaulte and later to Ericourt, and until the formation of the Cavalry Corps, in September, 1916, was employed in helping its division in attacks, making cavalry tracks, moving guns in Mametz Wood and general trench work under XIV and XV Corps."*

OPERATIONS DURING 1917

Preparations for the battle of Arras involved the 1st, 2nd and 3rd Field Squadrons, who carried out reconnaissances of new cavalry tracks and constructed water-points near Aubigny, Bailleulmont and Gouy. An advanced Cavalry Corps Headquarters was built at Duisans. The 1st Cavalry Division moved up to the First Army north of the Scarpe; the 2nd and 3rd Cavalry Divisions on 9th April moved to east of Arras, ready to take part in the Third Army battle. Again no opportunity occurred, but the 3rd Cavalry Division sustained heavy losses in an attempt to secure Mondry-le-Prieux, which was entered by a squadron of Essex Yeomanry and the 10th Hussars, who galloped forward under heavy machine-gun fire.

On 11th April the cavalry were withdrawn again to the area they had occupied during the winter. The 4th Cavalry Division had gone to the Fifth Army near Bullecourt, where

* *Brief History of R.E. with Cavalry. R.E. Journal, March, 1920, p. 52.*

" the 4th Field Squadron was employed on water-points near Sapignies and a cavalry track near Bullecourt. The 5th Field Squadron accompanied its division in the advance of the Fourth Army and were employed in filling craters, road work and constructing reserve defence lines, being quartered at Tetry."*

On 9th May the Cavalry Corps, leaving the 1st Cavalry Division with the First Army near Merville, moved down to the Fourth Army area on the Somme, joining the 5th Cavalry Division. " A portion of the front line between the Omignon river and Epéhy was taken over from the 59th and 42nd Divisions, and all four cavalry divisions were put in. Cavalry Corps Headquarters took over from III Corps at Catelet and the divisions were disposed along the Omignon and Cologne rivers." The C.R.E. became in effect a Corps Chief Engineer, and was given the assistance of three field engineers, and the 281st, 282nd, 565th A.T. Companies, R.E., 180th Tunnelling Company, No. 3 Reinforcement Company, R.E., and the 4th Pontoon Park.

" Apart from the ordinary R.E. work connected with the administration of a large area in a devastated zone, much was done on the improvement of the defences, and the corps was complimented on the state in which they left the trenches. Major V. H. Simon, commanding the 3rd Field Squadron, and Captain D. Wise, 2nd Field Squadron, were killed east of Ronsoy on 3rd June and 15th May, respectively.

" On 3rd July, 1917, the 3rd Cavalry Division moved up into the First Army area, and on 5th July, the corps handed back their trenches to III Corps (34th and 35th Divisions). Corps H.Q. moved to Aire and the divisions were located: 1st at Merville; 2nd round Magnicourt along the Canche river; 3rd at Busnes; 4th remaining with the Third Army, along the Omignon; and 5th north of St. Pol, with its field squadron at Troisvaux."

On 22nd July the 1st Field Squadron accompanied a brigade of the 1st Cavalry Division to the Second Army, and was employed on water-points, corduroy roads etc., between Watten

* *R.E. with Cavalry. R.E. Journal, June, 1926, p. 306.*

and Dickebusch. On 26th July the 3rd Field Squadron was similarly employed in the Westoutre area.

At the end of August, 1917, the usual winter programme of accommodation began, the bulk of the Cavalry Corps being destined for the area between the Cologne and Omignon rivers. The 4th Field Squadron and parts of the 2nd, 3rd and 5th were engaged on this work which had to be interrupted for the preparations for the battle of Cambrai.

"A detachment of the 3rd Field Squadron constructed an advanced Corps H.Q. and water-points for three divisions at Fins. A track-making battalion was formed from dismounted men of the 4th and 5th Cavalry Divisions and trained under Lieut-Colonel R. M. Bell and Lieutenant S. G. Bennett, 4th Field Squadron; a bridge for crossing the St. Quentin Canal was prepared by Lieutenant H. D. Maconochie, 3rd Squadron, and arranged for loading on to two tanks. This bridge was subsequently used to improve an existing bridge east of Masnières and facilitated the withdrawal of the Canadian Cavalry Brigade. By 27th November the Corps had moved back to Villers Carbonnel and commenced taking over a portion of the line between the Omignon river and Hargicourt, the 2nd Cavalry Division having been left at Fins."*

The Cavalry Corps was once more brought into action when the Germans launched their heavy counter-attack at Cambrai on 27th November. The field squadrons were employed on the construction of support lines and strong points.

On 6th December the Cavalry returned to their winter quarters, and for the next three months, during the preparations to meet the threatened German offensive, they held a section of the line of VII Corps, between Ronsoy and the Omignon valley. A dismounted force was formed from two of the cavalry divisions in turn, with a C.R.E. (Major A. F. S. Hill, 4th Field Squadron). Meanwhile, the rest of the Cavalry Corps was engaged on winter hutting, rear defence lines and on the preparation of all bridges in their area for demolition.

On 9th March, 1918, the Corps, now reduced to three divisions by the departure of the 4th Cavalry Division to Egypt and the

* *Ibid.*, p. 308.

disbandment of the 5th, handed over its portion of the front to XIX Corps, and was employed on the construction of defence works on the Fifth Army line, working under the Chief Engineer of the Canadian Corps. The C.R.E., Cavalry Corps was responsible for a sector of this line, and was lent the field companies and pioneers of the 50th Division, the 225th Field Company (39th Division), the 283rd and 288th A.T. Companies and a number of labour units.*

OPERATIONS DURING 1918

When the German attack began on 21st March, 1918, the 2nd and 3rd Cavalry Divisions were sent to III Corps, and 1st Cavalry Division and the 5th Field Squadron to XIX Corps.

" On 23rd March the 1st Squadron blew up the bridges over the Somme at Pargny and Bethencourt, 2nd Lieutenant G. F. Baylay being killed.† On the 24th they were at Cappy and Cerisy under VII Corps, and on the 25th at Bussy-le-Daours holding the line north of the Somme about Morlancourt; on this day they again came under the orders of the Cavalry Corps, which had arrived at Querrieu. The 2nd Cavalry Division was at Maucourt on the 21st and the field squadron reconnoitred the bridges over the Oise for demolition; on the 23rd Lieutenant Kezar's troop was in action at Jussy with the 3rd Cavalry Brigade, the other troops being detached to the 4th and 5th Brigades, and rejoining the squadron on the 27th. Meanwhile, the 2nd Squadron headquarters on the 22nd and 24th prepared fourteen bridges about Marucamp and Quierzy for demolition, and two more at Appilly and Bretigny. These they blew up on the 25th, the bridge at Pontoise being demolished on the same day. On the 29th the squadron dug posts at Dive le Franc, handing over to the French, and again the same thing at Ansaouvillers, whence it marched north to Boves, rejoining the Cavalry Corps on 30th March.

" The 3rd Cavalry Division joined with the 2nd under II Corps, and on the 26th the 3rd Squadron assisted the French to blow up some bridges near Pontoise. On the 27th, the

* *Ibid.*, *R.E. with Cavalry*. *R.E. Journal*, June, 1926, p. 309.

† See p. 350.

division assembled near St. Just, and on the 30th, rejoined the Corps at Sains-en-Amienois.

"The 5th Field Squadron, after retreating daily, was joined on 25th March by two tunnelling companies (173rd and 258th) and four A.T. companies (239th, 281st, 283rd and 288th) from XIX Corps, to form the XIX Corps R.E. Battalion, of which Major E. J. B. Buchanan (5th Field Squadron) was placed in command with Captain Fairtlough as adjutant. On the 25th the battalion blew up a culvert between Estrées and Foucaucourt, and on the 26th they dug and manned the Framerville-Varvillers line. On the 27th they retired to the Rouvroy-Framerville line, where they were heavily attacked, and had to retire to the Quesnil-Beaufort line, Lieutenant Matthewson being killed at Rouvroy. The battalion was reorganized at Cayeux, and again put into the line at Demuin, where they were heavily attacked and had to retire to Hangard, consolidating a position there, being withdrawn on the 31st to near Boves. Major Buchanan was seriously wounded and Lieutenant Greathed slightly wounded, during the action at Demuin. The battalion was relieved by infantry on 31st March, and the squadron rejoined the Cavalry Corps near Glissy on 1st April.

"On 27th April the 1st Cavalry Division was hastily transferred from the north to the south bank of the Somme to fill a gap in the line: it occupied this front until 3rd May, its field squadron being employed in support, and also in preparing some of the bridges near Daours for demolition. On 1st April the 2nd Cavalry Division, with part of the 3rd, attacked at Hangard Wood, north-east of Moreuil. The 2nd Field Squadron followed up to consolidate, when Major T. A. S. Swinburne was killed and Lieutenant de Meric wounded. On 3rd April the 3rd Cavalry Division went into support north-west of Gentelles, and the field squadron was employed on the Cachy Switch until the 8th. On 6th April Cavalry Corps H.Q. withdrew to Amiens with the 1st and 3rd Divisions, the 2nd Division moving back to Ailly-le-Haut Clocher."*

The Cavalry Corps was moved up to the neighbourhood of Aire on 17th April as a reserve behind the First Army during the German offensive in Flanders, but the divisions did not go into action. All through the summer, the cavalry were

* *R.E. with Cavalry. R.E. Journal, June, 1926, p. 310-II.*

employed on various defence works in the rear areas. When the Fourth Army operations began on 8th August, the Cavalry Corps was moved to west of Amiens to be in readiness to exploit any break-through, but once again there was no opportunity for the cavalry. The 1st and 3rd Divisions were in action on 8th and 9th October, and the field squadrons were engaged in the establishment of water-points, the filling-in of road-craters, the making of diversions and in searching for mines and traps.

The cavalry divisions were next moved northwards to the Lille area, and made preparations for a break-through with the Fifth Army, but the Armistice intervened, and on 11th November the divisions found themselves along the Blaton canal in and around Ath.

Thus it will be seen that the field squadrons had their share of the work, and if they were denied the dashing opportunities which throughout the war were the dream of the whole cavalry force, they carried out the same diversity of work which fell to the lot of their comrades in the field companies. They were undoubtedly hampered by their horses, and the substitution of light motor lorries as a means of transport would in no way have reduced their mobility, far from it.

Their story is the story of the last of the mounted engineers.*

* The valuable work of mounted engineers in Egypt and Palestine is described in Volume VI of this history.

CHAPTER XVII

ROYAL ENGINEERS AND THE ROYAL TANK CORPS

Invention of the Tank—The Heavy Section, Machine-Gun Corps
—The Tank Corps in France—Maintenance—Bridging—
Director-General of the Tank Corps.

INVENTION OF THE TANK

FROM the earliest times soldiers have endeavoured to build vehicles in which they could advance against the enemy behind armour protection and from which they would be able to throw missiles at their opponents. There are a few instances of the successful use of early types of fighting vehicles but it was usually found impossible, with the feeble muscular power of man or horse, to carry sufficient armour protection to withstand the missiles of the day. With the arrival of the internal combustion engine armoured cars were suggested, but the poor cross-country capacity of the wheeled vehicles of that time limited their use to special conditions and circumstances. It was not until the two inventions of the internal combustion engine and the endless track were combined, that it became possible to construct proper fighting vehicles which could carry sufficient armour to withstand the missiles of the normal weapons with which the infantry were armed.

Unarmoured tracked vehicles propelled by internal combustion engines made their appearance some years before the war. A proposal was made by Mr. de Mole in 1912 that such vehicles should be armoured and used as fighting vehicles. No nation, however, was sufficiently progressive to develop this idea.

There are few inventions which have not been sought by many minds simultaneously. Sometimes the inspiring flash has come to only one individual, but much more often several people have been independently groping towards the right

solution, and previous inventions of another type have pointed the way to the answer to the new question. The final product has been the result of several independent experiments, each giving some portion of the solution.

So it was with the tank. But Lieut.-Colonel (later Major-General Sir Ernest) Swinton, R.E., was the first to put forward the practical conception of an armed fighting vehicle protected by armour and propelled on caterpillar tracks. He specified exactly what the machine should be like and what it should do. After the war, a judicial commission was appointed to adjudicate upon the rewards due to inventors who had supplied the nation with valuable new devices for winning the war. This commission had, therefore, the duty of rewarding the inventor or inventors of the tank. They decided that the answer was in the plural, and they distributed the reward among a fairly small band of men, among whom we are glad to note in this history was Major-General Sir Ernest Swinton, whom the commission considered was mainly responsible for the initiation of the use of tanks in war.

Space being limited, the other inventors and the many able men who developed the use and military application of the tank, and fought this new arm to such great victory, will not quarrel with us if we now confine ourselves in this history to the work of Royal Engineers in this achievement.

Towards the end of 1914 Lieut.-Colonel E. D. Swinton was at General Headquarters in France as "Eyewitness," providing the public with information. He was impressed with the great waste of lives in trying to compete with the machine-gun and barbed wire, and he turned his mind to finding some mechanical device to overcome the strength of this defence. He had not heard of Mr. de Molle's suggestion of 1912 to use track vehicles for this purpose, but he had heard of caterpillar tractors, and he conceived the idea that they could be armoured and adapted to carry forward machine-guns. In October, 1914, Lieut.-Colonel Swinton brought the idea to the notice of the Committee of Imperial Defence, on the Staff of which he had worked before the war. Eight months later he persuaded G.H.Q., France, to submit the proposal officially. In the

meantime, in January, 1915, through the channel of the C.I.D. the idea came to the notice of Mr. Winston Churchill, the First Lord of the Admiralty, who, with his usual quick intuition, seized upon the idea and brought all his great driving power to bear to enlist the services of able men, notably Sir Eustace Tennyson D'Eyncourt, Commander Wilson and Mr. Tritton, to design and produce practical results. With these gentlemen were associated Colonel W. C. Dumble, R.E. and the indefatigable Colonel Crompton, R.E. (T.A.), always noted for appearing at the right place at the right time. There were, of course, many others concerned with the development of the tank, and other proposals and committees were formed later, for which the reader must go to other sources of information.

THE HEAVY SECTION, MACHINE-GUN CORPS

In July, 1915, Colonel Swinton returned to England as an assistant secretary of the C.I.D. and at once took in hand the co-ordination of the efforts which were being made in relation to the design of fighting vehicles on caterpillar tractors. Finally, on 2nd February, 1916, a machine became available for inspection as a fighting vehicle constructed to Colonel Swinton's specification. The trials took place at Hatfield and as a result it was decided to form a small unit of the Machine-Gun Corps, to be called the "Heavy Section," and Lieut-Colonel Swinton was appointed to command it, with his headquarters in London. He established a training camp at Elvedon, near Thetford, and two R.E. officers—Major M. O'C. Tandy and Captain Martel—were lent to him for a month to prepare a modern battlefield on the ground, over which the machines could practise.

These new fighting vehicles, at first called land cruisers, were rechristened "Tanks" by Colonel Swinton, a name which has continued ever since, though its origin was due to the necessity for secrecy and, therefore, the pretence that they were vehicles for use on water supply.

Lieut.-Colonel Swinton had the usual difficulty encountered by any new branch that tries to insert itself into a Government

office, but in spite of this he collected a band of very keen officers and men whom he inspired with enthusiasm. He particularly impressed the importance of secrecy on all ranks and it was largely due to his influence and leadership that secrecy was maintained until the tanks were employed. The Army in general and the Tank Corps in particular owe much to the great work carried out by Lieut.-Colonel Swinton in those early days.

This embryo of a new arm in warfare was officially named "The Heavy Section of the Machine-Gun Corps." In August, 1916, the first units of the Heavy Section, M.G.C., began to move to France. At the end of September the Commander-in-Chief in that theatre of war appointed Lieut.-Colonel H. J. Elles,* R.E., to command these units. They now became known as the "Heavy Branch," M.G.C., and it was arranged that Lieut.-Colonel Swinton should remain at home to guide design and development and raise new units. Later, however, Lieut.-Colonel Swinton was replaced, and his valuable experience was lost; this was a sad blow to the "Heavy Branch" and to Lieut.-Colonel Swinton himself. The Army lost much from this change of leadership at home in an important new branch of warfare that was destined to play such a great part in war.

THE TANK CORPS IN FRANCE

In May, 1917, the "Heavy Branch" became the "Tank Corps," with Brigadier-General H. J. Elles in command, and by April, 1918, the same officer had become G.O.C., Tank Corps.

There was much controversy (continued since the war) whether the first detachment of these new weapons should be thrown into battle for experiment and thus be disclosed to the enemy or whether they should wait until a strong force could effect a great tactical, even strategical, surprise. Colonel Swinton strongly urged the latter view.

* Later General Sir Hugh Elles, K.C.B., K.C.M.G., K.C.V.D., D.S.O., who held the appointments of Director of Military Training and Master-General of the Ordnance at the War Office.

It was on 15th September, 1916, that a small unit of " tanks " first went into battle, but on this occasion and in subsequent operations for fourteen months the tanks were used after the point of attack had been disclosed by the artillery preparation for the battle. The Tank Corps had continually pressed G.H.Q. for permission to use the tanks in the way for which they had been originally proposed, i.e., for a surprise attack and not as an additional assistance after a long preliminary bombardment. This point had been stressed in a remarkable memorandum on the rôle and employment of tanks written by Colonel Swinton, dated February, 1916. The great tank break-through of 8th August, 1918, was almost exactly in accordance with the forecast of their rôle in this memorandum.

In November, 1917, the Tank Corps was at last given an opportunity to attack without preliminary bombardment and preparations were made at very short notice for the Battle of Cambrai. In this battle General Elles advanced in the leading tank and led the Tank Corps to their great victory, which once for all settled the controversy upon the value of tanks and established them as a new arm in war.

Many Royal Engineer officers in France were anxious to join the Tank Corps but few could be spared. Lieut.-Colonel R. C. R. Hill, however, commanded a tank battalion, and Lieut.-Colonel L. C. A. de B. Doucet, R.E., commanded the tank supply units, which consisted of the older pattern tanks fitted up as supply tanks, able to pass over the shell-torn ground and refill the fighting tanks in the field. Captain G. le Q. Martel, R.E., was G.S.O.2 at Tank Corps Headquarters in France. Another officer, Captain S. H. Foot, R.E. (S.R.), joined as an engineer officer and a little later became a Brigade Major to a Tank Brigade. In 1918 he went to the War Office on the Staff of Major-General Sir John Capper, where he made some very valuable proposals for future policy in mechanization.

MAINTENANCE

At a very early stage it became clear that the repair side of the Tank Corps in France would be a matter of primary

importance. Repairs in the field were normally the duty of the Army Ordnance Corps, who employed ordnance mechanical engineers, but the Ordnance Corps started the war with totally inadequate strength and organization of mechanical engineers to compete with the work. From the earliest days it was manifest that the A.S.C. must take over from the A.O.C. the responsibility for maintenance of mechanical transport. On the arrival of tanks in France it was, therefore, decided not to overload the A.O.C. with additional responsibilities, but to form a body of engineers within the Tank Corps for this work. The decision was a wise one. These engineer officers belonged to the Tank Corps and wore the Tank Corps badge, though they remained on a special list as Tank Engineers. Several engineers who had received temporary commissions as Royal Engineers were transferred to the Tank Corps for this purpose. The head of the Tank Engineers was Colonel F. Searle, who had been well known in civil life before the war as a mechanical engineer. He founded a system of maintenance and repair by spare parts which undoubtedly contributed very largely to the mechanical success of the Corps, and this system has been largely followed ever since by all mechanized units.

In addition to repair work these Tank Engineers formed salvage units, which were later called field companies, for the salvage of damaged tanks on the battlefield. The work was a most hazardous undertaking, in which Captain Hon. R. T. R. P. Butler, D.S.O., M.C., distinguished himself. This officer originally held a temporary commission, R.E.

BRIDGING.

We have already seen that a body of mechanical engineers was needed on the repair side for tanks, and it soon became clear that assistance from engineers was also needed on the tactical side. For instance, although the tanks had considerable obstacle-crossing capacity, there were many common and natural obstacles that would hold them up. Assistance was required in crossing these obstacles, and required in the

forefront of the battle. It soon became clear that Royal Engineer units would eventually be needed to carry out much of this work and would have to make use of mechanical power to assist them. Special Royal Engineer units were not, however, formed until 1918, but in the meantime some interesting work of this nature was carried out, partly by the Tank Corps itself, and partly by Royal Engineer officers who were detailed to assist in the task. It will be remembered that the commander of the Tank Corps and some of his staff were Royal Engineer officers, so that no difficulty was experienced in directing this work even before the special units were formed.

The first apparatus that had to be devised was a type of bridge which would enable medium tanks to follow heavy tanks across very wide trenches that were beyond the spanning capacity of the medium tanks. To meet this demand, a bridge was designed in the form of a sledge. This consisted essentially of two steel joists as main girders, cross braced together, and provided with timber decking. The bridge was 20 ft. long and could be towed quite easily by a heavy tank; the tank would cross the wide trench and the bridge followed without difficulty. When the bridge was spanning the trench, the towing attachment could be released from inside the tank, leaving the bridge in position. A number of these bridges were made and would have been laid by the Tank Corps themselves during an advance, but by the time we had a number of medium tanks in France, the conditions of warfare had changed, and the bridges were therefore little used.

Another bridging device that was developed provided a means of assisting the passage of infantry, who were co-operating with tanks. The solution was found by carrying a light bridge in the form of a trench board on the tail of the tank. While advancing to the attack the tanks would carry these bridges like horns on their tails, and if they crossed a trench filled with barbed wire, the bridge would be lowered and released over the trench so as to provide a crossing place. The work of lowering the bridge into position was, of course, done quite simply from inside the tank.

At about this time it became clear that the Tank Corps would need far more assistance from the Royal Engineers and that special mechanized Royal Engineer units would eventually be required. As a first step Major C. E. Inglis, Royal Engineers (Professor of Engineering at Cambridge), so well known to the Corps, and at that time engaged at home on the design of bridges, was instructed to co-operate with the Tank Corps on all this work. Major Inglis visited headquarters Tank Corps in France; it was explained to him that special mechanized Royal Engineer units would probably be formed, and certain requirements were discussed with him. First of all as regards main bridges, it was clear that tanks would be built in increasing numbers and their weight and size were such that special road bridges were required. This was a question affecting the whole army, and Major Inglis was charged with the responsibility of producing designs of both girder and floating bridges to meet these requirements. As regards the special needs of the Tank Corps, one of the first demands was for a form of bridge to enable tanks to cross short gaps under fire. The country in France was intersected with small streams and canals; such obstacles could often be crossed by the use of quite short bridges about thirty feet in length. It was, however, decided to start on experimental work for a 21-ft. bridge which would enable tanks to cross canals at the locks. The idea was that the bridge should be carried by a special tank and lowered over the gap when required, the work of lowering being controlled from inside the tank.

Another request from the Tank Corps was that some thought should be given to the possibility of pushing a bridge mounted on idle trucks, the idea being that the bridge would be launched by a tank from the rear and so enable gaps of up to perhaps sixty feet to be spanned under fire.

In 1918 it was decided that three special Royal Engineer battalions should be formed to carry out this work in the field. These were the first fully mechanized Royal Engineer units. They were formed at Christchurch, Hants, in October, 1918. Each of these battalions was to have been equipped with twelve heavy Inglis tubular bridges to take the heaviest tanks

and also forty-eight special bridging tanks, each carrying a 21-ft. bridge for use on short spans such as canal locks. In addition, it was intended that these Royal Engineer units should carry out other special work of an engineering nature rendered necessary by the introduction of mechanization. They were hardly established when the Armistice occurred, and two of the three battalions were then disbanded. The third battalion was maintained to continue the experimental trials which had been begun, and was commanded by Lieut.-Colonel G. Le Q. Martel, R.E., who had initiated this work in France, while serving as G.S.O.2 at headquarters of the Tank Corps. Shortly after the Armistice, however, the battalion was reduced in size and was called "The Experimental Bridging Company," with Lieut.-Colonel Martel still in charge.

In the meantime, Major Inglis had produced some excellent experimental equipment. The tubular bridge carried the 35-ton tanks over a span of 105 ft. and could be erected very quickly. The special bridging tanks carrying the short-span bridges also materialized. In addition, special large pontoons were provided for use in conjunction with the tubular work for bridging wider rivers.

DIRECTOR-GENERAL OF THE TANK CORPS

Before leaving the war period mention must be made of the valuable work carried out for the Tank Corps by Major-General Sir John Capper (late R.E.). In May, 1917, General Capper was appointed Director-General of the Tank Corps with his headquarters in London. The Tank Committee was formed under his chairmanship to systematize and strengthen co-operation between the Army and the Ministry of Munitions. The Director-General was responsible for all training at home, which was carried out mainly at Bovington under a brigadier-general.

The Director-General constantly came over to France in an advisory capacity and this established a close and valuable liaison between the Tank Corps in the field and the administrative problems at home. He also visited G.H.Q. and the armies

in the field, to press upon them the importance of tanks. Under the Director-General, a close liaison was established between the section of the Ministry of Munitions dealing with tanks and the headquarters Tank Corps in France, and he did much to guide design on the right lines. He was responsible for putting before the War Cabinet, proposals for numbers and types of tanks required. The Director-General was not, however, on the War Office staff and this made his position much more difficult. In spite of this he had steered the Tank Corps through a difficult time, but in August, 1918, a change was made in the organization and Colonel J. F. C. Fuller came home to be in charge of a branch dealing with tanks under the Director of Staff Duties at the War Office, and the appointment of Director-General was abolished.

CHAPTER XVIII

FIELD DEFENCES, MINING AND CAMOUFLAGE

Field defences—Mining on the Western Front—Formation of tunnelling companies—Growth of mining during 1915—Appointment of Inspector Mines—Offensive mining operations—Decline of mine warfare in 1917—Tunnelling Companies in 1918—Personnel of tunnelling companies—Camouflage—Products of the camouflage factories.

FIELD DEFENCES

IN a war that lasted over four years, and, of which the greater part was more or less static trench warfare, it was natural that considerable development and change should have come about in the nature and disposition of the defensive works, in the respective shares of engineers and infantry in their construction, and in the numbers and organization of the engineer troops in the line. The change in the nature of the works affected not merely the design of the trenches, etc., but also their tactical organization and layout, and the manner and strength with which they were occupied.

The regulations and the training before the war only envisaged the use of field defences for purely temporary purposes, and specially emphasized the necessity for the resumption of an energetic advance at the earliest moment.* The conception that energetic advance might prove impossible and that the operations might degenerate into the conditions of siege warfare had not apparently entered the minds of those responsible for army training. The manual, *Military Engineering, Part II, Attack and Defence of Fortresses*, 1910, defined a "storm-proof" work as one of which "the design is such that, given a complete and efficient garrison, attacking infantry can be destroyed as fast as they can approach, no matter how great

* *Manual of Field Engineering*, 1911, Sec. I, para. 5.

their dash and determination."* It went on to say that "a work can only be rendered storm-proof by the construction of a deep ditch, causing the assailants to crowd together at points where they can be shot down at short range either from galleries in the counterscarp or from caponiers projecting from the escarp." In short by the methods of the eighteenth century! This too, after the South African War ten years earlier in which Boer defensive positions consisting of simple trenches and barbed wire had proved themselves over and over again to be storm-proof! The general attitude taken up in regard to instruction in siege works was that operations in a European war would be so mobile that the necessity for siege operations would be most unlikely to arise. One practice exercise in the attack of defensive works was held in 1907, with a view to studying the possible contingency of a British Expeditionary Force, which had landed on an enemy's coast, finding itself called on to attack the permanent defences on the land front of a coast fortress. Apart from this, little attention was paid to the subject. The lessons that could have been learned from the siege and defence of Port Arthur in 1904 were ignored, and no attention was paid to the German siege manoeuvres of 1908, of which a full account was published in English. The annual training of R.E. field companies in mine warfare was cut down and the mining equipment, previously held for training purposes, was nearly all taken away. The infantry also had very scanty training in field entrenching. They were indeed discouraged from practising it at manoeuvres by the rule that units who dug trenches must return afterwards and fill them in. Imbued with the spirit of the offensive, as inculcated by *Field Service Regulations*, few divisional commanders either asked for or took advice from their Cs.R.E., and still fewer had any conception of the value of the assistance that their field companies could give, or of how to employ them. It is not surprising that the Expeditionary Force arrived in France very ill prepared for the conditions which faced it after the few months of the opening phase of the war, conditions that, after

* *Military Engineering, Part II, Attack and Defence of Fortresses*, 1910, footnote to Sec. 2.

the flanking movement to the north had reached the sea; soon became those of siege warfare. It was fortunate that those immediately responsible for the training of R.E. field units before the war, with the customary independence of thought of the R.E. officer, had not shared the official view that the coming war would be of a type giving no scope for field or siege engineering. Both at home and in India experiments were carried out in the making up of *ex tempore* hand grenades, with the appliance known as the "Bangalore torpedo" for demolition of barbed wire, and with various other field and siege expedients, and field unit commanders did their best within the limits of the restrictions imposed from above to prepare their units for the work they saw coming.

In consequence of the omission by the higher commanders and staffs to study or practise the methods of siege warfare all the lessons which might have been drawn from past campaigns were lost. The elementary tactical principles which should govern the layout and occupation of a trench system were unknown and even the nomenclature had been forgotten. As the *Official History* puts it* "a fresh vocabulary was created to meet the new conditions." All trenches other than fire trenches were called "communication trenches" regardless of whether the communication was lateral or from the rear. The old word "approaches" used in the Peninsula and the Crimea, which gives a shorter and more soldierlike description of their purpose, had been forgotten. All forms of overhead cover, whether the flimsiest protection that would barely keep out splinters, or the deepest bomb-proof, were alike called "dug-outs." Mining became "tunnelling"; "grenades" became "bombs." Much worse than this, however, was the utter inadequacy of the supplies of entrenching materials, tools and trench weapons. In the first battles round Ypres, barbed wire was almost unobtainable,† entrenching tools scarce,‡ sandbags inadequate.§ The service hand-grenade,

* *Official History*, 1915, Vol. I, p. 153.

† *Official History*, 1914, Vol. II, p. 154.

‡ *Official History*, 1914, Vol. II, p. 273.

§ *Official History*, 1914, Vol. II, p. 206.

costing more than £1 and rarely obtainable, was quite unsuitable for trench warfare, since it had a long linen tail, a long handle and a percussion fuse which made it very unsafe to throw from a trench. No others were available from home before September, 1915, and in 1914 the field companies at the front were employed on the production of makeshift ones. No trench mortars were available and for these also rough and ready substitutes were made by the R.E. The German army, however, soon after trench warfare began, was fully equipped with hand grenades and trench mortars and also with light-ball pistols, of which none had been supplied for the B.E.F.

Towards the end of 1914, Captain B. C. Battye, R.E. (later Colonel, D.S.O.), then serving with the Indian Corps, designed and produced for that Corps cast iron segmented hand grenades, filled at first with gun-cotton dry primers and later with ammonal. At the end of December, 1914, Captain H. H. Bateman, R.E. (later Lieut.-Colonel, D.S.O., M.C.), of the 26th Field Company, acting under the orders of Brigadier-General S. R. Rice, then Chief Engineer of the I Corps, organized a bomb factory for the supply of the whole B.E.F., at 78 Rue de Lille, Béthune, where he produced, with French civilian labour as well as sappers, bombs of the Battye design filled with ammonal and fitted with Nobel lighters. For nine months, often under shell-fire, which luckily never scored a hit on the room where ammonal was being filled into the bombs, Captain Bateman and his band of workers continued to turn out bombs to an average daily output of 1,000 to 1,500. Including a special issue of 80,000 for the battle of Loos, the total output of the factory came to about a quarter of a million. The output of the Béthune factory was the only reliable source of supply for the B.E.F. until issues of cricket ball grenades with fuse lighters, which, however, were useless in wet weather, came from England in September, 1915. The well-known Mills bomb began to be supplied soon after.

The trench works made about the time of the first battles round Ypres consisted of shallow trenches, in short lengths, often separated by gaps amounting to 200, 300, or even 400

yards.* As the fighting stabilized, the trenches were deepened and connected up laterally. Trench positions for support and reserve troops were added later and approach trenches constructed. Thus the main elements of a defensive position were gradually built up. The fire trenches, which were at first very narrow, were made in short lengths separated by narrow traverses. As time went on they were widened to about 7 ft. at the top and 2 ft. at the bottom, with a depth of 6 ft. 6 in. or 7 ft.; and traverses 12 to 15 ft. in width were made which really would localize the effect of shells. The communication trenches were either zigzag in trace or were also laid out in short lengths with traverses. In the winter months drainage of all trenches became a matter of great importance and great difficulty. Many types of revetting were tried, but sandbags were by far the most popular. They required less skill, fewer special tools and smaller carrying parties. They were, moreover, far safer under shell-fire and easier to repair. Overhead cover was long in coming about. At first it consisted of roughly undercut shelters (known as "funk holes") in the front parapet, then these were enlarged and roofed with planks or corrugated iron with a little earth on the top. It was not until the summer of 1916 that really shell-proof cover was generally provided. This delay was due to the insufficiency of engineer troops and organization for supplying material, and also to the fact that most of the areas occupied in the winter of 1914/15 were in low lying ground with the water-table very near the surface.

The method of holding defensive lines of the above type during the first two years of the war may be described as the "linear" system. It consisted in regarding the front line as the main line of defence on which the defensive battle was to be fought out at all costs. It was therefore occupied as thickly as possible, generally with about a man per yard of parapet. The support line, eighty to a hundred yards in rear, was held at from a quarter to half the strength of the front line. For the first year of the war the shortage of troops seldom permitted of any being allotted to the reserve positions. In the winter of

* *Official History*, 1914, Vol. II, p. 175.

1915, 16 the normal practice of an infantry brigade holding a sector of the line was to allot two battalions to the front and support lines, one battalion to the reserve line, about 1,000 or 1,200 yards in rear of the front line, and to have one battalion in mobile reserve in a village at a short distance behind the trench system. A division holding the line would have two brigades in the line abreast of each other and disposed as above, the third resting in villages two or three miles behind. The practice of holding the front line thickly led to a maximum of casualties from shell-fire and did not prevent that line being penetrated whenever a serious attack was made upon it. The great tactical weakness of the defensive systems until near the end of the war was that they grew up in a haphazard manner, with no forethought. The position of the front line, on which everything depended, was never deliberately selected on tactical grounds but was always that line to which the exhausted troops happened to be clinging when the last phase of active fighting had come to an end. Any proposal to withdraw from a faulty front line position to another one with better tactical properties a few hundred yards in rear was anathema to the higher command.

"Strong points" for all-round defence were first provided during the first battle of Ypres and also in the fighting during the winter of 1914/15. They were for the purpose of breaking up an attack which had penetrated the front line and for providing centres of resistance pending an organized counter-attack. It was not until the summer of 1917 that the practice of holding the front line in strength began to be given up, and some divisions adopted the principle of manning it intermittently, relying for determined resistance on the reserve line. This tendency to make the main line of resistance farther back continued to develop until, early in 1918, the principle of the organization of the defence in depth was definitely adopted, and the method of applying it indicated, in instructions issued from G.H.Q. In these instructions it was clearly recognized that the foundation of the defensive organization must be the main battle position, selected by the commander as that on which he intended to fight out the battle and to expend his

last resources, and that in front of this position, and forming part of it, there should be an outpost position also organized in depth, and behind it some distance in rear, further positions of defence for use in the last resort. These last were to be sufficiently far in rear of the main battle position to make it necessary for the enemy to organize a second and distinct operation in order to attack them. Each of these three defensive systems took the form of an interdependent network of trenches, posts and defended localities, constructed with a view to securing the defence of all ground of chief tactical importance to the enemy. These posts were joined up whenever time admitted by lines of trenches, giving intercommunication everywhere and making it difficult for the enemy to detect the localities which were held in force. "Switch" lines of defence, connecting the forward works with those in rear, were provided to limit the lateral progress of an enemy who had broken through the forward lines. The normal distribution of the infantry to a position of this nature, in the case of a division in the defence, was one brigade to the outpost system, one brigade to the main battle position, and the remaining brigade as a mobile reserve, which might be located in the rear defensive position or wherever cover was available sufficiently near the main battle position for it to be brought into action for counter-attack purposes. This was the final form at the end of the war of a defensive position organized and occupied in depth, though naturally it was not everywhere fully attained since lack of labour often prevented its construction.

At the outbreak of war the engineers of a division, apart from the divisional signal company, consisted of two field companies. A proposal had been made a few years before to add a third company but this was rejected by the War Office. There had been in fact a counter-proposal to abolish field companies altogether and to substitute "pioneer" units, namely infantry with special training. It very soon became apparent that two field companies were quite insufficient for the large amount of work required in modern war. In December, 1914, it was decided to increase them to three per division, and the divisions at the front were reinforced by posting to each a

field company of the Territorial Force, taken from the territorial divisions training at home, who raised new ones to take their places. When the operations became more or less static, after the spring battles in Flanders and at Ypres, the increasing demands of trench warfare made it necessary to allot to each division a battalion of pioneers, obtained by conversion and special training of certain infantry battalions of the New Armies.

During the winter of 1914/15 it was discovered that the Germans were mining under our trenches in many places. To meet this menace, which the Army Council before the war had considered so negligible that the training of field companies in this form of warfare had been reduced to almost nothing, demands were made at the end of December, 1914, for special mining companies. The work of the tunnelling companies that were raised for this purpose is described in the next section of this chapter. Besides employment in mining under the enemy lines they were later of great value for the construction of deep shell-proof cover, and also, during the advance in 1918, for removing enemy booby traps and delay-action mines. The divisional field companies were also sometimes reinforced by attaching to them men of mining experience picked from infantry battalions recruited in the mining areas of Scotland, the Midlands and South Wales. It was not till these special measures had been taken that deep shell-proof cover became available in anything like sufficient quantity.

The shallow and scattered trenches of the first autumn and winter were mostly executed by the infantry themselves often with the field entrenching tool carried on the person. They were later deepened and widened also by the infantry of whom it is recorded that they displayed "considerable lethargy and a marked disinclination to dig"—no doubt owing to the inadequacy of their training before the war. When it was possible to undertake the deliberate execution of trench-work the usual practice during the first year of the war was to allot to the task a strong infantry working party and a section of a field company R.E. This was a wasteful method since the engineers were being employed on unskilled work when there

* *Official History*, 1915, Vol. I, p. 5.

was much skilled work required that could not be done at all without them. Another example of wasteful method was that for most of the first year all wiring was done by the R.E., though this was work which infantry could have easily been trained to do, and the strength of the engineers was quite inadequate to put up the large amount of entanglements required. This was no doubt the reason why the wire on the British front was always so much weaker than that on the front of our French neighbours.

In the course of time, as the necessity for skilled work in making dug-outs, in mining, revetting, trench boarding etc., became more and more pressing, the infantry were required to do the simple trenchwork without the assistance of engineers, except for laying out the trace and for supply of tools etc., and also to wire their own front, the engineers being kept for work which the infantry could not do. Even then the engineers required reinforcement by temporary working parties from the infantry for the unskilled work such as carrying up materials, the removal of spoil from mine galleries etc. This work was much disliked by the infantry who believed they were being exploited for the benefit of the R.E. and was called "R.E. fatigues." The arrangement was also not liked by the engineers who often had to work with unwilling and resentful infantry officers and men, who had never been taught that the work in the execution of which they were required to assist was for their own security, and that it was not unreasonable to ask them to lend a hand in it. Later the practice was adopted of attaching an infantry working party permanently to each field company, with whom they were billeted and fed. This arrangement worked much better. The infantry soon learnt to do the work required of them and became efficient at it; they made friends with their R.E. partners in toil and were willing and contented, but it was not very satisfactory to the infantry battalion commanders who lost a considerable number of their rank and file for a long time.

Apart from this the organization of the technical troops was defective, owing to its having grown up without forethought. The pioneer battalions did excellent and most

valuable work, but the divisional pioneer battalion was entirely independent of the C.R.E. and was supposed to, and generally did, receive its orders direct from the general staff. The latter no doubt as a rule acted on the advice of the C.R.E. in regard to the employment of the pioneers, but the want of a single controlling commander for all the technical work of the division was not conducive to efficiency. In practice the pioneers often to all intents and purposes worked under the C.R.E. who could thus divide the necessary tasks between them and his own field companies in the most convenient manner, but this arrangement, since the two commanding officers were of the same rank, and the pioneer C.O. sometimes the senior, was not an ideal one. The fact that it nearly always worked satisfactorily was due to the good sense and goodwill exhibited on both sides.

MINING ON THE WESTERN FRONT

In the war of 1914-18 it was perhaps not surprising that military mining, the oldest application of engineering to the art of war, should be employed on a vast and unprecedented scale. As, however, the size of the underground operations carried out on the Western front is not always realized, a statement of three outstanding facts, may help to give some measure of the extent of this struggle :—

In 1916, when mine warfare had reached its height on the Western front, some thirty of the eighty miles of front held by the B.E.F. were protected by underground galleries, in several instances at more than one level. In some sectors, notably south of La Bassée, it was possible to walk along a continuous underground gallery in front of the British trenches for several miles.

During 1916 nearly 1,500 mines were fired by both sides on the British-German front, the majority not as part of any major or local surface attack, but in the process of more or less continuous underground warfare.

By the middle of 1916 the British had a total force of approximately 25,000 men actively engaged in mining.

It will be realized from the above that to describe in detail the numerous underground operations carried out would be quite beyond the scope of this history. All that can be attempted is to give in outline the conditions which created the need for this intensive mining, the nature of the units formed in the corps to carry out the work, and a brief description of their achievements. For more detailed information the reader is referred to the following two books on the subject: *Work of the Royal Engineers in the European War 1914-19—Military Mining*, published by the Institution of Royal Engineers in 1922, and *Tunnellers, The story of Tunnelling Companies Royal Engineers, during the World War*, by Captain G. Grieve and E. Newman (Herbert Jenkins Ltd., 1936). These two books will be referred to hereafter as *Military Mining* and *Tunnellers* respectively. In addition to the above, *The Life of a Tunnelling Company*, by Captain H. W. Graham (Hexham J. Catherall & Co. Ltd., 1927), being the experiences of this officer in the 185th Tunnelling Company during the war, throws an intimate and interesting light on life in a mining unit.

During the years immediately preceding the Great War little study or training in mine warfare was carried out in the Corps, though two units, the 20th and 42nd Fortress Companies, R.E., received special training in this branch of engineering during the years 1911-14. These two companies went to France in August, 1914, with the B.E.F., in which, among their other functions, they were "earmarked for siege duties." Actually, however, as they were the first units to be converted to army troops companies, they took little direct part in the underground struggle that was shortly to develop. On the other hand many of the officers and N.C.Os. of these two units were drafted to the earlier tunnelling companies on formation, to provide the necessary nucleus of regular personnel.

The neglect to make a larger provision of trained personnel was largely due to the belief, then generally held, that any European war of the Great Powers would be quickly ended by one short decisive campaign; protracted sieges, in which underground attacks would be useful, had no place in this pre-war conception. For the same reason no doubt, in spite of a

significant instance of the attack and defence of trenches by mining during the Russo-Japanese war of 1904-5 (the first instance of the use of mining against field fortifications), the possibility of the employment of mining in trench warfare was given little consideration. Nevertheless it was exclusively in this new field that military mining was to be applied on such an extensive scale on the Western front.

Here the long period of position warfare which, commencing in the autumn of 1914, and lasting for nearly four years, produced conditions up till then associated with fortress warfare. Improvement in weapons during the years preceding the war had conferred advantages on the defence, the consequences of which had been difficult to foresee; the strength of positions behind wire entanglements had become almost the equivalent of that of the permanent fortifications of earlier periods. The two opposing systems of field works extended almost unbroken from the Swiss border to the English Channel, and therefore presented no vulnerable flanks. It soon became evident that decisive results could not be obtained by frontal attacks delivered by the then accepted methods of field warfare. A deadlock had been reached, in which many of the features peculiar to siege warfare were reproduced on a vast scale.

In many places the trenches were but a few hundred feet apart, and occasionally far less; they were packed with men and there was no depth in defence, so that the tactical situation was favourable to mine attacks. In these the Germans were the first aggressors. The attack was apparently part of a general plan, for in December and January, 1914-15, German mines were exploded in a number of sectors from Lorraine to the plains of Flanders, notably, on the British front, at Givenchy and Guinchy and in the Ypres salient.

To the British infantry in France, experiencing the first and in many respects the most trying winter of the campaign, a new horror was added. It was clear that immediate underground defensive measures were called for, as well as offensive mining in retaliation. Field companies, fortress companies and field squadrons started mining operations where the situation was most threatening. With their many other im-

portant duties, however, these units had neither the personnel and equipment, nor, in many instances, the necessary experience to cope with this new problem. To assist the field companies, officers and men with experience in mining in civil life were drawn from battalions in the line and formed into brigade mining sections, each of which usually consisted of one officer and about fifty other ranks. It was soon evident, however, that this improvisation was not the final solution, and that the formation of engineer units specially organized and equipped was essential.

FORMATION OF TUNNELLING COMPANIES

In December, 1914, Major J. Norton Griffiths, M.P., 2nd King Edward's Horse, had written to the War Office stating that the engineering firm of which he was the head had a number of expert underground tunnellers and borers, who had experience in driving tunnels under London and other large cities. He suggested that these "clay-kickers," as they were called from their special method of tunnelling, would be particularly suitable for mining in the Flanders clays. When therefore a decision to form special mining units was reached in February, 1915, Major Norton Griffiths was authorized to enlist miners for service in France, and the formation of eight tunnelling companies was approved by the War Office.

The need was so urgent that the first five tunnelling companies (170th, 171st, 172nd, 173rd and 174th) literally came into being in the front-line trenches, and elements of these units were engaged in active mining within a few weeks of their authorization. Miners or clay-kickers were enlisted one day, equipped at Chatham the next, and were working underground in France within a fortnight of leaving their civil occupation. A considerable proportion of the personnel was also obtained by transferring to the Corps men of brigade mining sections and any other suitable infantry with mining experience who volunteered. Most of the new units were attached to field companies at the outset but they quickly became independent. The formation of the remaining three

of the first batch of tunnelling companies (175th, 176th and 177th) took place under rather less harassing conditions. The 177th Company did not go into the line till June, 1915.

Officers were obtained by granting commissions in the Corps to mining engineers, or by the transfer of officers with a knowledge of mining already serving in other branches of the army. The earlier companies were commanded by regular R.E. officers. Later, as these became casualties or new companies were formed, selected war-time officers who had gained the requisite military experience were appointed to command. By 1918, all the tunnelling companies were commanded by officers holding temporary commissions.

The establishment of these units was initially nine officers and 283 other ranks organized into H.Q. (including a small nucleus of regular personnel for administrative duties) and four sections. These numbers were soon found to be quite inadequate, and, after several increases, an establishment of nineteen officers (including an adjutant and a medical officer) and 550 other ranks was finally approved. Each tunnelling company had in addition, for the provision of unskilled labour, a varying number of permanently attached infantry—often during the most intensive period of mine warfare as many as 500. Thus not infrequently the officer commanding was in control of over 1,000 men.

More details of the formation of the first tunnelling companies will be found in *Military Mining and Tunnellers*, but no account however brief is complete without some tribute to the genius and energy of Major Norton Griffiths, who was attached to G.H.Q. in France to advise and assist in the formation of these units. Apart, moreover, from his tireless enthusiasm for the task in hand, he was gifted with great foresight. It was, for instance, due to his insistence that tunnelling companies were provided with mechanical transport (four 3-ton lorries, one box car and twelve motor cycles); they were the first engineer units to be mechanized on any scale. To this wise provision not a little of the efficiency of tunnelling companies may be attributed.

In the matter of equipment, as well as personnel, much was

needed. Many essential items were archaic in design, for the British army had had no experience in mining since the Crimean War. The Rootes blower, an inefficient and exceptionally noisy rotary air pump was the only ventilating apparatus available ; it achieved little except to attract enemy attention. An unwieldy and dangerously ineffective form of smoke helmet was all that was provided for mine rescue ; listening apparatus was non-existent. Modern equipment, adapted after careful trials to suit active service conditions, had therefore to be obtained, or, as in the case of listening apparatus, special equipment had to be designed for the purpose.

In 1914, black gunpowder was still the standard explosive for mine charges and it was used in most of the earlier underground attacks. High explosive, however, soon entirely displaced black powder owing to the greater effect obtained. Gun-cotton was used at first, but was disliked because of the large amount of carbon monoxide left behind in the ground. Ammonal was then adopted as the service explosive for mines, though occasionally gun-cotton, blastine and other high explosives were used instead. The problem of providing an adequate supply of explosive, always available wherever required, was a formidable one, for the quantities used in mine charges rose by leaps and bounds ; in 1915, 5 tons was considered a big mine ; in 1917 the record mine of 42 tons in one single charge was fired.

GROWTH OF MINING DURING 1915

While this new force was being organized, mining activity continued to increase. During the spring of 1915, our infantry suffered casualties at several points as a result of German mines and in the subsequent fighting. Brigade mining sections, reinforced by the first elements of tunnelling companies as they became available, did their best to cope with the situation. These first efforts frequently consisted of narrow crooked galleries, too shallow for adequate defence. But if this work was not always effective, it served a great purpose in restoring confidence to the troops in the line. The holding of trenches knowing that they may be blown up at any moment, and

that no counter measures are being taken, is sufficient to shake the stoutest of hearts.

Nor were these early underground activities entirely confined to the defensive. Numerous galleries were driven under the enemy trenches, and from these mines were fired to assist infantry attacks and raids; one example was that of Hill 60. Here miners drawn from the 1st and 3rd Battalions Monmouthshire Regiment (I.A.), subsequently reinforced by a section of 171st Tunnelling Company, succeeded in driving under the German trenches three galleries from which mines were fired in conjunction with a successful infantry attack on 17th April, 1915.

By June, 1915, as we have seen, the first eight tunnelling companies had been formed and were in the line. Almost every week, however, mining broke out in some new sector of the front. In the same month the Third Army took over from the French a new front, north of the River Somme, where mining had also started. Five new tunnelling companies (178th, 179th, 180th, 181st and 182nd) were formed to deal with the increased underground liabilities. Still the demand for mining units outstripped the supply, both on account of increased mining activity, and the growing extent of front held by the B.E.F. In particular the Vimy Ridge, taken over from the French early in 1916, added a sector in which intensive underground fighting was in progress. As a result twelve more tunnelling companies (183rd, 184th, 195th, 250th, 251st, 252nd, 253rd, 254th, 255th, 256th, 257th and 258th) were formed at various times during the period August, 1915, to June, 1916.

Moreover underground operations were not entirely confined to the campaign in France. In the Gallipoli peninsula, mining broke out on the fronts held by the New Zealand Division* and the 29th Division in May, 1915, and soon spread to many sectors, for the nature of the soil was favourable and the tactical situation somewhat similar to that on the Western Front. Mining sections from Australian, New Zealand and British infantry were formed on much the same lines as in

* See *History of the New Zealand Engineers*, Evans, Cobb and Sharpe, Ltd., Wanganui, N.Z.

France. Several mining attacks were launched at the opposing trenches by both sides and intensive mine fighting developed in which our forces gradually gained ascendancy. An account of the mining operations in this campaign will be found in *Tunnellers*, Chapter III. It was in Gallipoli that the 254th Company started active life, though arriving only shortly before the evacuation. This unit absorbed within its ranks the British mining sections already formed.

In addition to the total of twenty-five tunnelling companies already mentioned, the overseas contingents provided seven (three Canadian, three Australian and one New Zealand), and the Australian forces also formed a unit designated "The Australian Electrical and Mechanical Mining and Boring Company." This unit, working over the entire British front, proved of the greatest value to all tunnelling companies both British and Dominion, particularly in carrying out trial bores to obtain geological information and in the provision and maintenance of power plants for the illumination of mine galleries and subways.

Thus, by early 1916, had been assembled a vast force of miners which in numbers was not far short of the total of other engineer effectives engaged in the front line in France.

Tunnelling companies from their inception had been made army troops; a wise provision in view of the importance of these units remaining more or less permanently in the same part of the line in order to gain an intimate knowledge of the local underground conditions. During 1915, the direction of the work of tunnelling companies had been of necessity delegated to corps or divisions. Neither in these formations, however, nor with armies or at H.Q., was there an expert to advise on the employment or administration of these new units. Chief Engineers and Cs.R.E. did what they could to fill this rôle among their many other heavy responsibilities and duties, but the tactics of military mining in this war of position was a specialized and intricate subject. Moreover, in a campaign where every battle overground had its mining counterpart below, co-ordination of underground policy and effort had become essential.

Thus the mining situation at the end of 1915 was far from satisfactory, and, although much valuable work had been carried out, there had also been much mis-spent energy and wasted effort. Units had frequently been pitted against trivial objectives quite incommensurate with the labour involved, and defensive systems had been put in where the likelihood of underground attack was remote.

There was also still much room for improvement in technical equipment, but, until some centralized organization existed to collect and weigh the opinions of units in the line on such questions as power plants, listening apparatus and problems of a similar nature, the best solutions were unlikely to be forthcoming. Again there was an obvious need for centralized control to compile records and data, and to disseminate items of technical importance to units. Hitherto facilities for the interchange of ideas and information on mining questions had been meagre.

APPOINTMENT OF INSPECTOR OF MINES

It was in these circumstances that on 1st January, 1916, Lieut.-Colonel R. Napier Harvey was appointed Inspector of Mines at G.H.Q. in France, with the rank of Brigadier-General. General Harvey in his previous capacity as assistant to the Engineer-in-Chief had been closely concerned with the formation of tunnelling companies from the inception of these units; he thus had first-hand knowledge of the task before him, while his unsparing energy and ready sympathy with the miner made the appointment a thoroughly successful and happy one. To his staff, Major R. G. Stokes, an experienced mining engineer, who had seen service in the line from the start of mining on the Western front, was appointed Assistant Inspector. Simultaneously with the formation of this inspectorate an R.E. officer was appointed Controller of Mines at each army H.Q., with the rank of Lieut.-Colonel and a technically qualified officer as assistant. The functions of these new appointments can be interpreted from the remarks in the preceding paragraphs; their precise duties and war establishments will be found in *Military Mining*, Part I, Chapter I.

The effect of the introduction of this specialized administration soon became evident. As has been seen, the Germans had gained a great advantage by an early start. Though, by vigorous local underground offensives, the difficult task of driving the enemy back had been accomplished at numerous points, there were still many sectors of the line, particularly on the fronts recently taken over by the B.E.F., where the enemy was under or dangerously close to our trenches. With control now centralized it was possible to concentrate underground forces where they were most needed. It was on the First Army front from the La Bassée canal to the Vimy Ridge that the most intense underground fighting took place, and on this front alone over 800 mines were discharged by both sides during 1916. Gradually, however, under the direction of Lieut.-Colonel G. C. Williams, Controller of Mines, First Army, the enemy was driven back. Superiority underground was obtained both here and at other parts of the line where the situation had been unfavourable.

Our success was primarily due to the fact that we were now better organized and equipped than our opponents. Data obtained during and since the war definitely prove that on the average we drove galleries more rapidly than the Germans. Moreover, as a rule, we were quicker to get into our galleries after a "blow", either our own or the enemy's, and by this method gained ground before the opposition could take counter measures.

The spring of 1916 saw our trenches adequately protected against sporadic underground attacks at nearly all threatened points and at the same time, under the able direction of General Harvey, mining offensives, designed to help forward future major operations planned by G.H.Q., were commenced.

Technical efficiency under the new administration also made great strides. Gas poisoning, due to carbon monoxide formed from the incomplete combustion of charges, was a prolific source of underground casualties. In fact, during 1915, deaths from this cause considerably exceeded those inflicted by direct enemy action in mine fighting. In the autumn of 1915, men trained in rescue work in the coal mines at home had been

enlisted to act as instructors to mine rescue squads to be formed in France, and Lieut.-Colonel D. Dale Logan, R.A.M.C., an officer with experience in this work and in diseases peculiar to miners was attached to G.H.Q., as adviser on these matters to the Engineer-in-Chief. On the appointment of General Harvey this mine rescue organization was absorbed in his inspectorate. Schools were formed in each army for the training of men in the wearing of oxygen breathing apparatus and mine rescue duties; well equipped rescue stations were established in all sectors where mining was in progress and a supply of canaries and white mice, used to detect the presence of carbon monoxide was provided. A detailed account of this aspect of the struggle will be found in *Military Mining*, Part II.

Later in 1916, the scope of these army schools was extended to include instruction in all branches of military mining in addition to mine rescue work. Various courses for officers and N.C.Os. were held in which instruction was given in the technique and tactics of mine fighting, the art of listening with and without instruments and the design and construction of mined dug-outs. These mine schools were also used as establishments for carrying out experiments and for testing mining apparatus.*

Geology was another field in which expert assistance was needed. With the Australian E. & M. Mining and Boring Company, already referred to, had come Major T. W. E. David,† indeed, this eminent geologist played a prominent part in the raising of the Australian mining units. Major David became geological adviser to the Inspector of Mines, and thanks to his knowledge and indefatigable work, both in and out of the line, tunnelling companies were provided with geological information which proved invaluable in planning offensive and defensive operations. Detailed information was obtained on the extent and depth of the blue clay (the most suitable mining strata) in Flanders, the seasonal variation of

* For further information see *Military Mining*, Part III, Chapter V.

† A memoir to Sir T. W. Edgeworth David will be found in the *R.E. Journal* of December, 1934.

water level in the chalk, and on many other questions of vital importance to the miner.*

As regards improvement in equipment, the introduction of power plants had obvious advantages in the promotion of efficiency and reduction of man-power. Much was done in this direction in the matter of pumping, ventilation and lighting, though owing to the limiting conditions of trench warfare excavation by power tools did not prove very successful. Probably the most important technical advance was the introduction of the Geophone, a simple but most effective instrument for underground listening, invented during 1915 by a Professor at the Sorbonne University in Paris. The introduction of central listening stations in large mine systems was also an important step.†

OFFENSIVE MINING OPERATIONS

The opening of the offensive on the Somme in July, 1916, was the first occasion on which tunnellers were employed to assist the initial stages of the advance of a major operation. Although conditions were unsuitable for offensive mining, the substratum being chalk in which the approach of a gallery could be easily heard by the enemy, the mines fired were extremely successful. In addition "Russian saps" were driven in the surface clay across no-man's-land to provide advanced emplacements for trench mortars and machine-guns, or communication trenches to be opened up at zero hour. Trenches across no-man's-land were also formed by hydraulic pipe-pushers.‡

Mines played little part in the Arras Vimy Ridge offensive; the soil there was chalk and conditions unfavourable. By far the most important contribution of the tunnelling companies

* For further details see *Work of the Royal Engineers, 1914-18 Geology*, published by the Institution of Royal Engineers.

† For further information see *Military Mining*, Part III, Chapter V.

‡ See *Military Mining*, Part I, Chapter IV and *Tunnellers*, Chapter V.

to the preparations for the operation was an extensive system of subways, the first occasion of their use on a large scale. Battalions, on more than half the front, were able by this means to take up their battle positions from the safe seclusion of tunnels, and thus avoid disheartening and often disconcerting pre-battle casualties. In the Vimy Ridge sector twelve subways averaging half a mile in length were driven. In front of Arras by driving some three miles of subways, a series of existing caves was connected up with the front line and with the covered-in moat of the town of Arras. Troops were thus able to descend underground in the centre of the town and travel in safety to the front line trenches some two miles distant. The caves also provided accommodation for 11,000 infantry and large quantities of stores. From the heads of subways communications across no-man's-land were provided by Russian saps or pipe-pushers as in the Somme offensive.*

The Messines Ridge offensive was launched on 7th June, 1917, to the accompaniment of the discharge of mines containing nearly a million pounds of high explosive on a front of ten miles. This is the greatest and at the same time most successful mining operation ever carried out in warfare. The enterprise is therefore deserving of rather more than the brief reference to which other major mining undertakings have had perforce to be confined in this short summary of the tunneller's work.

The soil on this front was clay, in which, unlike in the chalk farther south on the British front, work could be carried out comparatively noiselessly and thus with far smaller chance of detection. Galleries, some nearly half a mile long, were successfully driven beyond the enemy front line under the forward centres of hostile resistance. Altogether nineteen mines were laid and fired; the charges varied from 20,000 to 100,000 lb. of ammonal according to their depth and the effect to be achieved. All the mines were over fifty feet deep and some of the larger ones a hundred feet. The latter completely obliterated several acres of ground. Apart from the material destruction and disorganization wrought by the explosion of these heavily-

* See *Military Mining*, Chapter V.

charged mines, the effect on the morale of the defenders was shattering. Many of the enemy who escaped physical harm were so shaken and bewildered that they were incapable of resistance. Ludendorff in his *Memoirs* is insistent that but for the employment of these powerful mines, our infantry could not have effected a break-through on 7th June.

The attack on the Messines-Wytschaete Ridge was originally planned to take place in the summer of 1916, but postponement for a year in order to conform with high strategy on the Western front enabled the underground scheme of attack to be extended considerably. On the other hand, Lieut.-Colonel A. G. Stevenson, Controller of Mines, Second Army, and the tunnelling units under his direction, had an anxious and difficult task in maintaining the systems intact without revealing to the enemy that his positions were undermined. Moreover, some of the mines had been laid and tamped as early as April, 1916, and it says much for the skill and care with which this work had been done that they were still intact and were successfully fired on the appointed day over a year later.

As already stated, the galleries were driven through blue clay, impervious to moisture and similar to that on which central London stands and through which many of the "Tubes" have been tunnelled. Over this dry favourable stratum, however, was a subsoil of porous sandy loam varying in depth from five to forty feet. This was saturated with water held up by the clay below, as a result the loam turned to running sand when a shaft was driven through it. At many points, therefore, it was found impracticable to get down into the blue clay without the employment of special methods unsuitable to front-line conditions. In fact our skilled mining engineers found that in general a shaft could not be sunk through a greater overburden than twenty-five feet of sandy loam. Fortunately, this adverse stratum was shallower in the valley behind our forward defences than on the higher ground, and we were thus enabled to get down into the favourable blue clay strata here. On the top of the Messines-Wytschaete Ridge itself, however, the covering of sandy loam was thirty to forty feet thick, and there

were therefore very few points where the Germans could reach the blue clay. We learnt afterwards that rumours of a vast mining offensive on this front did reach the enemy through his agents, but that, on being advised by his geological experts, after putting down trial bore-holes, that deep mining was impracticable, he dismissed the reports as unworthy of credence. The German experts were in the main correct, but fortunately for us, they failed to appreciate that behind the British lines the conditions were far more favourable.

Any mining undertaking, even a small protective system of galleries, requires careful planning and direction if it is to succeed, but an offensive scheme on the scale of that launched in support of the Messines battle, on which some 6,000 tunnelers and attached infantry were employed over a long period, called for foresight, planning and direction of a very high order. Moreover, the problems to be surmounted were many and varied.

Not the least of these was the dispersal and concealment of the large quantities of spoil, excavated from the long galleries (4 ft. 3 in. by 2 ft. 3 in. in section), so that enemy suspicion of mining was not aroused. This task was rendered far more difficult by the fact that, as no outcrop of blue clay occurred on the surface in this area, the mere sight of earth of this very distinctive colour was indicative of deep mining operations. At some points the spoil was built into dummy breast-works at night; at others craters were blown artificially and the spoil dumped in them. In each case the tell-tale blue clay had to be covered with surface soil or camouflage material before daylight.

Survey presented another problem. It was of first importance that the mines should destroy the strong points on which the enemy relied for his defence. The direction of the galleries therefore had to be determined very accurately on data obtained from an excellent series of aeroplane photographs taken for the purpose. The best testimony to the precision with which the work was executed, is that all the mines achieved their objectives.

The design and construction of an underground chamber to

hold 100,000 lb. of explosives, and arrangements to ensure the efficient detonation of this large charge also provided engineering and technical problems which were successfully overcome. The loading of mines of this size called for a high degree of organization. It was desirable to avoid the risk of having large dumps of high explosive exposed to enemy fire close behind the lines; the explosive, moreover, had to be brought up by lorry from the rear, then by horse transport or trench tramway, then by infantry carrying party, before being finally taken down the shaft and along the galleries to the chamber loading party. To ensure an even flow of supply, and thus avoid undue accretion of explosive at any point in the chain, necessitated careful co-ordination and timing. In some instances the large mines were loaded without hitch in one night.

The battle of Messines affords the sole instance in modern warfare of the explosion of heavy mines playing an outstanding part in the prosecution of an assault on a strongly defended position over a wide front. Not only did the tactical dispositions, adopted during that period of position warfare in which this operation took place, lend themselves to this form of attack, but, as has been shown, the exceptional geological formation beneath the battle-ground was peculiarly suitable. The length of time available for preparation was a further favourable factor. The likelihood of a similar combination of conditions in some future campaign is probably rather remote. The unique nature of the enterprise, however, in no way detracts from the merits of the achievement.

Tunnellers played an important though less spectacular part in the preparations for the last great British offensive of 1917—Passchendaele. The soil was not particularly favourable to mining, and as explained in the succeeding section changing conditions of warfare were rendering this form of attack less effective. Ten and a half tunnelling companies were employed on this front in the provision of underground accommodation which experience was now proving to be so valuable. Battle headquarters for brigade and battalions, dressing stations, subways, observation posts, and shelters for troops were all

included in the programme. A congratulatory message from Sir Douglas Haig to the Engineer-in-Chief in which the Commander-in-Chief refers to "the splendid work accomplished by the tunnelling companies" affords convincing evidence that the by now traditional efficiency of these units was well maintained.*

DECLINE OF MINE WARFARE IN 1917

As already stated, mining activity reached its height in the middle of 1916. Thereafter it gradually fell away and underground attacks practically ceased with the triumph of Messines. The decline of mining activity in the later part of position warfare on the Western front may be traced to the gradual change in the conduct of the defence. In the earlier stages of the campaign conditions conducive to the maintenance of a strongly held front line obtained, and suitable objectives for mining enterprise were presented. With the continual growth of armaments and increase in shell power, however, the tendency to develop defence in depth, and to hold a front by fire power rather than man-power became more and more marked. The continuous front line was replaced by weakly held forward observation posts, supported by positions situated well to the rear. By the close of 1917, it had become a recognized principle that the main centres of resistance should be sited beyond the range of hostile trench-mortars and incidentally that of underground attack. Furthermore, our own isolated front-line posts did not create for the execution and concealment of mining operations those favourable conditions which had been a feature of the solidly constructed forward defence systems of the earlier phase.

Thus the evolution of position warfare tended more and more to discount the value of mining as a means of assisting the infantry assault. But though the primary purpose for which mining troops had been organized gradually disappeared, the same factors which eventually led to an almost complete cessation of mining activity called for skilled underground

* See *Tunnellers*, Chapter XI.

work in another direction ; the bulk of the tunnelling company personnel during the position warfare period of 1917-18 were employed in fulfilling the insistent and increasing demands for dug-outs, subways and similar mined works.

On the First Army front alone over twenty miles of subways were constructed in 1917. Many of these works were miniature underground fortresses. Extensive dug-out accommodation for the garrison, headquarters, signal and dressing stations, magazines and stores led off the main thoroughfares ; numerous gas-proofed and defensible entrances and exits were provided along their length ; and approaches led to machine-gun and trench-mortar emplacements at vantage points on the surface. In many instances trench tramways ran into the subways to facilitate the supply of ammunition and rations, and to evacuate casualties ; a small power-station provided light throughout, and water was laid on. The garrisons were thus self-contained.

Not only was this class of work invaluable in facilitating reliefs and reducing the casualties of everyday trench life, but the subways by linking up dug-out accommodation enabled the garrison to maintain a prolonged and concerted resistance when the surface defences had, during an attack, been overrun by the enemy. The defence of the Givenchy subway during the German offensive of 9th April, 1918, and following days, in which action the 251st Company took a prominent part, affords a classic example of the strength of works of this nature when garrisoned by determined men.*

TUNNELLING COMPANIES IN 1918

During the German offensives in the spring of 1918, tunnelers proved, if indeed further proof was necessary, that they were stubborn fighters above as well as below ground. The eight tunnelling companies on the Fifth Army front played their part manfully as infantry in numerous rearguard actions during the retreat on the Somme. They also carried out many demolitions during this action. As the German effort gradually relaxed and the front again became more or less stabilized,

* See *Tunnellers*, Chapter XIII.

tunnelling companies reverted to what had now become their normal rôle—the construction of deep dug-outs and subways. Some units, however, were employed on the preparation of extensive demolition schemes and the construction of reserve lines of defence—tasks for which they were well adapted.

The turn of the tide in the summer of 1918 called for the skill of the tunnellers in another direction; the rendering safe, or the removal, of the numerous land mines, traps and delay-action mines laid by the enemy. The Germans in their deliberate withdrawal on the Arras front, early in 1917, had left behind many of these demoralizing devices, and it was then realized that a tunneller accustomed to delve in dark and dangerous places and an expert in explosives was the man to deal with this menace. Scouting parties formed from tunnelling companies on this front had dealt with the situation on this occasion with signal success. When therefore, in 1918, a German withdrawal on a large scale appeared imminent, selected parties of tunnellers in all the armies were given a special course of instruction, based on previous experience, in the methods of investigating newly won ground and the destruction of enemy traps, etc. As a result, specially trained tunnellers accompanied advanced guards of all formations during the victorious advance. Their task was to examine and pass as fit for occupation, dug-outs, subways, buildings, etc., and any other locality in which enemy mines were likely to be laid. The work required steady nerves, keen observation, caution and ready deduction. The best proof of the efficiency of these detachments is the small number of casualties suffered by the British army from these insidious devices. Some idea of the extent of the work can be gauged by the fact that in carrying out the task over two and a half million pounds of explosive were removed or rendered harmless. The detection of cunningly concealed delay action mines proved an exceptionally difficult matter and, when discovered, the extraction from the heavy charge, of the fuse, often on the point of firing, was a delicate and highly dangerous operation. Considering the great risks that had necessarily to be taken, however, casualties among these tunnelling company detachments were surprisingly low.

Besides providing these forward detachments, tunnelling companies, in common with all available engineer units, were employed in the restoration of communications so extensively damaged by enemy action. In this new field of activity they did outstanding work. Though they possessed few skilled tradesmen they had the great advantage of being in a position to furnish a large force of men skilled in the use of pick and shovel and thus, unlike the majority of engineer units, did not have to rely to the same extent on working parties from other arms. Their comparatively liberal provision of mechanical transport was another asset in their favour. Many miles of roads were built or reinstated and 149 heavy and thirty eight light bridges constructed. The most notable engineering achievement was the construction of a heavy bridge of 180-ft. span over the Canal du Nord by the New Zealand Tunnelling Company. The work of the tunnelling companies during the fighting of 1918 is also dealt with in Chapters XIV and XV.

The great demand for miners at home after the Armistice resulted in tunnelling companies being among the first units to be disbanded. Prior to dispersion, however, they received a special message of appreciation of their work from Sir Douglas Haig in which he said "They have earned the thanks of the whole army for their contribution to the defeat of the enemy. Their fighting spirit and technical efficiency has enhanced the reputation of the whole Corps of Royal Engineers, and of the Engineers of the Overseas Forces." The full text of this unique tribute will be found in the concluding chapter of *Tunnellers*.

PERSONNEL OF THE TUNNELLING COMPANIES

The history of the tunnelling companies during 1914-18 affords a fine example of the successful performance of one of the main rôles of the Corps of Royal Engineers in a major war—the adaptation of the engineering resources of the nation to military requirements. The outstanding success of these mining units must, however, in a very large degree be attributed to the excellence of the personnel.

The miner, whether from the metalliferous mines overseas or from the collieries of Great Britain, from which the majority of the rank and file were drawn, possesses qualities that go to the making of a first-class soldier. Inured from youth to the rigours and dangers of life in the pit, the miner withstood well the hardships of the trenches, which differed only in degree from those of his normal life. Moreover he was accustomed to obey the stringent regulations enforced for safety underground and was well schooled in teamwork: thus the yoke of military discipline fell lightly on his shoulders. Above all, just as sailors are united in the brotherhood of the sea, so are miners animated by a deep sense of loyalty to their fellow underground workers, a bond which in a military environment is easily forged into a fine *esprit de corps*. The last words of Sapper William Hackett, v.c.* "I am a tunneller, I must look after my mate" is typical of the spirit of these men.

It is difficult to pay adequate tribute to the work of those who commanded this fine body of men. Many of the officers in civil life were colliery officials of eminence in mining circles at home or in the Dominions. A very large number, however, were metalliferous mining engineers who had answered the call from all quarters of the globe, "from China to Peru." They had had experience in running mining enterprises in remote districts where they had to fend and think for themselves—first-class training for the future R.E. officer. These officers, used to improvisation, were capable and ready to take on any engineering job above as well as below ground.

This enterprising spirit permeated all ranks, and towards the end of the war, when, as we have seen, mining work being no longer required, the tunnelling companies undertook other engineering tasks, the versatility of these units did much to enhance a reputation already gained underground. The tunnellers, organized as specialized R.E. units, not only carried out the task for which they were formed with conspicuous success, but also qualified as true sappers under Kipling's definition in that they were "men who do something all round."

* For an account of the circumstances under which this posthumous V.C. was awarded. See *Tunnellers*, pp. 166-7.

CAMOUFLAGE

Camouflage in the form of *ruses de guerre* is as old as war itself but had been practised by ingenious individuals merely to create an opportunity or counter a definite threat. In the Great War, however, it was soon recognized that the concealment of gun positions and the like from air observation was a vital and continual necessity. To Guirand de Scevola, a French gunner, is largely due the credit of applying his artist's imagination and technique to this purpose early in the war, thus laying the foundation of a military unit—*service de camouflage*—whose sole duty was the practice of concealment, mainly of guns. The derivation of the word "camouflage" is uncertain; it is a slang word of which perhaps "disguise" is the nearest English equivalent; it may be defined as "concealment of the method of concealment." As a tribute to the country of its origin the word was immediately adopted into the English language. The French detachment under Guirand de Scevola was formed at Amiens in February, 1915, and its activities were soon extended to the concealment of observation posts. The first of these, an imitation tree lined with steel in which an observer was able to stand, was erected near Lihons in May, 1915.

The idea of forming a similar section in the British army was first mooted in the winter of 1915. The well-known artist, Mr. Solomon J. Solomon, R.A., who had interested himself in this new art, was invited to come out to France to assist. He brought with him a small party, selected by himself in England, consisting of three artists (one being Mr. W. W. Russell—later Sir Walter Russell, R.A., Keeper of the Royal Academy), a recent Director of Scenery for Covent Garden (Mr. Oliver P. Bernard) and his stage carpenter (Mr. Holmes). The last was a typical Yorkshireman, independent but dependable, a master of his craft. To Colonel D. Brady (then F.W.S., War Office) fell the duty of interviewing Holmes for selection, but his Irish temperament must have been tested to the limit, when Holmes, calmly sitting on his table, replied to Brady's remark that he would have to wear uniform, "Not on your life,

Cocky"; Holmes remained "Mr." to the end. The wide black sombrero which he always wore made him fair game for the amateur spy hunter in forward areas and much time was spent in rescuing him from guard-rooms. Additional artists and men of theatrical trades from various units were assembled at St. Omer in 1916, and, after a brief attempt to start work at Poperinghe, they were formed into a unit under the thinly veiled title of "Special Works Park, R.E.," whose headquarters were established in a factory at Wimereux.

Captain F. J. C. Wyatt, R.E., was placed in command and Solomon, now a temporary Lieut.-Colonel, R.E., was attached as Technical Adviser. The total strength of the unit on 22nd March, 1916, was ten officers and eighty-two other ranks. Seven camoufleurs were lent by the French to assist in its development, and in June a small detachment (Southern Special Works Park) opened a factory at Amiens, under the command of Captain C. R. Chesney, R.E. This factory catered for the needs of the Third and Fourth Armies. Development was rapid and successive increases in establishment soon became necessary. In June, 1916, it was increased by thirteen officers and 159 other ranks, and a second factory (Northern Special Works Park) was opened at Aire in November, under the command of Captain J. P. Rhodes, R.E., to meet the demands of the First and Second Armies. The French camoufleurs left in July, 1916, and their valuable assistance was recognized by the award of one D.S.O., five M.Cs. and one D.C.M., which were presented by H.M. King George V in August, 1916.

Demands for camouflage work of all kinds continued to increase throughout 1917, and to meet them it was found necessary to extend the organization towards the front line, forming small depots or factories in corps areas, each under a Corps Camouflage Officer. Suitable increases in establishment were made and Captain F. H. E. Townshend, R.E., was appointed as Staff Officer. The final organization in November, 1918, was—a Controller of Camouflage at G.H.Q. (Lieut.-Colonel Wyatt) with a small staff, a camouflage officer with each army and corps, a camouflage factory in each army and a factory at the base; in all sixty officers and 392 other ranks.

All the officers with the exception of the regulars Wyatt, Chesney, Rhodes and Townshend—were, or became, temporary R.E., the bulk coming from field companies: about 20 per cent were artists transferred from various units—among them Wallis Mills, of *Punch*. With the exception of the original nucleus of theatrical tradesmen, all the N.C.Os. and men were drafted from normal R.E. sources. In addition, a large number of French women were employed in the garnishing of nets and other unskilled work.

A small detachment was sent, under Captain Rhodes, with the British Army to Italy in November, 1917, returning in March, 1918.

An experimental section was formed at an early stage and stationed on the airfield at St. Omer, where all new ideas in gun covers etc. were tested from the air, both visually and photographically. Meanwhile, an experimental school had been opened in Hyde Park in the summer of 1916 under Solomon. This was eventually taken over in May, 1918, by Captain Rhodes, and regular courses instituted. Close liaison was maintained with the camouflage service in the B.E.F. While the American army was being assembled in France a small party of the Corps of Engineers was attached to the Special Works Park headquarters for instruction.

When the German offensive in 1918 put a temporary stop to normal camouflage activities the personnel were used to lay out the new defence lines in rear, involving the manufacture of scores of miles of tracing tape and thousands of iron pins. When the enemy obtained possession of Mount Kemmel, which gave them direct observation over all our communications in that area, a rapid method of making road screening material was evolved and over a hundred miles of screening twelve feet high was supplied for erection. This consisted of wire netting interlaced with vertical strips of canvas, alternating black and white, and scientifically spaced to present an apparently solid screen.

The whole unit was disbanded after the Armistice and no provision made for its resurrection. A small experimental section was maintained under the R.E. Board until 1923, when

it was abolished, but a retired artillery officer was attached to the Board to co-ordinate experiments carried out in the various commands, the policy being to encourage units to do their own camouflage.

PRODUCTS OF THE CAMOUFLAGE FACTORIES

The main occupation of the special works parks was the manufacture of screening for guns against observation from the air, and the manufacture of observation posts.

Gun screens at first consisted of large canvas sheets painted to resemble the local ground pattern as seen from the air. The first big order came in June, 1916, and was for sixty covers to hide the guns massing for the attack at Arras. They varied from 36 to 60 ft. square, and were to be made of hessian canvas as was the usual practice at that time. The canvas came in rolls 6 ft. wide which had to be joined together to form the necessary size of cover, entailing nearly five miles of stitching. There was but one sapper, an elderly gentleman, who knew how to use the only treadle sewing machine in the unit. He worked in the open from dawn till dark, and completed the task in one day thanks to frequent ministrations of stimulants. As soon as each cover was sewn a gang armed with long brushes and paint pots applied the necessary colours complete with daisies and buttercups. Fortunately the weather was fine and the canvas covers were dry enough to dispatch the next day.

The experimental section soon demonstrated the futility of canvas sheets, and netting garnished with painted strips of canvas gradually became the standard material. As it was manifestly impossible to cater for specific positions in sufficient quantities, mass production was evolved and the netting produced in three patterns of colours to suit average conditions. The canvas was painted and cut mechanically into appropriate lengths of strips, but the actual tying into the netting—wire or fish—was done by hand by an army of women. In all, nearly fourteen million square yards of garnished netting were supplied.

Observation posts were of two kinds, viz., trees or other objects to accommodate an observer or periscope, and portions of trenches, brickwork, etc., to conceal the observer's head. A classic French example of the former was a facsimile of the corpse of a soldier which lay in no-man's-land on hands and knees facing their own trenches; the observation slit was in the seat of his trousers. The technique of making these observation posts was as follows. First, the object to be imitated was sketched by an artist and a thorough reconnaissance made of the locality. The external appearance was then faithfully copied in suitable material (thin sheet iron or reinforced plaster), and fitted round a standardized bullet-proof core designed to suit particular cases, e.g., trees large enough to accommodate an observer, thinner trees or posts to hold a periscope and pieces of wall or parapet to hide the observer's head. The original object was then removed during the night and replaced by its facsimile. In the case of large objects, very careful organization was required to ensure that the whole transaction should be completed during darkness so that the substitution should escape notice.

In addition, there were many side lines, such as sniper suits and "Chinese Attack" figures. The latter were painted millboard silhouettes representing men in various postures in attack formation and were used to draw enemy fire, either to divert it from a real attack or to make the enemy disclose their defence dispositions. Nearly 12,000 of these figures were used, and many instances were recorded of (literally) spectacular successes.

CHAPTER XIX

SEARCHLIGHTS AND FORWARD WATER SUPPLY IN FRANCE

Searchlights during 1914-16—Expansion during 1917—Searchlights in 1918—Water supply for fighting formations—The Water Supply Committee—Water supply on the Somme, 1916—Water for the battles of 1917—Water problems in 1918.

SEARCHLIGHTS DURING 1914-16

IN August, 1914, aerial warfare was in its infancy, a few pilots discharged pistols at hostile aircraft without any results, and occasionally a very small bomb was dropped without doing any damage; but the great value of the aeroplane for reconnaissance was very soon demonstrated, notably by the timely disclosure of General Von Kluck's strategic moves before the first battle of the Marne in September.

In Chapter III we have recorded that the first German air raid on the home country occurred on the night of 19th/20th January, 1915. Although the British Expeditionary Force had been provided from the outset with a small allotment of anti-aircraft artillery, it was not until March of that year that a small night raid in the vicinity of G.H.Q. caused the C.-in-C. to ask for the dispatch of three or four searchlights to France to work in co-operation with these guns. As a result two searchlight sections were made up from regular R.E., with a proportion of London Electrical Engineers at Chatham and Plymouth, each equipped with three 60-cm. electric projectors, and dispatched to France in April under the command of Lieutenant Kermack. These sections were equipped with heavy stationary generators and were far from mobile.

From these small beginnings was developed a large organization of A.A. searchlight units which, by the end of the war embraced a total strength of some 2,000 all ranks. As at home,

the personnel was furnished in great part by the London and Tyne Electrical Engineers, though many of the R.E. fortress units of the Territorial Force also contributed, and the final total included a large number of men of low medical category transferred from the infantry.

In August, 1915, it was decided that experiments should be made in the lighting up of no-man's-land with the oxyacetylene lamps with which field companies were at that time equipped. These were to be set up in the most advanced points of the trench system. As field companies already had insufficient personnel to deal with the work on hand, each company was reinforced by twelve other ranks drawn from R.E. searchlight units of the Territorial Force. As might have been expected the opening up of lamps in these very forward positions immediately drew a concentration of shelling and a hail of small arms fire, and the detachments came to be known as "The Suicide Brigade." Their arrival in any part of the trench system with a view to lighting up was most unwelcome to the normal garrison, and orders were soon issued to discontinue the experiments.

In April, 1916, the 50th (Regular) Field Searchlight Company R.E. (see Chapter III), arrived in France with its three sections completely mobile with motor transport for lights, generators, equipment and personnel. The headquarter section was stationed at G.H.Q., where its O.C. (Captain W. C. H. Prichard) became adviser to the Engineer-in-Chief on all matters dealing with searchlights. The three sections were stationed at Boulogne, Calais and Rouen respectively. By the end of May, 1916, six more anti-aircraft searchlight sections (A.A.S.S.) raised by the London Electrical Engineers (L.E.E.) and Tyne Electrical Engineers (T.E.E.) and comprising three lights each, had arrived in France and were stationed at Audruicq, G.H.Q., 1st and 2nd Echelons, Ableville, Etaples and Abancourt.

In June, the last bomb dropped by the last aeroplane during a raid on the ammunition dump at Audruicq succeeded in starting an explosion which blew up 40,000 tons of ammunition—practically the whole contents of the dump. The pilot of the German aircraft was quite unaware that he had scored this great success, and it was six months before the enemy learnt of

it through a letter from America. This disastrous conflagration, however, lit up the minds of G.H.Q. to the real dangers of bombing from the air and gave a great impetus to A.A. defence in France.

Throughout 1916, further A.A.S.S. arrived, but owing to the current shortages of man-power and equipment it was decided to reduce the sections to two lights only, and this decision was supported by the tactical argument that, when deployed alone, the three lights of a section served to delineate the target more clearly to the enemy. The reduced establishment provided for one officer and eighteen N.C.Os. and sappers with one A.S.C. driver attached. Four new sections were forthwith created from personnel rendered surplus by this reduction.

Meanwhile, on 1st July, the battle of the Somme began, and about September, 1916, hostile aircraft began bombing by night in forward areas particularly the Maricourt area on the Somme battlefield. In the autumn, machine-gunning of the roads by aircraft began, so Nos. 2 and 5 A.A. Searchlight Sections were ordered to the area between Montauban, Trones Wood and the Somme. Their activity forced the enemy to fly at considerable heights, and so reduced the damage. In the last months of 1916, air raids were constantly made by night along the whole of the Somme valley as far as Amiens. Nos. 2 and 5 A.A. Searchlight Sections and No. 2 Section 50th (F.S.L.) Company were allotted to this region.

Soon after his arrival in April, 1916, Captain (temporary Major) Prichard handed over the command of the 50th (F.S.L.) Company to Lieutenant French Mullen, so that he himself as adviser to the Engineer-in-Chief, could give all his time to the distribution and co-ordination of the new A.A.S.S. as they arrived in France, and to the formulation of a common doctrine of operation. Artillery commanders at various levels from those of battery sections up to the M.Gs.R.A. at army headquarters directed the operations not only of the A.A. guns, but also of the searchlights to serve the guns, leaving, however, the technical operation of the lights and the discipline and administration of the personnel to the R.E. officers.

Location of aircraft by night was at first entirely unassisted.

but later the ear-trumpet locator and special binoculars for night work were issued. Some individuals found that they had a special gift for acquiring by practice an ear that could locate aeroplanes, and a few always maintained that they could do better with their own ears than with the trumpets provided.

It was soon found that a man standing to one side of a light could see up the beam to the aeroplane, follow it and hold it far more easily than the man working the light; consequently an arm was fixed to the projector, the other end resting upon a circular rail with a radius of 15 ft. supported on pickets. Later this was further improved by fixing a small handwheel with a worm and quadrant gear so that the controller could not only traverse the light, as he walked round the circular rail, but also elevate or depress it. Eventually a telescope was added and its movement co-ordinated mechanically with that of the projector.

During 1916, and even in the early part of 1917, it was not practicable to do much to improve or alter the type of lights, generators and vehicles being supplied by the Ministry of Munitions, because the demand for A.A. defence was not yet so urgent in France or even at home as it became later. It was, however, obvious that if lights and generators were mobile they would have greater tactical value; and that 90-cm. projectors would be far more effective than 60-cm., while the generator for the 90-cm. light could still be mounted in a mobile lorry. At base depots, dumps and railway junctions, well behind army areas, mobility was not so necessary and in such places 120-cm. projectors with larger stationary generators were desirable.

EXPANSION DURING 1917

On the 1st January, 1917, Captain W. C. H. Prichard, already promoted substantive major, was now formally appointed Inspector of Searchlights (I.S.) in France, with the temporary rank of Lieut.-Colonel. The responsibilities and duties of the I.S. on the Staff of the Engineer-in-Chief were :—

To advise upon the distribution of all A.A.S. units.

To specify types of equipment and submit demands for quantities.

To deal with questions affecting searchlight personnel and to submit demands for more units.

To arrange for the technical training of all searchlight personnel.

To advise in consultation with the Engineer-in-Chief and the M.G.R.A. at G.H.Q. upon the doctrine for working searchlights in action.

To co-ordinate uniform methods of working searchlights in all units.

To test the efficiency of A.A.S. units with the help of his Assistant Inspectors.

To organize and administer a workshop for repairs.

Early in 1917, the War Office formally approved the formation of a total of forty-five A.A. searchlight sections and also authorized an entire re-equipment with 90-cm. projectors. To save delay the personnel for the new sections were sent to France without equipment, which was supplied through the agency of an equipment depot established under the Inspector of Searchlights at Calais and operated by No. 26 A.A. Searchlight Section.

During the spring, hostile aircraft attacks were mainly confined to the Audruicq and Calais areas. At Audruicq there was a very large ammunition depot, as well as the stores and workshops of the British railway organization in France and other important depots and installations, and, close by, at Zeneghem there were other large ammunition depots. These very vulnerable areas received A.A. protection from the beginning, and, in June 1917, the defences were combined into one command known as "A & Z Defences" which grew into a very large organization as the war advanced. One of the earliest tasks of the searchlight sections here was to lay out and operate "false areas" to deceive the enemy. These are believed to have been the first of their kind, and certainly attracted many of the bombs intended for the real depots.

Other false areas were in due course laid out at different places, though not always with the same success.

The searchlights could by this time pick up aircraft in their beams, but still further experience and technical developments were required to make certain of holding them effectively. Accordingly, the object aimed at was the denial of the target areas to raiders by means of barrages combined with the use of false areas, and the actual destruction of enemy aircraft was a secondary, though welcome, result.

Dunkerque was on several occasions made the object of a combined enemy attack by sea, long-range land guns and aircraft. Accordingly, in April, 1917, No. 11 A.A. Searchlight Section was transferred to this area where it operated successfully in conjunction with French air defences. In July, August and September, 1917, very heavy night bombing was experienced in the XV Corps area behind Nieuport and in the Second and Fifth Army areas in the third battle of Ypres. Two sections of 50th (F.S.L.) Company and fourteen A.A. searchlight sections were accordingly concentrated there. At this time also the Isbergues steel works and the Béthune area were being persistently bombed, so four sections were allotted for their protection. The use of lights in the forward areas then began to be developed on a line between Ypres and Brielen.

The lights thus concentrated began to work with great efficiency, and in spite of the misty atmosphere prevailing in some of the low-lying country, between 50 and 60 per cent of raiding aircraft were detected and held in the beams. Several hostile aircraft were destroyed by A.A. gunfire, and many were driven off. The enemy was forced to fly at heights of 6,000 to 12,000 feet, which resulted in indiscriminate bombing with a great reduction in casualties.

The searchlights themselves were often severely bombed, and "digging in" for protection of the personnel and equipment had to be resorted to. Eventually, although casualties were still caused by shell-fire, the efficiency of the earthwork protection was such that no casualties were caused by bombs when the men were actually under cover. The detachments throughout showed great determination and courage in keeping the

searchlights directed on to enemy aircraft whilst being bombed, a result which the enemy was never able to achieve in their own A.A. defences. One Lewis gun per light was issued to A.A. searchlight sections and these were mounted so as to fire along the searchlight beam. There is no record of their bringing down an aeroplane, but they proved an excellent stimulus to the morale of the section in action.

In August, 1917, a great expansion of A.A. defence units and equipment had been begun as a result of the realization that attacks by aircraft had become serious and were rapidly increasing in number, weight and intensity. A higher priority had been given to the raising of A.A. units and to the provision of their equipment. An increase of thirty sections was authorized, and their establishment was again increased from two lights to three. Training of new personnel had been proceeding incessantly through 1917, but at the same time a very serious shortage of man-power had arisen in the army as a whole, due to the heavy casualties in the infantry, artillery and the R.E. field companies. This shortage was made good by combing-out from other units all men of high medical category, and replacing them by men of low medical category who, in the case of those posted to the A.A. searchlight sections, had to be trained especially for their new rôle. A number of American and Canadian troops were also attached to the British searchlight units for training.

By the end of 1917, 90-cm. projectors had replaced 60-cm. throughout the units in France. At the same time, the process of replacing the non-mobile generating sets by petrol-electric lorries began in the forward sections, and the great advantage of increased mobility was immediately felt. The electric generator and all electrical equipment in the lorry were designed by Messrs. Stevens & Co. for 90-cm. projectors, the petrol driven lorry was designed by Messrs. Dennis. Driving and maintenance required specially skilled and trained R.E. drivers, but these were forthcoming and in their hands the vehicles and equipment proved most reliable. Orders were also placed in 1917 for 120-cm. projectors with more powerful stationary generators for A.A. protection of bases, depots, and

railway junctions well behind the army areas where it was not anticipated that the enemy ground troops would penetrate, but it was not until 1918 that all these orders for new equipment and additional A.A. searchlight units bore fruit.

In August, 1917, an Assistant Inspector of Searchlights, with the rank of major, was authorized for each army, and with the rank of captain for the lines of communication. The A.I.S. of each army was the searchlight adviser to the artillery commander and the technical commander of all the searchlight resources in the army area. The appointments first made to fill these posts were :

First Army	Major R. G. Madge (L.E.E.) R.E.
Second Army	Major D. R. French Mullen, R.E.
Third Army	Major G. Fergus Wood (L.E.E.), R.E.
Fourth Army	In reserve.
Fifth Army	Major A. W. M. Mawby (L.E.E.), R.E.
L. of C.	Captain H. G. G. Clarke (L.E.E.), R.E.

A.A. searchlight sections, in spite of the great increase in their numbers, remained independent units throughout. They were organized in five groups under the five Assistant Inspectors of Searchlights, and not, as might have been expected, in companies for command and administration. This company organization was, however, being prepared, but was not taken into use before the Armistice.

After the successful battle of Cambrai in November, 1917, the enemy began to bomb heavily at night in the crowded areas of the Third and Fifth Armies, and the 50th (F.S.L.) Company and fourteen sections were therefore concentrated in these areas to form a continuous lighted belt close up to the front line. The action of the lights and guns was so effective that hostile aircraft rarely penetrated and casualties were light. On some occasions the searchlights picked up every aircraft that approached.

In February, the defences of Audruicq and Zeneghem were further developed and included with those of Calais and St.

Omer to form the Northern Air Defences under a Deputy Inspector of Searchlights Northern Lines of Communication. The officer first appointed to this post was Captain E. F. Rendell (T.E.F.) R.E. Experience, however, showed that the control of so extended a defence from a single point became unwieldy, and the Calais and St. Omer areas were therefore operated in action as separate organizations, the officer controlling the searchlights at each place receiving the title of Area Searchlight Officer (A.S.O.).

SEARCHLIGHTS IN 1918

In preparation for the German offensive expected in March, 1918, eight sections were allotted to the protection of the railway junctions at Hazebrouck, St. Pol and Doullens. During the fighting in March and April the forward areas of the First, Second, Third and Fifth Armies were heavily bombed. German troop penetration overran several of the non-mobile sections, but the mobile equipments were in action continuously within 2,000 to 5,000 yards of our retreating line, giving the A.A. guns and the troops valuable help. The railway junctions mentioned above, and base depots at Abbeville, Abancourt, Etaples, Boulogne, Calais and Audruicq were also heavily attacked, but the defence prevented serious damage.

Throughout 1918, night bombing by both sides developed greatly in intensity, not only of areas well behind the front but also of troop concentrations, railway junctions, railheads and other targets close behind the fighting troops. Early in the year it had at last been found possible to allot bombing squadrons to the task of carrying out reprisal raids on a large scale against the industrial centres of the Rhineland. These squadrons were organized as an Independent Air Force and were based on the so-called "Southern Aerodromes" in Lorraine. For their defence the formation of twelve additional three-light A.A. searchlight sections had been approved, but none of them became available before the Armistice. In the meantime, four sections were moved from France to co-operate with the A.A. guns. The airfields were constantly

attacked and these sections experienced a trying time, their lights being frequently put out of action by bombs.

The summer of 1918 was occupied with the development of the lighted belt behind the line. The sections thus employed were regarded as corps troops, and into this framework new sections were fitted as they became available.

Experience at home had shown conclusively that the most effective method of dealing with night raiders was by the use of night-flying aircraft working in conjunction with searchlights. By now the state of the defences in England had rendered her vulnerable areas practically immune from attack, and, in June, 1918, No. 151 Night Fighting Squadron became available for operation with the B.E.F. in France. Another similar squadron arrived just before the Armistice. The increase in searchlights had by then made it practicable to produce a lighted belt, similar to those in the home defences, at least three to four lights deep along a considerable part of the front of the B.E.F. In this lighted belt, which, after the type of aircraft then in use, was styled the "Camel Line," 151 Night Fighting Squadron was very successful. On our side of the line alone they brought down twenty-five hostile aircraft and others on the enemy's side. In the end there were nine searchlight sections with First Army, five with Third Army, and the 50th (F.S.L.) Company and five sections with Fourth Army.

The final British advance began in the Fourth Army area on 8th August, and was very shortly taken up along the whole line. The "Camel Line" followed up as closely as circumstances permitted, the searchlights keeping their night action stations roughly between 2,000 and 6,000 yards behind the front and endeavouring to maintain continuous touch with the lights of neighbouring armies. During August, September and October, enemy bombing continued, but in gradually decreasing volume and severity, and by the end of October had practically ceased in the British area.

After the Armistice the A.A. searchlight sections were concentrated and the process of demobilization began, though several of the sections advanced with the Second Army into

Germany, and the searchlights of others were used for illuminating work on the reconstruction of demolished bridges and railways.

It had been estimated in June, 1918, that twenty additional sections would be required to complete the defences then thought essential, making a total of 285 lights organized in ninety-five sections of three lights each. By the 1st August there were in fact only seventy of the previously planned seventy-five sections in France, and up to the end of the war not more than seventy-seven were actually formed for service overseas. Of these, one, No. 34, had been transferred to the Italian theatre in January, 1918.

WATER SUPPLY FOR FIGHTING FORMATIONS

General Remarks

During the fighting in France the largest demands for water generally came from divisional and corps areas, for during the great battles it was always near the front that the largest concentrations of men and animals occurred, often with very little previous notice. To a less extent there were, of course, considerable concentrations, especially of animals, in army areas. In rear areas the conditions were easier, once the existing water supplies of the civil population had been developed and supplemented, often by British army engineers. In this chapter we, therefore, deal mainly with water supply in the areas of armies, of corps and of divisions, as this presented the major problem.

Fortunately for those responsible for supplying water we started military operations with only a small force, and in country where existing supplies for the civil population could with some assistance, cope with the demands of the B.E.F. Later we moved into country very sparsely supplied with water and the real problems arose. There was thus just sufficient time available to build up a water supply organization for the B.E.F., and to collect and distribute the considerable quantities of plant, equipment and stores required.

For full technical particulars of this water-supply work

for fighting formation the reader is referred to the volume dealing with water supply in *Work of R.E. in the European War, 1914-19*. Information about L. of C. areas is included in the volume dealing with work under the Director of Works.

At first the British army was equipped only for the supply of water to men and animals in small quantities from supplies available on, or just below, the ground. At the close of hostilities the water supply organization and equipment had been so greatly developed and improved that operations involving troop concentrations of unexampled density could be undertaken at short notice in any area desirable for strategic or tactical reasons, without reference to the presence of water on or near the surface. The salient features of this development were the formation of a water supply staff, the collection of intelligence and geological data, the increase in mechanical plant for well-boring, filtration and pumping and the distribution of water by pipe-lines and mechanical transport.

THE WATER SUPPLY COMMITTEE

In May, 1915, a Water Supply Committee was appointed at G.H.Q., presided over by Colonel W. A. Liddell, from the Engineer-in-Chief's Office, with a member of the General Staff and a member of the medical services. On 15th June, 1915, the committee recommended scales for supply of water to men and animals under varying conditions; purification at the front by regimental water carts, at the rear by special plant installed on motor lorries and barges; storage in twenty-four water-tank canal barges with a capacity of 12,000 gallons each; and distribution by increasing the number of regimental water carts, and by the addition to each supply column of a motor transport water section, equipped with purification and de-poisoning plant and tanks. Six barges and their plant were ordered at once, and also one M.T. Army Water Column.

In January, 1916, in view of the extension of the British front, the increase of the B.E.F., and the large operations contemplated north of the Somme, the Water Supply Committee was reappointed. The committee took special note of

the proposed large concentration of troops and of the waterless area between the rivers Ancre and Escaut. They also had information of water supply difficulties experienced by the French armies in Champagne in 1915 during their very limited advance there. On the 26th February, the committee recommended that :—

- (a) Water supply points should be established at suitable places along the front and that water should be provided as far forward as possible by means of specially installed pumps and piping.
- (b) Supplies should be supplemented by a system of motor transport for the supply of water, approximately equivalent to four army water columns ; and that the establishment of regimental water carts should be temporarily augmented.
- (c) 191 3-ton lorries each carrying 600 gallons of water should be supplied as soon as possible to meet the requirements of six corps.
- (d) All available water purification plants on motor vehicles should be allotted to corps in whose areas the difficulties of water supply would be greatest.
- (e) The addition of eighty water carts per corps in six corps. If carts of the authorized pattern were not available, water tanks should be fitted on suitable horsed carts.
- (f) A special staff should be appointed in each army for the organization and execution of works in connexion with the supply of water to the troops.

These recommendations were accepted, and a water supply officer was attached to the Chief Engineer of each army and corps, as his adviser, and to be responsible for the regulation and issue of all water supply stores.

In 1915, eighteen power pumping plants each to deliver about 2,000 gallons per hour and 120 miles of 4-in. steel piping and accessories had been ordered from the War Office. In January and February, 1916, considerable numbers of pumps (capacity 2,000 to 7,000 gallons per hour and up to 350-ft. head) were ordered together with large quantities of piping and accessories,

in fact the whole available material of this nature in England at the time was sent to France.

The installation of water supply systems was carried out by field companies R.E. in divisional areas, and by army troops companies in corps areas, supplemented by unskilled labour. By 1st July, 1916, over a hundred power pumps had been established in the Fourth Army area and almost 120 miles of water mains were laid. It was, however, necessary to increase the number of engine drivers and other technical trades. For this purpose a detachment of No. 1 London and Tyne Electrical and Mechanical Company, R.E. (T.F.) was sent to work first for the Third and then for the Fourth Army in the Somme area. So necessary was this type of unit found to be that in December, 1916, five new E. & M. Companies were raised (one for each army), to work in liaison with corps water supply officers. These units were always very much overworked.

Boring for water began in 1915. In March, 1917, three water boring sections (twelve men in each) were formed, later increased by two more sections. They were attached to E. & M. companies. A very large number of boreholes was drilled and equipped with pumps delivering great quantities of water. In June, 1918, an Inspector was appointed to the staff of the Engineer-in-Chief to work in liaison with E. & M. companies and boring sections and with army and corps water supply officers.

Great importance should be attached to the appointment, in 1915, to the Staff of the Engineer-in-Chief of two very qualified and exceptionally efficient and hard-working geologists—Captains David and King (see pp. 160, 163 and 472). The information they supplied showing the water resources of the country, water tables in chalk, boring possibilities, etc., saved a vast amount of time and labour.

WATER SUPPLY ON THE SOMME, 1916

Again the reader is referred to the volume on water supply in *Work of the R.E. in the European War, 1914-19*, which gives in considerable detail a very clear account of the water-supply

work carried out in preparation for and during the following operations—Somme battles, 1916, German withdrawal to Hindenburg Line, battles of Arras, Messines, Passchendaele and Cambrai, 1917, German offensives in March and April, 1918, British Fourth Army attack in August, 1918, and the final British advance. The following extracts do not deal with all the above operations but include sufficient to indicate the magnitude and special features of the work carried out.

Let us first deal with the battle of the Somme, fought in an almost waterless area. In June, 1916, a memorandum was widely circulated to all concerned informing them of the preparations that had been made and were still continuing for the supply of water during the forthcoming offensive. This was a most important document because it visualized a scheme which worked most successfully, and became a pattern for all subsequent water supply for military operations in France.

In this memorandum it was stated that the work already done included the establishment in forward areas (III, VIII, X and XV Corps) of water storage, totalling 126,000 gallons, at points varying from 7,000 to 30,000 gallons each; the provision of ten advanced pumping stations, two mobile barge units on the Somme and a depot of mobile pumping sets; the allotment to each corps of eighty additional water carts, and to the army of one water-tank company with both 1-ton and 3-ton lorries (200 and 600 gallons each) for water carriage up to ten miles from water points to unit water carts. All known wells and other water intelligence were tabulated. The importance of developing local sources by using mobile equipment was stressed. Army reserves would include semi-permanent powerful pumps, mobile and hand pumps, canvas storage tanks and special lorries for sterilizing, de-poisoning and emergency pumping. It was laid down that the provision of water was a R.E. service, but the filling of water transport vehicles and water distribution from water points to units was a Supply service. Finally all pipes were to be buried 2 ft. 6 in. deep.

The execution of the water supply schemes during the battles of 1916 worked satisfactorily. The great difficulty was the occasional arrival at some water points of unexpectedly

large numbers of horses. At the height of the battle, water had to be provided for 300,000 men and 150,000 animals; more than 10,000 gallons had to be transported by road, and 1½ million gallons were pumped daily. It was clearly essential that there should be centralized control of all water supply schemes under the Chief Engineer of each army with an adequate staff in touch with G. and Q. staffs.

WATER FOR THE BATTLES OF 1917

The Germans withdrew across an area in which there is at all times a great scarcity of surface water, but this was accentuated in 1917 by their thorough demolition and fouling of existing wells. The divisional R.E. had the task of finding and reopening these wells, which were normally about 250 feet deep. Deep well hand-pumps were needed but were not available. In their absence the windlass and bucket system was improvised until belt pumps could be fixed. In the lower valleys shallow wells could be sunk, but the situation was generally saved by drilling new boreholes. For instance five of the boreholes put down in March and April delivered 40,000 gallons per day.

In the Second Army area the development of water supplies continued through the winter and spring of 1916/17: 180 miles of piping were laid and pumping stations installed to deliver daily 1 million gallons of treated drinking water and ½ million gallons of untreated water for horses.

Before the battle of Messines a memorandum on water supply was issued, similar to that which was issued before the battles of the Somme, and the plan again worked very well.

During the period in which water supply was being developed for the Messines battle, work was in progress on a large scale in an area north of Ypres up to the river Yser, including the Belgian sector. The geological formation here was such that deep boreholes were impossible, and it was decided that water would have to be pumped from the river Yser. Two large installations were, therefore, planned at Haringhe and Rousbrugge. The Haringhe scheme was begun at the end of April, 1917, and, when it was completed, ten sterilizers and three

de-poisoners supplied 120,000 gallons of pure water daily. There was extra plant for use when the Yser was turbid. At Rousbrugge a barrage on the river was constructed to prevent tidal water from mixing with the fresh, which was taken by 4-in. pipes to sedimentation tanks. The water then passed through mechanical sand filters and was finally treated with chlorine.

WATER PROBLEMS IN 1918

The disorganization caused by the rapid withdrawals of large numbers of men and animals in face of the German assaults in the spring of 1918, produced serious problems, and many quite new sources of water had to be developed.

Very soon after our victory on the 8th August, 1918, confidential information was given to the Engineer-in-Chief concerning the proposed large scale advance. Without this pre-knowledge and chance to prepare there would almost certainly have been a breakdown in water supply, for the proposals included the crossing of the practically waterless plateau twelve to twenty miles in breadth between the rivers Ancre and Escaut. The advancing forces were estimated at 600,000 men and 300,000 horses, who for a period must depend on transported water. The amount of transport for this purpose was worked out by the engineers, and transport lorries and G.S. wagons fitted with storage tanks were allotted by the Q.M.G. A map of water supply information was distributed in considerable quantities.

The most critical period was between 21st August, and 7th September, after which a well watered country was entered. In the critical period the situation was saved by the recovery of the British boreholes put down in this area in 1917. The extensive and successful use of mobile air compressors for giving an air lift in the boreholes worked them to their full capacity. In one army area alone thirteen compressors, during a period of six weeks from 3rd August to 14th September, delivered 20 million gallons of water.

It is estimated that in the last four months of fighting over 20 million gallons of water were transported by road. The

total transport in four water-tank companies during the advance consisted of 633 Ford cars, 118 3-ton lorries and eighty-six sterilizers. These companies were used for filling storage at water points and *not* for distribution to units. The best results were obtained when these water-tank companies were controlled by the Chief Engineer of the army.

The Northern Armies advanced through a well watered country where the most urgent work was purification by mobile plant, but the enemy's demolitions of water installations often necessitated rapid improvisation in order to reinstate them.

CHAPTER XX

GAS WARFARE

Defence against gas—The box respirator—Anti-gas organization in the B.E.F.—Offensive gas warfare—Gas at the battle of Loos—The Special Brigade R.E.—The Livens projector—Use of gas in subsequent operations.

DEFENCE AGAINST GAS

Defence against gas in the field came under R.E. direction in April, 1916, when the organization for gas defence, which prior to then had been the responsibility of the R.A.M.C., was combined with the engineer organization for gas warfare against the enemy, and both branches placed under the control of a Director of Gas Services drawn from the Royal Engineers.

In April 1915, when the Germans first made use of gas against the Allies in front of Ypres, our troops were completely unprotected against it. Both at home and at the front experiments with various types of respirator were at once carried out; methods of making dug-outs gas-proof and clearing gas from trenches were improvised; alarm apparatus was installed and the troops were trained in the action to be taken when these gas alarms were sounded. All these measures were at first made the responsibility of the Royal Army Medical Corps, and an organization for their direction at the front in France and Belgium was built up under the control of Lieut. Colonel S. L. Cummins, C.M.G., R.A.M.C. This organization worked in close co-operation with a corresponding organization at the Medical Branch of the War Office, under the control of Colonel W. Horrocks, R.A.M.C. (later Sir William Horrocks, K.C.M.G., C.B.). This War Office organization became responsible for all research and experiment in defence against gas and for the manufacture of all gas masks and other protective appliances.

The anti-gas organization with the B.E.F. had at G.H.Q. its headquarters, consisting of Lieut.-Colonel Cummins and a

small staff of chemical assistants, and a Central Laboratory under Professor W. Watson, F.R.S. (later Lieut.-Colonel, D.S.O.) and Lieutenant B. Mouat-Jones (later Lieut.-Colonel, D.S.O.). This laboratory did very valuable work in the rapid identification of the chemicals used by the enemy in shells and other appliances. At the headquarters of each army was a Chemical Adviser, who was responsible for advising the Army Commander and his staff on all matters concerning defence against gas, and also for inspection of anti-gas appliances and for supervision of the instruction of officers and other ranks in gas defence measures at army anti-gas schools.

The gas used by the Germans in April, 1915, and for some months afterwards, was chlorine. The first form of protection devised against this was a large pad of cotton waste impregnated with hyposulphite and carbonate of soda and wrapped in cotton netting. This had to be fixed so as to cover the mouth and nose and the netting ends tied behind the head. This hasty improvisation was the best that could be made at short notice, but was not very effective. It was not long before the anti-gas organization at home produced the "hypo" helmet which was a large flannelette bag made to cover the head and provided with celluloid eyepieces. The open end of the bag was to be tucked in under the jacket so that all air breathed had to pass through the flannelette which was impregnated with hyposulphite of soda giving protection against chlorine. An improved form of this helmet was introduced after a few months. The impregnating chemical was modified by the addition of phenate to the hyposulphite to meet attack with phosgene which it was suspected the enemy would use. The improved helmet also had a mouthpiece with outlet valve, and glass eyepieces instead of celluloid which were liable to crack. With this helmet, which was known as the "P" helmet, air was breathed in through the flannelette and through the nose, and out through the mouthpiece valve. After the Germans had used phosgene in formidable attacks in December, 1915, it was considered necessary to improve the protection against this very dangerous gas. This was done by adding hexamine to the hypo and phenate used in the impregnation of the

flannelette. The result was known as the "PH" helmet, which was issued to the troops in January, 1916. It was in all other respects similar to the "P" helmet but gave greatly improved protection against phosgene. Later on goggles were incorporated in the helmet, which was then called the "PHG." This was the situation in the spring of 1916, by which time Colonel Cummins had built up a very efficient organization for directing the measures of defence against gas. The circumstances under which this organization was combined with the engineer organization for the prosecution of gas warfare against the enemy, and both branches placed under the control of an officer of the Royal Engineers, will now be described.

In May, 1915, the British Cabinet decided to use gas as a measure of retaliation against the enemy. Sir John French, the Commander-in-Chief of the B.E.F. appointed Major C. H. Foulkes, D.S.O., R.E., to organize measures for using gas, and to command, train and direct the employment of the special units to be raised for this purpose. These units were organized as R.E. companies and were later formed into a brigade which, with the idea of camouflaging its identity and purpose, was designated "The Special Brigade, R.E." Major Foulkes (who was promoted Lieut.-Colonel on receiving this appointment) spent the summer months of 1915 in investigations and experiments on efficient methods of using gas and in organizing and training his command. Its first use in the field was at the battle of Loos on 25th September, 1915. The work of the Special Brigade and the methods of using gas for offensive purposes are described later in this chapter.

A result of the developments above described was that there grew up in the field two distinct and independent organizations dealing with gas warfare, one studying it and practising it from the point of view of protecting the troops against enemy gas attacks, and the other intent on attacking the enemy with gas weapons. Commanders and staffs found that they had two independent sets of advisers on gas warfare, not always holding identical views. It became clear that greater efficiency would be obtained by unity of organization and command so that the whole subject would be studied and

developed as a single problem. To this end Sir Douglas Haig in April, 1916, appointed Brigadier-General H. F. Thullier, C.M.G., late R.E., at that time commanding the 2nd Infantry Brigade, to be Director of Gas Services, to co-ordinate and control the activities of the offensive and defensive organizations and to be the Gas Adviser to the General Staff at G.H.Q. Colonel Cummins remained as General Thullier's Assistant Director for the control of anti-gas measures, and Lieut.-Colonel Foulkes, who was then promoted to the temporary rank of Colonel, remained in command of the Special Brigade, R.E., and in charge of all offensive operations.

THE BOX RESPIRATOR

The chief problem at this time in connexion with defence was whether it was really safe to continue to rely on the "PH" helmet for protection against whatever gases the Germans might use. They had already made use of some new ones in artillery shell, and from the information gleaned by the chemical intelligence officers, who were part of the anti-gas organization, there was reason to suppose they might introduce others. It would not be possible to add other chemicals to the impregnating material without reducing the protection against chlorine or phosgene, and this would be a dangerous step, since the Germans, as soon as they had captured some of our helmets and discovered that they did not give protection against certain gases, would use these against us. The necessity for a new type of mask giving more general protection, or capable of being easily modified to meet new developments, was clearly indicated. This had already been recognized, and in February, 1916, a special form of box respirator had been introduced and issued to the personnel of the Special Brigade, R.E., and to machine-gun companies, field artillery etc., but *not* to the infantry since it was too large and too heavy to be carried on the person by marching men. It had a large canister containing granulated charcoal and other chemicals, connected by a flexible rubber tube to a face-piece with suitable inlet and outlet breathing valves. The design of the large box respirator

was by Mr. B. Lambert of the University of Oxford (afterwards Major, R.E., and Chemical Adviser, Line of Communications). He also invented the special charcoal and chemical granules contained in the canister.

To devise a modified form of the box respirator which would be small and light enough to be carried by the infantry soldier, and yet contain sufficient filtering material to give efficient protection, was a problem of great difficulty. It was however tackled with determination and energy and was successfully solved. Colonel Cummins, R.A.M.C. and Captain Auld, Royal Berkshire Regiment (later Lieut.-Colonel, O.B.E., R.E.) worked out at G.H.Q. the general design of the small box respirator, and were assisted in certain details by Major G. Douglas, R.A.M.C. and Lieut.-Colonel W. Watson of the Central Laboratory. The granules of the canister were those invented by Major Lambert, but they were modified later by the provision of a more active charcoal produced by Captain E. F. Harrison (afterwards Lieut.-Colonel, C.M.G.) of the Anti-Gas Department at the War Office. Colonel Horrocks, and the Supply Branch of the War Office Anti-Gas Department worked with great energy to secure speedy production of the first order for a million small box respirators and the issue to the troops began in August, 1916.

This respirator had the vital advantage that it enabled any new development in gas warfare on the part of the enemy to be parried with little difficulty. New canisters filled with chemical materials giving protection against the new gas could be manufactured and substituted for those in use, and, since the canister was carried in a satchel slung from the neck, even an increase in the weight of its contents would not cause the face-piece to come away and so admit gas. The increasing use by the Germans of Blue Cross compounds in shells (mainly diphenyl chlorarsine) made it necessary to add an additional filtering unit to the canister of the respirator in the form of an extension clipped on to it. Over a million of the new type were made, sent to France and issued to the troops in less than three months, and were entirely effective in giving protection against Blue Cross gases. When the Germans took

us by surprise in using mustard gas (dichlorodiethylsulphide) shells in July, 1917, the box respirator was found to give complete protection against it to the lungs and eyes, but the liquid gas was capable of causing severe burns on other parts of the body through the clothing or even through boots, and many casualties arose from this cause. When in the winter of 1917/18 it was decided to develop what was called the "M" device, a generator for discharging a more efficient form of particulate smoke cloud of diphenyl chlorarsine (described later in this chapter), it became necessary to increase still further the protection given by the box respirator. This was done by the development of a new type of canister in which some folds of cheese-cloth were introduced; it also had more active charcoal and chemical granules which gave better protection against concentrations of all forms of gas. This canister was never issued to the troops in order that the intention to use the "M" device should not be disclosed to the enemy.

The work of research and experiment required for the changes that became necessary from time to time in the composition of the contents of the canister of the box respirator was carried out by the Anti-Gas Department at the War Office, in the closest co-operation with the Central Laboratory and the Chemical Advisers in France. The home anti-gas organization, which in November, 1917, was transferred from the War Office to the Ministry of Munitions and amalgamated with the Gas Warfare (offensive) Research Department, was responsible for the manufacture of the many millions of flannelette helmets and box respirators which were used by the British armies throughout the war, and also by some of the armies of our allies. An account of the work of these home departments in connexion with anti-gas work is given in Chapter IV.

ANTI-GAS ORGANIZATION IN THE B.E.F.

In June, 1917, Brigadier-General Thuillier was appointed to the command of the 15th (Scottish) Division and Colonel Foulkes, who was promoted to the rank of Brigadier-General, succeeded him as Director of Gas Services with the B.E.F.

At the same time Colonel Cummins rejoined the R.A.M.C. and Major (later Brigadier-General Sir Harold) Hartley, M.C., R.E. took Colonel Cummins's place as Assistant Director for anti-gas measures. Major Hartley, who before the war was a lecturer in chemistry at Balliol College, Oxford, had been Chemical Adviser to the Third Army for a considerable time; his scientific knowledge, his capacity for understanding army organization and methods of work, and his tactful and helpful dealings with commanders and staffs had been of high value. He continued to do very important and valuable work for the anti-gas service till the end of the war. Other chemical advisers at the headquarters of armies, all of whom performed difficult and valuable services, were Major G. W. Monier-Williams, R.E., Major L. J. Barley, D.S.O., Scottish Rifles, Major H. McCombie, D.S.O., M.C., Worcestershire Regiment, Major A. J. Allmand, M.C., Cheshire Regiment, Lieut.-Colonel S. J. M. Auld, O.B.E., Royal Berkshire Regiment (later R.E.), Major A. E. Hodgkin, M.C., Cheshire Regiment, Lieut.-Colonel D. R. Edwardes-Ker, O.B.E., The Buffs. and Major F. J. S. Wyeth, M.C., Essex Regiment. Major B. Lambert, R.E. was Chemical Adviser to all L. of C. troops and also adviser to the Royal Army Ordnance Corps with regard to the issue, withdrawal and reconditioning of respirators. He had been, as we have seen, the author of the original idea of the box respirator. Colonel G. Douglas, C.M.G., M.C., R.A.M.C. was the physiological adviser to the Director of Gas Services. His advice on the effects of the various types of gas used or proposed by either side, and on the treatment of those affected by them was of high value.

The anti-gas organization with the B.E.F. had other very important functions besides those which have been mentioned. A chemical intelligence service was established having a trained chemical officer at every army, and later at corps headquarters. Its duty was to examine German prisoners, to scrutinize all captured documents with a view to obtaining information of any new development in gas warfare projected by the enemy and to ascertain the effects of our own gas weapons. All information relating to gas warfare was collated by Captain

S. J. M. Auld, and his successor, Captain T. H. Adams, at the headquarters of the Gas Directorate from prisoners' statements, captured documents, reports of secret agents, etc. From the information thus obtained inferences of value were often drawn which enabled the anti-gas organization to anticipate the use of new gases by the enemy and to prepare protection against them. Everyone, from high commanders down to the lowest ranks, had to be instructed in the nature of the dangers against which they had to have protection, and the necessity for strict discipline and good training had to be impressed on them. This was effected by frequent visits of the senior gas advisers to army and corps headquarters, by personal interviews with commanders and staff officers, and by the establishment of army anti-gas schools where instructors from infantry brigades and battalions could be trained. The chemical advisers at army and corps headquarters maintained constant inspections to ensure that all units understood and practised the use both of individual and collective means of protection.

Apparatus for giving alarm when gas attacks took place—rattles, strombos horns, etc., were issued to troops. Spraying equipment, with the necessary supplies of solution, was distributed, and the troops taught to use it for clearing gas from the trenches. The methods of making dug-outs and cellars proof against the entry of gas were designed and their execution enforced. When mustard gas was used arrangements had to be devised and brought into operation for decontaminating the persons and clothing of those subjected to it, and for decontaminating ground, buildings and weapons. The necessity for scrupulous care and constant inspection of box respirators, without which they could rapidly become unserviceable, and for collecting and sending back to the bases for reconditioning all those that had become faulty, necessitated the issue of careful instructions and the training of all officers and men. Divisional gas officers were appointed to instruct and advise on all these points and to report when gas discipline was not being fully maintained. Besides the protection of men it was necessary to devise protection for horses in the form of a

respirator which was carried rolled and fastened to the nose-band when not in use. All these, and other precautionary measures had to be organized and executed with minute care and thoroughness and constituted an anxious responsibility for all the anti-gas staff.

After its first establishment the organization was continually developing to meet new conditions, and by the careful work of its intelligence service and the admirable technical research and experimental work of its skilled chemists, physiologists and physicists, it was always, except on one occasion, successful in anticipating new developments by the enemy and providing the necessary protection in time to guard against them. The one exception was the use of mustard gas by the Germans in 1917, which was unfortunately not anticipated. Many casualties were caused by this before the troops were trained to recognize it. The box respirator, as has been mentioned, gave adequate protection against this gas to the lungs and eyes, but could not protect other parts of the body. For the latter purpose oilskin gauntlets and protective clothing were issued to some artillery units that had to handle contaminated material, but a general issue to the troops was not considered practicable.

It may be said that the most important achievement of the anti-gas organization at the front was the development, in conjunction with the Anti-Gas Department at the War Office, of the British box respirator. This appliance became world famous. The high standard of protection it afforded and the readiness with which it was modified to meet every development made it without doubt the most efficient protective appliance devised by any of the combatants in the war, and also made it a principal factor in the striking superiority which the British gas services achieved over the German ones in the war of the chemists of which an account is given below.

OFFENSIVE GAS WARFARE

At 5 p.m. on 22nd April, 1915, the Germans discharged their first poison gas cloud against French-African troops in the Ypres salient, to be followed by several others against British

and Canadians during the following weeks. As the result, considerable local tactical successes were gained. The next day Sir John French not only telegraphed to the War Office asking for respirators, but he urged that immediate steps be taken for retaliation in kind. Political interest at this moment was centred at home in the formation of a Coalition Ministry and it was not until 18th May, that the Secretary of State for War announced that Cabinet sanction had been given for undertaking reprisals.

On 26th May, General Robertson (Sir John French's Chief of Staff) sent for Major Foulkes, R.E., who was in command of the 11th Field Company, and gave him an almost free hand to organize and train the gas troops who eventually became the Special Brigade, R.E. The following day this officer carried a letter to General von Donop, the Master-General of Ordnance, in which General Robertson wrote :—

"The employment of gas may develop into a big thing, and all branches of the staff here feel that gas may become a fifth arm and that we need some officer at G.H.Q. who will deal with the question as a whole. The Commander-in-Chief has therefore appointed Major Foulkes, R.E., for this duty. He has no pretence to technical knowledge, as far as I know, and it is not considered that he need have very much. But he has had much experience at the front, and can explain what we need and how we can perhaps best use it."

Meanwhile, as already explained in Chapter IV, Colonel Jackson, R.E., who was employed at the time under the Director of Fortifications and Works, had been put in charge of the preliminary investigations and he was already in touch with a number of scientists and with the Chemical Sub-Committee specially constituted by the Council of the Royal Society to assist the War Office in the matter. The general problem of protection against gas was being handled by the Royal Army Medical Corps at the War Office.

At this time nothing was known of the behaviour of gas discharged in quantity in the open air ; nor were we aware of the methods employed by the Germans for storing their gas,

for bringing it up to the trenches or for releasing it ; and even the nature of the gas they had used was in dispute. Moreover, during the pre-war years the Germans had established almost a world monopoly in the manufacture of chemicals, while the plant available in this country for their production was almost non-existent. The difficulties with which we were faced were therefore formidable ; and time pressed, as it was the intention to use gas at the opening of the Battle of Loos which was first fixed for 10th July.

An experiment was carried out on 4th June at the Eastner Kellner Chemical Works at Runcorn in which chlorine gas (the only substance it was possible to procure in any quantity) was discharged from specially constructed steel cylinders designed on the syphon principle, and it was from the meagre details observed on this occasion that the plans for the first gas attack were drawn up.

Thousands of cylinders had now to be manufactured in this country and in America, and the output of chlorine had to be greatly expanded. Meanwhile the recruiting of the personnel to be entrusted with the discharge commenced.

It was the intention to install the cylinders in the trenches in batteries placed twenty-five yards apart, and to put two men in charge of each battery to open the valves, one a chemist specially enlisted from the technical colleges and schools in this country, and the other a soldier from an infantry battalion in the line who would supply the necessary experience of trench warfare conditions. The cylinders were to be emptied in turn, so that the duration of the discharge could be controlled; and from the total frontage from which the infantry attack was to be launched, which was first intended to be 5,000 yards, the number of cylinders to be provided could be calculated, as well as the men and officers required for dealing with them.

Much of this proposed organization was based on conjecture, but it proved to be so suitable in practice that in the following years hardly any modification in principle was found necessary, although the equipment was improved, a much more poisonous cloud gas was brought into use (a chlorine and phosgene mixture) and the strength of the companies was altered

so as to be based on the extent of trench system normally held by a division, instead of, as at first, on a fixed frontage of attack. A depot was formed in Helfaut, a small village just outside St. Omer, practice trenches were dug on the neighbouring common and the officers and men were trained, as they arrived, in handling the cylinders and discharge pipes which were sent out in advance for the purpose.

GAS AT THE BATTLE OF LOOS

Meanwhile exasperating delays were occurring in the manufacture of gas and cylinders: the latter were at first acetylene-welded and it was found that chlorine acted on the joints and caused leakages. As the date of attack was postponed from 10th July, to the end of August, and then in turn to 8th, 15th and finally to 25th September, and as new divisions began to arrive in France, the front selected for the attack was gradually widened. As more and more cylinders were to be expected during this extended period the length of trench to be prepared for the gas attack was also increased (it was eventually trebled) and a corresponding increase became necessary in the number of R.E. Special Companies required. Finally four were formed, each consisting of ten sections under an officer.

The first draft reached Helfaut on 18th July, and as the companies were completed they were moved up into the line according to a prearranged plan: they reconnoitred their fronts, selected bays in the trenches for the reception of cylinders and marked each emplacement with a numbered peg, the utmost secrecy being maintained as to the object of these preparations. As officers were not arriving from home in sufficient numbers, twelve subalterns were borrowed from Territorial battalions temporarily at rest, while eight others joined from England on 18th September, only seven days before the first gas attack took place!

There was also a shortage in the number of cylinders that had been promised and the later consignments were rushed up to the front as they were landed. One lot, the last to arrive, left Runcorn by special train on 22nd

September, reached Boulogne on the morning of the 24th, left by lorry and was carried into the trenches and put in position the same night! Meanwhile a meteorological unit had been formed which, on receipt of reports from centres all over Europe, as well as from seventeen stations behind the front line (the observations being made by trained men of the Special Companies), was able to issue weather forecasts twice a day.

By this time it had been established that the Germans had used chlorine in their first cloud discharges, we had no choice at this period but to employ the same gas: but, whereas their attacks had been made against unprotected troops, ours were to be undertaken against men who were all equipped with respirators, whilst the German officers and machine gunners carried oxygen breathing sets containing a supply of oxygen which lasted thirty minutes. Two elements were therefore absolutely essential for success: The attack must come as a complete surprise—before the German soldier had taken his gas training seriously and before an improved pattern of mask could be issued to him; and the duration of our gas discharge must exceed thirty minutes in order to incapacitate even the personnel equipped with oxygen sets.

As regards the first point, the Commander-in-Chief, Sir John French, and the Army Commander, Sir Douglas Haig, attached the greatest importance to the gas discharge because, as explained in the *Official History*, they considered that with the troops and artillery at their disposal at the time no attack could succeed unless the conditions were favourable for gas. Moreover, the frontage was not of their own choosing, and even the time and date of the attack had been imposed on them by our French allies.

As regards the duration of the discharge, the shortage of cylinders made it necessary to interpose periods of smoke at intervals during the discharge, to simulate gas. This was the reason why smoke was used for the first time in modern warfare, and it was found so successful in its secondary object of covering the movements of advancing troops that hardly any British operation took place subsequently without

it. The Stokes mortar, too, made its first appearance on this occasion. The 3-in. pattern had been previously condemned as unsafe for use with high-explosive bombs, but a few 4-in. mortars had been ordered for firing gas bombs. These bombs could not be produced in time, so smoke bombs were extemporized in the field and fired at Loos to thicken the cloud. The mortars became so popular in consequence that pressing demands were made for them by the infantry; the original defects were overcome and high explosive bombs were fired from tens of thousands of these weapons throughout the later stages of the war.

In the early morning of 25th September, 5,500 cylinders were in position in the front line, in charge of fifty-nine officers and 1,404 men of the Special Companies. The weather report was not very favourable. Certain safety limits had been laid down, namely a wind velocity of not less than four to six miles an hour and a direction of not under 45 deg. to the general line of the trench system. Neither of these conditions was fulfilled, but Sir Douglas Haig decided to take a risk as he considered that the attack could not succeed without the assistance of gas.

Watches had been synchronized in the 400 gas emplacements, and punctually at zero hour (5.50 a.m.), with a redoubled artillery bombardment, the gas and smoke were released on a front of $24\frac{1}{2}$ miles, the gas frontage itself being about one-third of this, 14,500 yards. The first aeroplane reports that came in a few minutes later were to the effect that the gas cloud was rolling steadily towards the German lines; and from the tall wooden tower which had been specially constructed in the grounds of Sir Douglas Haig's battle headquarters at Hinges an awe-inspiring spectacle was visible. For apart from the fumes and dust caused by the artillery drum fire and the clouds of gas, smoke was being emitted from 11,000 "candles," 25,000 phosphorus hand-grenades and 10,000 bombs fired from the Stokes mortars in addition to those fired from catapults and from other types of mortar. The smoke enveloped the German artillery observers and machine-gunners in an impenetrable cloud.

Immediately the gas was observed the enemy opened a heavy bombardment on our front line. In places the discharge was not interfered with, but in others heavy shells fell in the trench or burst on the parapet, overturning tons of earth and burying the emplacements and their crews.

In the din of the bombardment and in these distracting circumstances, the men of the Special Companies, now receiving their baptism of fire, stuck to their work with the utmost gallantry, and in some of the bays all twelve of the cylinders that had been installed were emptied, though there were others where the officers, exercising their discretion, discontinued the discharge as soon as it was evident that the cloud was likely to interfere with the movements of the infantry. On the 2nd Division front the infantry brigade commanders were warned that it was dangerous to open the cylinders at all, but peremptory orders were given to comply with the programme. This gave rise to exaggerated rumours as to the effects of the gas among our own troops and to the subsequent prejudice against using gas in attack—a prejudice which it took a long time to dispel.

So well had the secret of the gas installation been kept that the attack came as a complete surprise to the Germans. Along parts of the front the gas reached their trench system and caused a complete panic, but in others it drifted along at an acute angle and only reached the enemy well away to the flank. Some of the infantry in their eagerness to advance left their trenches ten minutes too soon and ran into the gas; others lost their direction in the smoke with which, for reasons of safety, the programme ended and which they mistook for gas. But on the whole, contrary to the general impression at the time, the gas attack was a success and it is probable that without it no ground would have been gained that day. As it was, the famous Hohenzollern Redoubt was overrun with very little loss and some of the battalions advanced a mile and more at the first rush. Many gassed Germans were found in the trenches and prisoners admitted that they had suffered severe gas casualties. These admissions were repeated in contemporary accounts in the German Press and in post-war

histories, but it was not until fifteen months later that official German documents came into our possession which confirmed these reports. An extract from one of these from Fourth (German) Army Corps Headquarters, dated 27th September, 1915, is given below :-

"No preparations for a gas attack had been observed. The gas cloud was so strong that at 6 kilometres behind the front it was only possible to see at ten paces distance. At 1,500 metres from the enemy trenches the artillery was in great danger from gas. Breech blocks became unusable and it was impossible to give orders. By the ever-recurring gas clouds the respirators gradually became less effective."

The German official communiqué of 25th September, 1915, contained these words :-

"Even this retirement was not the result of the English Commander's abilities, but was the consequence of a successful surprise attack with intoxicating gases."

THE SPECIAL BRIGADE R.E.

Considerable technical benefit was obtained from the experience at Loos and from the gas attacks that were launched later in 1915, and the four original companies that bore the engineer numbers 186-189 were expanded into the Special Brigade, R.E., consisting of sixteen cylinder companies, organized in four battalions and lettered A to Q, for cloud enterprises; four mortar companies in one battalion, numbered 1 to 4 and equipped with the 4-in. Stokes mortar, for firing gas, thermite and smoke bombs; and Z Company which employed flame projectors including the heavy type that had a range of a hundred yards. Later in the war every company was trained in the use of all these methods, except the flame projectors, which were fired a number of times during the period of the Battle of the Somme but were then abandoned as being too unwieldy.

THE LIVENS PROJECTOR

Meanwhile, Captain Livens, who commanded Z Company, devised a projector, consisting of a steel tube, which fired a bomb containing 30 lb. of phosgene. The tubes were set in the ground in batteries of about twenty at an angle of 45 deg., variations in range being obtained by altering the propellant charges. As many as 4,000 of these projectors could be fired simultaneously in a single discharge, by an electrical device, and the resulting cloud, being very dense and released in the target instead of drifting down upon it, overcame the protection afforded by the best German respirators and caused large numbers of casualties.

The projectors were inaccurate as mortars, but the concentrations of gas set up in a projector target were so extremely heavy that accuracy was unimportant. The targets were usually local strong points, headquarters, etc., and the effect of the resulting clouds was transitory. Cylinder discharges on the other hand were more prolonged and the whole of the enemy trench system was covered by them, while the cloud penetrated to the rear areas and caused casualties many kilometers behind the front line.

The drums were sometimes filled with high explosive or thermit instead of gas; or sometimes with inflammable oils, 1,500 being fired to set alight the woods on the Messines Ridge just before its capture in 1917. Occasionally, too, harmless but evil-smelling substances were used immediately before an assault, so that the enemy might be placed at a disadvantage in having to wear their masks when resisting our troops.

Projectors were used on a large scale for the first time at the opening of the Battle of Arras on 4th April, 1917, when 2,340 drums were discharged: but much larger operations took place subsequently; for instance 4,200 drums (and 3,100 Stokes mortar bombs) were fired on the night before the great tank attack at Cambrai in November, 1917; 2,960 drums were fired on 19th March, 1918, into St. Quentin, where the German troops were assembling on the eve of their great assault; and 3,730 drums (and 1,400 Stokes mortar bombs) into Lens on 21st March itself.

USE OF GAS IN SUBSEQUENT OPERATIONS

The cloud method of attack was not altogether abandoned and many such attacks were launched up till the end of the war. The tactics employed for taking the enemy by surprise were very varied. Nearly all the attacks took place at night so that the advancing cloud should not be observed by the enemy's sentries. Sometimes the discharge was followed by another, and even a third, at intervals of an hour or two, and occasionally it was preceded by an artillery bombardment in order to discourage observation and to add to the confusion in the enemy's lines.

Similarly, with the projector operations, the emplacements were sometimes sited to the flanks of a target so that the troops occupying the latter might not be put on the alert by the flash of the discharge. On other occasions the attack took place (on a distant target) in a dead calm when the use of gas was not expected. Sometimes, too, dummy emplacements to a flank were camouflaged with studied carelessness and, being recognized on air photographs, drew fire, while the real installation was being built up elsewhere undisturbed. In fact, so varied were the tactics employed that in a captured document the Fourth (German) Army Commander complained that the British were violating all the technical laws of gas warfare.

Cloud attacks were most frequent in 1916, when 110 took place, and projector operations in 1917. The latter were more popular with infantry commanders because the mortars were dug between lines of trenches and their installation could take place gradually, the drums being loaded into them at the last moment. Consequently, less demands were made on infantry units for labour, although the total weight of the material carried for a given quantity of gas discharged, was actually four times as great as in the case of a cylinder operation.

Because of their requirements for labour and because the results achieved only became known some time after the event, gas operations were usually undertaken with reluctance by infantry commanders in spite of the pressure put on them by G.H.Q., and it was found—as the American Special Units

put it later on -that "one had to go out and sell gas to the army."

To reduce the difficulty of installation, cylinders were sometimes placed, in 1918, in "retired" positions, and were discharged after the troops had been withdrawn from the trenches in front of them: 4,000 were discharged in this manner near the forest of Nieppe in June, and later on, several such operations took place from the Ypres salient and elsewhere, thousands of cylinders being transported on trench tramways, discharged electrically from the trucks, and taken back empty immediately afterwards.

Gas was discharged on a large scale as part of the preparation for all the great battles of the war, and the Special Brigade was continuously engaged, except for a brief period of rest lasting two months at the beginning of 1918, when the opportunity was taken of arming the men with rifles instead of the revolvers which they had previously carried. They acted as infantry on many occasions during the operations of 1918, and in the conditions of open warfare which developed they took every opportunity that presented itself of discharging gas from projectors and Stokes mortars which were rushed up at very short notice by mobile detachments in lorries.

The total strength of the Brigade was 258 officers and 5,832 men. Altogether no fewer than 768 separate gas operations were carried out, in addition to many with smoke, thermit, oil, "stinks" and high explosive: 88,000 cylinders were emptied, and 197,000 projector drums and 178,000 Stokes mortar bombs were fired, representing a total discharge of 5,700 tons of gas. The magnitude of the operations varied from the electrical release of 160 tons of gas from 5,110 cylinders to the firing of a few Stokes mortar bombs from the outskirts of a half-captured village. As an illustration of their activity it may be mentioned that on the night preceding H.M. the King's visit of inspection to Helfaut eight gas operations were successfully carried out, one with cylinders, five with projectors and two with Stokes mortars.

After the first period of extemporization, during which much of the material supplied was very defective, accidents

very rarely occurred and our infantry suffered hardly at all from our own gas. Infantry commanders who had previously been hostile begged for the attachment of gas troops, and many appreciations were expressed of the technical skill of the Special Companies and of the gallantry with which their work was performed.

The total casualties of the Special Brigade during the war were 5,384, many of which occurred when they were acting as infantry in 1918, and 557 decorations were bestowed, of which 494, including one Victoria Cross, were "immediate awards."

There can be no question but that the enemy suffered very severely from these operations. At first particulars of their losses were difficult to obtain, and prisoners who volunteered information on every other subject refused to discuss their gas casualties. They had been specially warned to be silent, and even burial parties after a gas attack were forbidden to discuss the business on which they had been engaged. The same reticence is noticeable amongst the post-war German writers and regimental historians. Towards the end of the war, however, an immense number of official documents fell into our hands, many of which expressed alarm at the demoralization among the troops caused by their losses from gas, and even the German War Ministry in a document dated 14th April, 1918, attempted to correct the impression which was gaining ground that the masks were ineffective against our gas. The constant insistence on strict gas discipline was a regular feature of these orders, and from captured letters and diaries it was evident that the German troops feared gas above all else, that it was a constant subject of discussion amongst them and that their losses from it had a profound effect, both moral and material, that seriously reduced their fitness for battle.

CHAPTER XXI

SURVEY ON THE WESTERN FRONT

Provision of maps in 1914—The call for more accurate maps—Start of a new survey—Birth of sound ranging—Expansion in 1915—Improvements in artillery survey—Developments during 1916—Achievements of artillery survey—Achievements in map production on the Western front.

PROVISION OF MAPS IN 1914

ON the 11th August, 1914, Major (later Brigadier) E. M. Jack embarked, with the Expeditionary Force, as "i c Maps" (G.S.O.3) or, as he was soon to become better known, "Maps G.H.Q." He had but one clerk and no special transport. Captain (later Colonel) O. E. Wynne, with one clerk, supervised map supply and storage on the L. of C., first at Amiens, then at Le Mons, and after at Neuville St. George, at which places Captain B.H. (later Colonel) Wilbraham, with the Printing Company, R.E., also had his headquarters, pushing mobile sections out to corps headquarters.

Maps were issued to the troops on embarkation. They consisted of one strategical, and thirty-six tactical maps. The latter, packed in sets which had to be broken and maps extracted to deal with the emergency of the moment, covered an area between the Channel and a line from Le Havre to Luxemburg, but at different scales (1/100,000 and 1/80,000). Apparently formations were expected to make them last for the duration of the war. Actually a brigade supply weighed about three-quarters of a ton, and, as the brigade transport was incapable of dealing with this unexpected addition, the sets were broken up and distributed to be carried on the person. Fortunately the printing plates of all these maps, and of many more French 1/80,000 sheets to the south, lay ready for printing at the Ordnance Survey.

Fighting at first was of the type anticipated by the General Staff, but covered an area greater than that provided for. The retreat to the Marne rapidly left map supply behind. The original issue, thrown away or returned in supply trains, had, temporarily failed in its purpose. Major Jack, getting transport and help where he could, distributed in person, his few hundred reserve stock of southern sheets. The Ordnance Survey started printing, sending stocks across the Channel as and when possible, and it became apparent that the mobile plant of the Printing Company was wholly inadequate. The French *Service Géographique de l'Armée*, and the proprietors of *Carte Tardie* (a series of motoring maps) did their best to help, and, in September, Major Jack was given an additional clerk and a box car. The Printing Company under Captain Wilbraham was concentrated at G.H.Q.

The advance from the Marne to the Aisne ended in the first long drawn out battle, and here the accuracy of map material began to show its importance. Fortunately the new French 1/50,000 series had covered this area in small sheets, one of which the Printing Company was able to reproduce. It was soon evident, however, that the conduct of such a battle called for larger scale maps, so designed as to facilitate some easy method of referring to any particular spot, whether named or not.

Next came the move of the Expeditionary Force to Flanders, and here the same problems awaited it. By a fortunate coincidence the printing plates of the Belgian 1/20,000 and 1/40,000 maps had been brought to England in October. These maps, superior to all contemporary French cartography, were printed at once by the Geographical Section and sufficed for the needs of troops in Belgium, but units actually in France had to use the 1/80,000. The Ordnance Survey enlarged these photographically to 1/20,000 and printed them in sheets which formed an extension of the Belgian series.

Meanwhile Major F. M. Close and a party of Ordnance surveyors were hurried to Boulogne to map the base camp, as plans of the requisite reliability did not exist.

On 7th November the 1st Ranging Section, R.E.—consisting

of one officer, Captain (later Brigadier) Winterbotham, and four rank and file—embarked to join the 8th Divisional Artillery. This experimental unit was designed to locate an enemy target by fixing the position of an aeroplane signalling when vertically over it. In these early times there was no wireless communication between the aeroplane observer and the ground. Important targets could be reported only on return to the aerodrome. The method of locating an aeroplane at a given moment of its flight, and of connecting that position with its range and bearing from our own artillery positions, called for normal but extensive trigonometrical surveying. This in turn called for immediate touch with the French survey authorities in order to secure the positions (co-ordinates) of their trigonometrical stations. And at this point—when survey operations in the field actually began—the position may be briefly reviewed.

Major Jack, who now had Captain Wilbraham and the Printing Company with him, had evolved a satisfactory system of map distribution to brigades. The Ordnance Survey and the Geographical Section were supplying sufficient quantities of Belgian and French maps. A workable system of squaring the 1/20,000 maps and of giving understandable place references had been evolved.

THE CALL FOR MORE ACCURATE MAPS

On the other hand all commanders, in particular those of the artillery, were calling for better and more precise surveys. Shooting from the French 1/80,000 was mere guesswork. The rudimentary system of cross observation on flashes (or "flash spotting"), then in vogue, was useless because the assumed map positions of O.P.s. could not be depended upon. Registration invariably disclosed wide differences between map direction and those measured by the gun sight. To embark on a re-survey seemed ill advised, because opinion—invariably optimistic—forecast a speedy advance.

For two months the 1st Ranging Section continued its experiments, but rain and fog limited opportunity to about one

day a week. Then wireless communication was established between ground and aeroplane and the problem was changed. The Ranging Section was free for other work, and had already acquired a mass of trigonometrical information. During these early days the section had fallen naturally into the habit of surveying the positions of our own batteries and of providing lists of bearings and distances, which were an enormous help in ranging. Problems of locating flashes had also been discussed, and some good battery identifications secured by bearing and angle of depression (on the depression range-finder principle) from the tower of La Gorgue Church.

Finally an effort was made to revise the French 1/80,000 by the same graphic system as is practised normally for the 1-in. in Great Britain. But that is only possible where the detail already mapped is trustworthy—and it was not. Major Jack and Captain Winterbotham agreed, in consultation, that a fresh survey was inevitable, and early in 1915 a start was made.

START OF A NEW SURVEY

Continuing the survey of our own batteries the 1st Ranging Section, reinforced by fifteen thoroughly expert Ordnance Survey planetablers, began surveying the occupied areas. Considering the comparative excellence of the Belgian maps it was obviously sound to extend the Belgian system into France, including its projection and sheet lines. Mapping had, however, to depend upon the French national triangulation, and before field work could begin, a mass of difficult computation had to be done, burdened with poor connexions and actual differences in position between the French and Belgian systems. Seven hundred and fifty square miles of mapping were completed in a month. In February, six more Ordnance Survey men arrived, survey was extended south and west, and a detachment revised the very poor French plans of Calais, now becoming an important base port.

In March, 1915, First and Second Army headquarters were formed, and map supply, together with minor printing tasks,

were met by appointing to each a " Maps " Officer, with two clerks, a car and a section of the Printing Company, R.E. These Maps and Printing Sections had no surveying personnel. On the 22nd April, the 1st Ranging Section disappeared as a divisional unit, to reappear as the 1st Ranging and Survey Section (a G.H.Q. unit). It was charged with all field surveying on the British front.

It may seem curious that a unit attached to a divisional artillery should have started the remapping of the whole theatre of operations, but it was a matter of the happiest significance. In some theatres, such as those in Africa, guidance across country and compass mapping were of the first importance, but on the Western front the co-ordination and direction of fire power were to prove our chief task. The early association with an artillery, lacking all survey method and unable to locate its targets, was to influence our methods and our growth. In these early days, however, survey measures were confined to locating our own guns and to mapping the ground in our own occupation.

The latter point is interesting because the responsibility for mapping ahead, fell, by regulation, upon the Intelligence Branch of the Staff. In actual practice that ruling nowhere survived the test of war. The first definite act of topography within the enemy lines came to the Ranging and Survey Section in the shape of one of the first photographs ever taken from an aeroplane. It was taken over Neuve Chapelle about a fortnight before the battle and was immediately used for map revision. From that time survey units took over forward mapping with the goodwill, if not the expressed sanction, of those concerned.

In April, 1915, came the first officer recruit—Lieutenant F. J. Salmon (Survey of Ceylon—later Lieut.-Colonel—and Commissioner for Lands and Surveys in Palestine), who was posted to the 1st Ranging and Survey Section. He was followed by Captain Gaine, a land surveyor from Canada. These postings, the first from that reserve constituted by the land surveyors of the Overseas Empire, are historically interesting.

BIRTH OF SOUND RANGING

At this time there was talk of "sound ranging" or surveying the position of a hostile gun by recording the actual times at which the sound of discharge reached a number of surveyed positions. The French authorities had, typically enough, already made progress with this new idea in several distinct ways. Although faced with expansion of all sorts, our own General Staff was, perhaps, slow to act. It required the direct intervention of Colonel (later Sir Cooze) Hedley, who had seen French progress in Paris, to set definite investigation afoot. Fortunately, for the problem is one essentially of surveying and signalling, the committee of three appointed in May—Colonel Dreyer, R.A., Captain Winterbotham, and Captain Lefroy of Signals (then R.F.)—included the necessary knowledge. As the artillery representative later fell out, the report, whose conclusions were finally accepted, was entirely a Corps affair. The event proved those conclusions to be sound and practical, and the system chosen to be the best employed by any army. The first organized section did not appear, however, until 18th October, 1915. The choice of command fell upon Lieutenant (later Professor) W. L. Bragg, already a Nobel prizeman in physics, and a member of the Cambridge Territorial Artillery.

EXPANSION IN 1915

By the middle of June the duties of the Ranging and Survey Section had outgrown its powers. Hurrying between Ypres and Béthune, observers could not keep pace with the survey of our own guns, and topographical mapping lacked due supervision. The Battle of Loos loomed ahead, and further extensions of the British front were in contemplation. On the urgent representation of the officer commanding, G.H.Q. took action, and in July three army Topographical Sections were formed. By this time the survey of the First and Second Army areas was complete, extending as far back as G.H.Q. (St. Omer). To the South, however, from Notre Dame de Lorette to the Somme, there existed but a few French Army *Plan Directeurs*,

covering little in depth and that uncertainly. The newly-forming Third Army was to take over this area and to it the nucleus of the 1st Ranging and Survey Section was posted, becoming the 3rd Topographical Section, with Major Winterbotham in command. Captain Gaine took command of the 1st, and Major C. S. Reid of the 2nd, incorporating in it his existing Maps and Printing Section.

The combined establishments of a topographical section and of a maps and printing section was four officers and thirty-four other ranks. It may be said that these establishments, and all those which succeeded them, were invariably exceeded. One of the penalties of an inadequate provision for surveys and maps is that local commanders (even down to battalions), insist on having some sort of map or sketch of their immediate surroundings. If it is not provided, men are withdrawn from the ranks, grouped into small unequipped sections, and made to produce something.

The battle of Loos provided many lessons. The country opposite Laventie on the left-front was covered by a special fortress survey (*plan directeur*) of Lille, but Loos itself and the mining area in German possession were mapped only on the normal 1/80,000. Fortunately a French army had recently compiled a more trustworthy 1/20,000 from property and mining plans. After considerable staff opposition these French maps were adopted for use in the attack, and all batteries, from Laventie to Notre Dame de Lorette were surveyed, and provided with range and bearing to a variety of datum points. It became evident, however, that nothing short of good mapping all the way from gun to target, the provision of plotted arcs of fire and of every indication that contours and spot heights could give to help in the proper computing the angle of sight, would really suffice for so new a problem and so rapidly growing an artillery.

IMPROVEMENTS IN ARTILLERY SURVEY

With these lessons in mind the mapping of the Third Army area was begun. From the reserve trenches to army headquarters the ground was planetabled at 1/20,000. Forward

of the reserve trenches Napoleon's century-old manuscript cadastral plans (at 1/2,500) were reduced to 1/10,000, fitted on to the French triangulation, and then corrected and brought up to date from air photographs. The General Staff gave all authority for survey operations, and as a result we produced really good map material. For heavy and siege artillery this was arranged on "artillery boards" on which the position of the battery was plotted, and a graduated arc (reading from it) added. Further developments of battery survey may now be anticipated. The very numerous individual surveys consequent on fixing individual guns were soon found to have permanent rather than temporary value. The practice of marking each location with an iron pin grew, and these soon developed into the well-known "bearing picket" which carried on it a record of its co-ordinate position and of the bearing, from it, to a selection of surrounding and suitable reference points. Reinforcing artillery, if provided with a list of those pickets often came rapidly and easily into action without further aid.

No really accurate artillery concentration could be effected, however, without a survey of targets of the same order of accuracy as the survey of our own guns. The next step was to provide that survey. Flash spotting suffered from lack of survey knowledge in fixing the O.P. and deducing correct bearings from it, and secondly from the unsolved difficulty of concentrating observation on one only of the many hostile batteries which were active at the moment.

By the middle of July, 1915, only one section of flash spotters—naturally one using the good Belgian map material of the Ypres salient—had had any success. The 3rd Topographical Section was, therefore, empowered to raise an Artillery Survey Detachment for the continual and accurate observation of its front. Observing train and troop movements and opportunity targets of all sorts, and concentrating on flash spotting from dusk to dawn, this detachment was manned by Artillery observers and by gillies from the 51st (Highland) Division. Covering first the whole front continuously, and then breaking into groups of four posts with a control station, each admirably served by Army Signals, and in progressive hands, visual

observation may now be left. The organization was soon to cover the whole of the Western front and that in a manner admittedly superior to contemporary efforts by friend or foe. An able young officer—Lieutenant H. H. Hemming—who was one of the original members of the Artillery Survey Detachment, and who later became a temporary Major in the Corps, took the same leading part in the development of flash spotting as Major Bragg in sound ranging.

With sound and visual methods of location well started, with a growing volume of photography from the air, and with accurate maps as the basis of analysis, the next step was to eliminate the many and conflicting "hostile battery lists" which perplexed the artillery command, and to substitute therefor the accurate information secured by the topographical sections. The Third Army set an example and the Topographical Section Lists, amplified by special maps, reigned supreme. In later days the responsibility for these lists came gradually back to the counter battery staff officers, but not until accurate location had displaced hearsay evidence.

Thus 1915 was the formative year in which practically every field-survey method was not only explored, but shaped nearly correctly to its end.

DEVELOPMENTS DURING 1916

Early in 1916, topographical sections became Field Survey Companies with an establishment which, in practice, they had already outgrown. The Royal Engineer (regular) officers concerned were Major H. Wood (late of the Survey of India) in the First Army, Major C. S. Reid in the Second, Major H. Winterbotham in the Third, and Major M. N. MacLeod (also late of the Survey of India) in the Fourth. It is impossible, either here or later, to give the names of all those temporary officers who served so ably in the field survey battalions, as even at this time (1916) some hundred were so employed. Coming from colonial surveys, from engineering and other professions or from academic life, these young officers were, perhaps, the pick of the army, and they had an *esprit de corps* as happy as it was vigorous.

By this time the southern extension of our line from Notre Dame de Lorette to the Somme had been covered with a belt of really reliable mapping. A rather absurd refusal to allow the survey and mapping of our own trenches (indispensable for infantry and artillery alike) had been overcome, and secret editions showing every sort of British, as well as enemy, organization, were supplied. The artillery board had become the normal geographical equipment for heavy and siege batteries, and gradually field artillerymen were learning to rely upon similar methods.

In February, 1916, were formed the first schools of sound ranging and flash spotting: the former in the Second Army area, and the latter in the Third. As both systems demand precise survey and a real eye for country, topographical survey was taught at both schools, officers were taken over the enemy lines in aircraft, and changes of position and communication were practised. By this time all survey units had their own linesmen.

The battle of the Somme then intervened to test the new organization. The first point to emerge was that of printing. Map supply for an army of (say) 100,000 men in war is equivalent to that for the whole population of Great Britain in peace, yet the implications of the encounter battle were still allowed to hamper output by refusing heavy printing machinery. The Fourth Army made use of printing establishments in Amiens, the Third, less fortunate in local resources, bought a machine in London and managed to move it to St. Pol. Daily editions of trench maps brought the situation up to date during intensive fighting. There must always be, in war, an insistent demand for those diagrams and situation sketches necessary to the higher command, and this demand had to be met by the formation of corps topographical sections equipped with duplicators. In actual fact the formation of these corps sections was of small value except to assist in the general staff routine, but they saved man-power by putting an end to temporary detachments.

The new visual and sound methods of observation proved invaluable but the artillery, by concentrating the responsibility

for counter battery work in the hands of specially selected officers, changed our channels of report, and delays were liable to occur.

In July, the Fifth Army arrived, and the 5th Field Survey Company was formed under the command of Captain B. E. F. Keeling, the first temporary officer to command a company. He owed his early training to the Corps, for he had served under Colonel Sir Henry G. Lyons when the latter had, so efficiently, remodelled the Survey of Egypt.

ACHIEVEMENTS OF THE ARTILLERY SURVEY

One illustration may now be given of the survey efficiency attained at this period. An Austrian howitzer battery came into action opposite Arras. It was desired not only to "place" it at once but to identify its calibre and type. The placing was done by sound ranging, which also placed the burst of a shell over a house shown on a new map of the eastern suburb. An observer sent with the map to identify the house in question found pieces of the shell. Identification was complete.

In 1917, Major Keeling, wounded in the Somme Battle, was relieved in the 5th Field Survey Company by Major F. B. Legh of the Corps. On his return to duty he, in turn, took over the 3rd Field Survey Company from Lieut.-Colonel H. Winterbotham, who was ordered to G.H.Q. as technical adviser. At G.H.Q. a Depot Field Survey Company was formed to include all the schools hitherto operating in army areas, and to prepare for the hoped-for mobile warfare.

At this date, the field survey companies were increased in establishments and reorganized as battalions. The total survey strength was now nearly 4,000 all ranks; examinations of captured territory were showing that over 90 per cent of the German batteries had been correctly placed and identified; the artillery were using sound ranging and flash spotting increasingly for ranging; and the surprise effect of unregistered, yet accurate, fire was becoming recognized.

The battle of Cambrai was a striking example of the ever-increasing power and precision of an artillery so directed.

The precision was greatly helped by the calibration of guns at experimental ranges equipped with the same instruments as used for sound ranging. By simple adaptation the times of discharge, and of the penetration of two screens, were recorded photographically. Theoretically such calibration should occur with every change in the type or "lot" of ammunition provided, but the so-called "error of the day" was yielding to treatment.

During 1917, Major Wood left to organize survey work in Macedonia, and Major B. H. Wilbraham took over command of the 1st Field Survey Battalion. The Depot Field Survey Battalion at G.H.Q., under the Command of Lieut.-Colonel L. N. F. King, had already absorbed the headquarter section of the old printing company which now ceased to exist as a unit.

The German offensive in the spring of 1918 on the Fifth and Third Army fronts brought fresh problems. Generally speaking field survey units lost little, either in men or equipment, during the retreat. On the other hand, fresh mapping behind the line became imperative. The French cadastral plans (Napoleon's old survey) of the Somme area were removed (after violent protest) from Amiens, and every available topographer concentrated on the production of maps of the reserve line and to the rear of it. Map supply would have been a difficult matter had not the Overseas Branch of the Ordnance Survey, installed at Wimereux, been able to undertake most of the printing.

In April, General Bourgeois, Inspector General of French Artillery, and head of the *Service Géographique de l'Armée*, called a conference of American, British, French and Italian representatives to evolve a common system of co-ordinate references. Hitherto French and British positions (and locations) had been given on different systems. Any universal system implied the use of the same projections and origins. The inevitable solution is the use of the rectangular co-ordinates of the chosen projection and origin in all army matters as well as in surveying, and this was agreed to. It was never to materialize, however, because the activity and movement of the last hundred days made change impossible.

But before the victorious advance began, the field survey units were to score a final success. During the fortnight before the battle of Amiens visibility was so poor as to forbid flash spotting and to make it extremely difficult even to fix the positions of our own guns. Nevertheless, German batteries were so accurately located, and our own fire so skilfully directed without preliminary warning, that the infantry advance was almost unhampered by gunfire.

During the final advance, flash spotting and sound ranging units were able to follow up and come into action with good effect. Indeed the least mobile factor of a field survey battalion was its old-fashioned printing machinery.

ACHIEVEMENTS IN MAP PRODUCTION ON THE WESTERN FRONT

The foregoing pages may perhaps give the impression that normal mapping duties suffered from a preoccupation with artillery matters. Such was not the case. The record of survey and mapping reached almost astronomical figures. For example 10,000 square miles of triangulation were observed or re-adjusted, and 6,000 square miles were surveyed, printed and published at the scale of 1/20,000. Some 34 million maps were issued to the troops, with an average daily distribution of about 20,000. Fourteen thousand artillery boards and over 1,000 raised models were supplied. Special editions designed to facilitate one or another aspect of what was so much an engineer's war covered twenty-one separate and distinct styles, and field survey battalions often printed a new situation map every day. Such was the mapping record of an improvised service.

CHAPTER XXII

WORKS DIRECTORATE IN FRANCE

Initial organization for works services in the B.E.F. Bases in France.—Staff, units and unskilled labour. Works executed during 1914. 16. Abolition of the I.G.C. and appointment of D.C.T.—Works during 1917.—Events of 1918.—The Director of Works, B.E.F.

We have already noted that the Institution of Royal Engineers published, in 1919 and 1920, a series of volumes entitled *Work of the R.E. in the European War, 1914-19*. The under-mentioned volumes of this series give very full descriptions, in considerable technical detail with many plans and illustrations, of the work carried out under the Director of Works in France: *Work under the Director of Works (France)*, *Water Supply (France)*, *Supply of Engineer Stores and Equipment*, and *Miscellaneous*. We cannot, for lack of space, reproduce all this valuable material, and must confine ourselves to recording sufficient historical information to give the reader a general picture of the work and the conditions under which it was carried out.

INITIAL ORGANIZATION FOR WORKS SERVICES IN THE B.E.F.

In August, 1914, the Works Directorate of the British Expeditionary Force, when mobilized, consisted of:—

Director of Works, Brigadier General A. M. Stuart (transferred from the post of Assistant Director of Fortifications and Works, War Office).

Deputy Director of Works, Colonel E. H. Hemming.

Assistant Director of Works, Colonel C. W. R. St. John.

Thirty-five R.E. officers, not shown on any establishment and without any subordinate staff. Many of these were almost immediately reposted to units to replace casualties.

The 20th and 29th Fortress Companies, R.E. arrived early in France and were at the disposal of the Director of Works. The 42nd Fortress Company, R.E. was soon also placed at his disposal, but it and the 20th Fortress Company were almost at once transferred to the front to work under the Engineer Adviser at G.H.Q. The organization included no labour units of any kind, and it was some weeks before such units were available.

In the mobilization tables the provision of subordinate staff—foremen of works, mechanics, inspectors of R.E. machinery, clerks and draughtsmen—had been overlooked except for two clerks in the D.W.'s office. No foremen of works arrived before December, 1914.

The D.W. was under the orders of the Inspector General, Lines of Communications, established at Amiens, at which place the D.W. and his staff reported on 17th August, 1914.

It is instructive to compare the above numbers of personnel initially under the D.W., with those he controlled at later dates. In November, 1918, he had 197 officers under his orders excluding those with the units working under him. The number of subordinate staff (foremen of works, clerks, etc.) at that date is not recorded but was proportionate to and, of course, far exceeded the 197 officers, and incidentally included thirty-six women of the Q.M.A.A.C. A year previously the subordinate staff had totalled 340 and the number of R.E. units under D.W. had risen to fifty four, while several British and many French contractors were carrying out contracts for large works.

At the end of this chapter will be found tables showing the organization of the Works Directorate and the staffs of the Director of Works, his Deputy Directors and Cs.R.E.

In addition, during the war the Works Directorate had given birth to six independent directorates carrying out work initiated by the D.W., i.e., Stores, Forestry, Roads, Docks, Lands and R.A.F. Works.

Readers of this chapter will be amazed that mobilization tables had provided such an exiguous staff, with no subordinates to deal with the work which from the very start poured in upon the D.W., expanding every day. In the Introduction,

however, we have explained the causes of the regrettable misconceptions and lack of provision for engineer work in the war of 1914-18. To understand this chapter the reader may wish to refresh his memory upon what was said on that subject.

In Chapter VIII we have dealt with the activities of the E.-in-C. and Chief Engineers and the definition of their responsibilities as ultimately established. But there was a period of evolution before that stage was reached. We explained that at the beginning of the war there was no E.-in-C. and no Chief Engineers; consequently the D.W. under the orders of the Inspector General of Communications (I.G.C.) was responsible for engineering work from the bases up to the undefined rear boundary of the areas of the divisional Cs.R.E. Up to that shadowy boundary the D.W. alone had financial authority to begin any work ordered by the Q.M.G.

As related in Chapter VIII, the R.E. adviser at G.H.Q., Major-General G. Fowke, found it necessary to assume personal control of engineer work in the combatant area to a considerable depth, and for this he received the covering authority of the Commander-in-Chief himself; but it was not until March, 1915, that this procedure and the *de facto* establishments of an Engineer-in-Chief and of Chief Engineers of armies and of Corps were regularized by the issue of a War Office Army Order. The responsibility of the D.W. thus ceased at the rear boundary of army areas.

BASES IN FRANCE

In August, 1914, Boulogne, Amiens, Havre and Rouen, were the sites of the first British bases established in France. For the Indian Corps, which arrived in September, a base was opened at Marseilles. The rapid German advance to the neighbourhood of Paris necessitated a very hurried evacuation of these bases at the end of August, resulting in considerable disorganization of the L. of C. in which, of course, the Works Directorate was involved.

New bases were hastily opened at Le Mans, St. Nazaire and

Nantes, with the I.G.C. at Villeneuve. It was some time before these new bases were operating smoothly.

The victory on the Marne and the German retreat enabled the British advanced base to be established at Abbeville in mid-October. At the same time bases were re-established at Boulogne, Havre and Rouen. The bases at St. Nazaire, Nantes and Le Mans were closed down by the end of January, 1915.

In December, 1914, Dieppe became a British military station. Early in 1915, Etaples became a reinforcement camp and hospital base, and in May, Calais was taken into use to increase port accommodation. Other centres were opened at Abancourt for supplies, at Le Tréport for hospitals, and at Fécamp, Etretat, and Pont de L'Aube. Later new shipping berths were constructed at Dieppe, Fécamp and Havre.

In October, 1915, the supply of ammunition was mounting fast and it became obvious that future supplies would be enormous. New ammunition depots and landing facilities had to be provided. Increase of shipping berths and new sites for storage were put in hand at Rouen and its neighbourhood and at Audruicq near Boulogne, and Dunkirk began to be developed as a base port.

In February, 1915, the D.W. divided the communications area into northern and southern works areas. In the northern area, Calais to Etaples, he delegated considerable responsibility to a deputy (Colonel Huskisson, later C.E. of an army), located at Bologne. The southern area remained under D.W.'s control with a Deputy Director (Colonel E. H. Hemming) in his office and an A.D.W. (Colonel G. Harrison) at Rouen. Works districts were in charge of A.Ds.W. established at Calais, Boulogne, Etaples, Abbeville, Dieppe, Havre, Marseilles. In June, 1916, the southern and L. of C. works area became a separate charge under Colonel Harrison. In June, 1918, a central works area was interpolated between northern and southern under the charge of Colonel W. Baker Brown. In 1916, the title of A.D.W. was changed to C.R.E. of a Works district. The necessary number of Division Officers worked under each C.R.E. as in the peace organization at home.

The hiring of lands and buildings in France entailed much

responsible work in consultation with the French. For this a branch of the D.W.'s office was created under the control of a professional land agent with military rank—Captain (later Colonel) Blount.

STAFF, UNITS AND UNSKILLED LABOUR

In March, 1915, six Territorial R.E. fortress companies arrived to augment the very limited skilled and unskilled labour at the disposal of D.W. It was still necessary, however, to depend mainly on contracts placed with French firms, but some large British contractors had now established their businesses in the theatre and were also working for D.W. The lack of unskilled labour had from the beginning been the cause of great difficulties, slightly relieved in September 1915, when a Labour Corps of 600 Belgians was supplied to the Works Directorate.

All departments of the army, A.O.D., A.S.C., etc., and all army formations were similarly in need of labour, so it was decided to raise labour units under a director on the staff of the Q.M.G. who would allot units to the various directorates and army formations requiring them. Such a labour organization should have come into existence directly the army mobilized. It eventually grew to very large numbers and contained many nationalities, including Africans and Chinese.

At the end of 1916 the Works Directorate contained 128 unattached officers, about 250 subordinate staff and six and a half artisan works companies, whose total strength was about twenty officers and 1,000 other ranks. In addition, thirteen officers, five R.E. companies and three and a half labour battalions were employed on forestry, and a further three and a half labour battalions on the construction of ammunition depots.

In November, 1917, the foregoing figures had become 171 unattached officers, 540 subordinate staff, three base park companies, eight stores sections, and thirty-one other R.E. units. In the beginning of 1917 two Electrical and Mechanical Companies R.E. had been allotted to D.W. for electric power and light installations, workshops and well-boring plants.

Chapter XXIII deals with the provision of engineer stores. Here we will merely state that the provision of these vital stores, required in such vast quantities, and the organization to handle and distribute them had also received no consideration in our pre war preparations and mobilization tables. The result was that every R.E. officer responsible for getting work done, i.e., A.Ds.W. and works officers on the L. of C., and Cs.R.E. and company commanders in army formations took the initiative in searching for, purchasing and manufacturing engineer stores, competing with each other in the French market and going ever farther and farther afield in their search. This state of affairs was emphasized when we settled down to stationary trench warfare, for which even vaster quantities of materials and of stores of new types were required.

This praiseworthy individualist initiative by R.E. officers created a chaotic lack of system which had to be reorganized. The duty of providing engineer stores was placed upon the D.W. and at the beginning of 1915, sites were selected for base parks and base workshops at Havre and Boulogne, and a purchasing officer was established in Paris. Cs.R.E. of districts collected material within their own area for dispatch to parks. In July, 1915, a special Stores Branch was established in the D.W.'s office. The further evolution of the engineer stores organization is dealt with in Chapter XXIII.

It is not within the scope of this history to give technical descriptions of the services carried out by the Works Directorate, our object will be merely to give the reader some idea of the size and variety of its operations. The D.W. evidently worked on the principle of fulfilling willingly all demands made upon him, however novel or difficult, and of organizing when necessary new branches of his directorate to undertake the various types of works demanded.

Some of these new branches developed so quickly and to such a size that they became independent directorates, usually under an officer taken from the Works Directorate, e.g., the Assistant Director of Works, Major R. L. B. Thompson became Deputy Director of Forestry with the rank of Colonel; Colonel G. Harrison became Director of R.A.F. Works; Colonel

J. S. Sewell, Director of Stores with the rank of Brigadier-General and absorbed the whole of the stores organization built up by the D.W.; the whole of the Lands Branch was taken over by the new Lands Director, Major-General L. B. Friend (late R.E.); and Lieut.-Colonel G. E. Smith and B. A. G. Shelley left the D.W. to create a new Works Directorate in Italy when we sent troops to that country at the end of 1917.

WORKS EXECUTED DURING 1914-16

By the end of 1915, the Works Directorate may well have been proud of what they had managed to do. Their activities may be summarized under the following headings:—

Ports, including the building of new docks, piers and wharves, e.g., at Boulogne.

Depots of various kinds at bases and at other places in the communications areas, e.g., for ammunition in stupendous quantities, for ordnance stores, for A.S.C. supplies, for drafts awaiting transfer to or from the front, for remounts, for petrol and for engineer stores, bridges and materials.

Workshops for ordnance, for motor transport and for engineer stores.

Aerodromes for the R.A.F. including hangars and other special buildings for aircraft.

Hutting for personnel, not only in the communications area but also for erection in the areas of army formations.

Roads for main and for subsidiary communications and in camps and depots of all kinds.

Decauville tram-lines in depots.

Hospitals and convalescent depots.

Schools for training.

Veterinary hospitals.

Protection against air raids.

Acquisition of land and hirings.

Such services and many others required many types of buildings up to the very largest steel sheds; bakeries, laundries, delousing and bathing stations; mechanical plant of many

types, e.g., for the bulk conveyance and storage of oats; water supply on a large scale (see Chapter XXII); provision of electric light and power, drainage and sewage disposal; quarrying and bulk supply of roadmetal; and the bulk supply of timber in many sizes and enormous quantities.

In 1916 the growth of the B.E.F. was very rapid, and the area of the operations of its four armies soon reached to the River Somme. The growth of the communications area behind kept pace with the expansion of the army, but the responsibilities of the Works Directorate and the demands upon it grew even faster. There was a large increase in the demands for hutting and for all types of works. At the nine base ports from Dunkirk to Rouen increases were required in the berths for ships and unloading facilities. Depots of all types, not only at the base ports but also in the communications area, had to be extended. There was a great development in road construction and maintenance, and, of course, an expansion and reorganization of the supply of engineer stores and material. In 1916 the Royal Flying Corps was growing very rapidly. Their demands upon the D.W. for aerodromes and accommodation were considerable and continued to increase.

ABOLITION OF THE I.G.C. AND APPOINTMENT OF D.G.I.

On 2nd December, 1916, the office of the I.G.C. was abolished. The control of the administration of the Directorates in the Communication Area (including the D.W's.) was transferred to the Q.M.G. The command of personnel in the L. of C. areas and the control of troop movements was assigned to the G.O.C. of L. of C. While the D.W. now obtained sanction from the Q.M.G. for work required on the L. of C., in technical matters and in the administration of his department he was now placed under the E.-in-C., who, however, delegated considerable powers, and in technical matters gave him almost a free hand. The D.W's. responsibility for provision and distribution of engineer stores and materials are dealt with in the next chapter.

The extensive military operations on the Somme during 1916 disclosed the overburdened condition of the existing

system of railways and roads in that area. The French railway system and management became overstrained and unable to support large forces and operations. Nor had the necessary attention been given at home to the requests of the Director of Railways of the B.E.F. for the railway plant and material, rolling stock and personnel, that he had foreseen would be necessary.

The Prime Minister realized that there must be a far larger conception of the scale of the railway, road, inland waterways and ports organization required on the L. of C. in France. In November, 1916, a Transportation Directorate in France was formed. On the 2nd December, the Director General, Sir Eric Geddes, was now to control the construction and management of railways (including light railways), roads, docks and inland waterways, not only on the lines of communication, but also in army and corps areas right up to the approximate rear boundary of the area under enemy shell-fire. He appointed four directors: for railways, light railways, roads, docks and inland waterways.

While working in co-operation with the Q.M.G. the D.G.T. was independent of that officer and had direct access to the Commander-in-Chief. Moreover, the Director of Railways at the War Office was subordinate to the D.G.T. and Sir Eric Geddes had direct access to the Prime Minister. He was therefore in a position to ensure that the requirements of his directorates in France would be fully met by the administration in England, drawing upon world-wide resources.

The work of the reorganized and enlarged Directorate of Transportation in France is dealt with in Chapters XXVII to XXXI. Here we are only concerned with the effect of its creation upon the Directorate of Works.

The D.W. handed over all his roadwork and quarries to the new Directors of light railways and roads, while the new Director of Docks took over the D.W.'s work in the ports. The D.W. was thus relieved of considerable responsibility and work, but this decrease was immediately offset by the rapid and intensive development and extension of the communications area and by the continual growth of the B.E.F. He also

undertook to provide the accommodation for personnel, and the offices, sheds, etc., for the very large Transportation Directorates which now came into existence.

WORKS DURING 1917

In January and February and the first fortnight of March, work was much hampered by a very serious and sustained frost.

The first major event which threw a large amount of work upon all directorates in the communication area was the withdrawal of the Germans in March, 1917, from their Somme salient to a much shorter well-prepared chord line from opposite Arras to St. Quentin. In this deliberate withdrawal the enemy carried out with the utmost German thoroughness and ruthlessness complete demolition of all that could possibly be of any use to our own army, which found itself in a devastated wilderness where everything it required had to be created or brought forward. The amount of work thus thrown upon the Works Directorate can be imagined.

From May to December, 1917, there were continuous battles at Arras, in the Ypres salient and at Cambrai. The traffic on the L. of C. and the development and extension of works was very great. For instance, at Vendroux, near Calais, in April, 1917, a large scheme was begun for the construction of an entirely new ordnance and supply depot.

During 1917, the supply of tents began to fail on account of the shortage of hemp, with the result that personnel hutting was demanded for $\frac{1}{4}$ million men and for 42,000 hospital beds. There was also a great and much-needed increase in our labour force which required further accommodation.

The opening of a new theatre of war in Italy compelled the D.W. to part with some of his officers and personnel for a new Works Directorate to be described in Chapter XXXII.

During 1917 the Royal Flying Corps grew phenomenally, and the newly-formed Tank Corps further added to the work of the D.W. In December, 1917, the Independent Air Force was created for the special duty of bombing Germany. Aero-

dromes for this force had to be constructed in the region of Nancy, and a large aircraft supply depot at Courban, a hundred miles south-west of Nancy.

EVENTS OF 1918

Whereas in the previous year the Germans had created enormous demands for work by withdrawing from the Somme salient, in March and April, 1918 they completely disorganized not only our front but our communication area by bursting through on a wide front as far as Amiens and also re-crossing the Marne.

This major event caused all available personnel, skilled and unskilled, British and Chinese, to be collected from the L. of C. and put on to the construction of defensive positions; and engineer stores depots were of course very heavily drawn upon. The D.W. himself took charge of this work, taking with him four Cs.R.E. from the L. of C. Four artisan works companies were withdrawn from him by the E.-in-C. for work farther forward in army areas. Other units under his orders found themselves overrun by the invasion and came under orders of the Chief Engineers of armies and even of corps. By 9th April, the emergency was sufficiently in hand to allow the D.W. to return to his H.Q. at Abbeville, and his four artisan works companies were soon returned to him. Preparation of bridges on the L. of C. for demolition and the blocking of roads had been undertaken by L. of C. works-officers. The D.W. also undertook preparations for inundations in the Dunkirk area.

The German break-through, of course, necessitated the evacuation of many L. of C. establishments and installations and their re-erection farther back. Perhaps the largest of these among many were a hospital and a convalescent camp each to hold 15,000 men, which, however, were not finally moved when the tide of battle once more flowed in our favour. The German break-through brought to a standstill considerable extensions to the ammunition depots at Audruicq, Zeneghem, Dannes, Blargies, Saigneville and Ronxmesnil, but they were resumed in July and August.

Throughout 1918 the increase in range and numbers and severity of the enemy's air raids threw upon D.W. the work of protection of L. of C. buildings, especially hospitals.

On 17th March, 1918, in accordance with the Q.M.G.'s instructions a Directorate for Lands and Hirings was formed. The new director took over D.W.'s staff which had been doing this work.

In May, 1918, the Royal Flying Corps and the Royal Naval Air Service were amalgamated into the Royal Air Force, a new separate fighting service and administered by the new Air Ministry. Accordingly the "R.F.C. Works" in France became a separate directorate under Brigadier-General G. Harrison.

On the declaration of the Armistice on 11th November, 1918, work was at once stopped on all new services except the provision of hutted camps for demobilization, and light cover for ammunition requiring protection at Rouen, Etaples, Boulogne, Dunkirk, Havre and Honfleur. The total to be accommodated in the demobilization camps was 140,000 all ranks.

THE DIRECTOR OF WORKS, B.E.F.

On 9th August, 1914, Colonel A. M. Stuart mobilized the staff of the Works Directorate of the B.E.F.

On 7th April, 1919, Major-General Sir Andrew Stuart, K.C.M.G. ceased to be Director of Works, B.E.F. on the completion of a victorious war.

The magnitude of the tasks the directorate had successfully accomplished has, we trust, been made fairly clear in this chapter. Sir Andrew Stuart's previous career had been a preparation for these tasks. He had been employed on special technical work connected with submarine mining, telegraphy and inspection of engineer stores. In the four years preceding the war he had been Assistant Director of Fortifications and Works in the section of the War Office dealing with all fortifications, ordnance buildings, and barrack services at foreign stations. His scientific mind had acquired a knowledge of

many technical branches which enabled him to meet on equal terms the many specialists in steel construction or the provision of electrical and other machinery who were called into consultation. He had a broad outlook and a sterling character, was a glutton for work and fortunately possessed a constitution which could endure an unlimited amount of it.

He was not in the least dismayed by the state of affairs at the beginning of the war, already described, caused by the total lack of provision and organization fit for the task, but cheerfully set to work to create what was needed, as this chapter has endeavoured to relate.

ORGANIZATION OF WORKS ON THE L. OF C., 1918

<i>Works Area</i>	<i>Engineer Districts</i>
<i>Deputy Director of Works, North</i>	C.R.E., Dunkirk,
<i>Headquarters, Boulogne</i>	C.R.E., Calais,
	C.R.E., Ardres,
	C.R.E., Boulogne,
	C.R.E., St. Omer,
	C.R.E., Etaples.
<i>Deputy Director of Works, Centre and South</i>	C.R.E., Abbeville,
<i>Headquarters, Amiens</i>	C.R.E., Amiens,
	C.R.E., Abancourt,
	C.R.E., Central Area and Paris,
	C.R.E., Marseilles.
<i>Deputy Director of Works, West</i>	C.R.E., Rouen,
<i>Headquarters, Rouen</i>	C.R.E., Havre,
	C.R.E., Trouville,
	C.R.E., Dieppe.

Note.—Engineer Districts conformed to L. of C. areas, except that Calais Area contained Calais and Ardres Engineer Districts.

STAFF OF WORKS DIRECTORATE, G.H.Q., 1918

Director of Works

Deputy Director of Works,

D.A.D.W.,

Staff Officer for Designs.

Assistant Director of Works, Personnel,

Assistant Director of Works, Stores,

D.A.D.W., Stores.

D.A.D.W. for Contracts and Finance.

STAFF OF A WORKS AREA, 1918

Deputy Director of Works

D.A.D.W. for Personnel and Correspondence.

Superintending Inspector of Works for Contracts, Finance
and Stores,

Inspecting E. and M. Officer.

STAFF OF 1ST OR 2ND CLASS ENGINEER DISTRICT, 1918

Commander Royal Engineers (Lieut.-Colonel)

Staff Officers for Personnel and Correspondence,

S.I.W. or I.W. for Contracts and Finance,

Officer in charge of Stores,

Electrical and Mechanical Officer,

Division Officers (as required).

Units as required and available :—

Artisan Works Companies,

Section, Electrical and Mechanical Company,

Area Employment Companies,

Labour Companies (Chinese etc.).

Prisoner of War Company.

STAFF OF 3RD CLASS ENGINEER DISTRICT, 1918

Commanding Royal Engineer (Major)

Division Officers (as required),

Warrant Officer or N.C.O. in charge of Stores.

Units as above.

CHAPTER XXIII

SUPPLY OF ENGINEER STORES AND PLANT IN FRANCE

Initial difficulties—Growth of the Stores Organization during 1915—Stores supply during 1916—Water-supply plant and stores—Further expansion during 1917—Events of 1918—Transport of engineer stores and material—Quantities of stores required.

INITIAL DIFFICULTIES

THE reader should refer to the Introduction and to Chapters IV, VIII and XXII, for information concerning the paralysing effect of the lack of preparation by our country for the war of 1914-18, and the misappreciation beforehand of the nature of that war. There was, as we have seen, a special lack of correct appreciation by the General Staff of the need for preparation of a strong expert organization for engineer work. In the chapters referred to above mention has been made of the great handicap placed upon our pre-war preparation by the French promise to carry out all work required by the British army on the L. of C., an undertaking which it was apparent from the start they were quite powerless to implement.

These pre-war misappreciations threw a very heavy task upon the senior engineer officers who were called upon to improvise in the theatre of war, during a prolonged retreat and subsequent rapid advance, an organization capable of executing the engineer work demanded, which of course included the supply of engineer stores and material.

The reader is also referred to Chapter III dealing with the organization of the office of the Director of Fortifications and Works at the War Office, which describes the creation *after* the outbreak of war of a very efficient organization for the supply of engineer stores, in the first instance for France and later for all other theatres of war.

In this chapter we shall not repeat the description of the War Office organization, but confine ourselves to the procedure in France for making demands upon the War Office and for receiving and distributing what was sent.

We shall not deal with the supply of stores for the Signal Service, because, although it was, during 1914-19, a part of the Royal Engineers, the history of that service is being written separately by the Royal Corps of Signals.

During peace the Army Ordnance Corps had compiled for the general use of the army a *Vocabulary of Stores* and also *Mobilisation Stores Tables* for the equipment of every unit of the army on mobilizing for war. In peace units could demand and obtain from the A.O.C., upon fixed scales of quantity and type, anything which was included in that vocabulary or in the mobilization tables.

In peace the stores and materials of many different types and varying quantities required by the engineers for their works services were supplied to them by means of contracts made by the Director of Fortifications and Works or by Chief Engineers of Commands, or they were supplied by the contractors who undertook contracts for works.

Roughly speaking the same procedure was continued in war at home and in the overseas theatres, but, although the A.O.C. continued to supply certain named stores for equipment of R.E. units on war establishment scales and other stores, e.g., sandbags, picks and shovels, for operations of war, they, hampered like everyone else by the previous general misappreciation of the scale and type of the war, were not prepared to supply quantities required for emergency work. Under these circumstances engineer officers in the D.F.W.'s office in London and in the theatre of war set to work vigorously to improvise a procedure for acquiring the stores and material of all types required for engineer work with army formations and on the L. of C.

This chapter therefore attempts to tell the story of the initial rapid improvisation of supply of engineer stores and material and the evolution of a very large, well ordered organization for that purpose, out of the initial chaotic scramble

caused by the praiseworthy initiative of every R.E. officer, down to the rank of unit or even section commanders, to acquire the stores required for their work from any source of supply they could find, a procedure which, of course, resulted in cut-throat competition and a scant regard for the moral law of *meum et tuum*, a procedure commonly termed "scrounging."

For France the organized main sources of supply of engineer stores were (1) from the D.F.W.'s office which could draw on the resources not only of the home country but of the whole available world; (2) by purchase, manufacture or by development of resources in France; (3) by manufacture in R.E. workshops in France; and (4) from large British and French contractors, who supplied the stores and materials for the works which they had contracted to execute, either importing them into France or securing them in that country.

The evolution of the relations between the Engineer-in-Chief (E.-in-C.) and the Director of Works (D.W.) and their relative responsibility for the provision and distribution of engineer stores, and the relations of the D.W. with the Inspector General of Communications (I.G.C.) and later with the Q.M.G. and Director General of Transportation (D.G.T.) have been explained in Chapters VIII, XXII and XXVII. Briefly they may be summarized as follows:—

On mobilization and on the deployment of the B.E.F. in France there was no E.-in-C. and no corps or army Chief Engineers, but in September, 1914, the Engineer Adviser at G.H.Q. received direct orders from the Commander-in-Chief to assume the responsibilities and functions of E.-in-C. In March, 1915, this procedure and the powers of the E.-in-C., and of the corps and army C.Es. were defined and confirmed by G.H.Q. The D.W. was at first under the orders of the I.G.C. and officially was responsible solely to him for all works and services and supply of engineer stores for those works up to the rear boundary of divisions.

At the beginning of the war there was therefore no organization responsible for supplying engineer stores, other than the equipment of units, to the divisions and no previous provision

of such stores. Engineer advisers soon assumed this responsibility but stores and materials to meet their demands were not available, and only slowly became available. Not until the late summer of 1915 were they obtainable in reasonable quantities.

In December, 1916, the post of I.G.C. was abolished and the control of his directorates, including the Works Directorate, was transferred to the Q.M.G. who, while retaining the power to sanction works to be executed in the communication area, placed the D.W. for technical matters and for the supply of engineer stores under the E.-in-C. This procedure was confirmed by an Army Order in April, 1917. The E.-in-C. delegated almost full powers to the D.W. for the technical execution of works in the communication area subject to the co-ordination of standards. The D.W. was in addition charged by the E.-in-C. with responsibility for supply of engineer stores throughout the theatre of war and for their distribution to the parks controlled by C.Es. of armies who were responsible for further distribution to corps dumps.

Gradually the E.-in-C. exercised more and more supervision over the supply and distribution of stores throughout the whole theatre of war in France. By July, 1917, he had, through his deputy, established complete co-ordination of forecasts, demands for, and allotment of stores to C.Es. of armies and to the D.W.

In July, 1918, both the E.-in-C. and the D.W. were relieved entirely of the responsibility for the custody and distribution of engineer stores in accordance with the E.-in-C's. allotments, as the Q.M.G. established under his own orders an independent directorate for this purpose; Colonel J. S. Sewell became the director with the rank of Brigadier-General and took with him the staff of what had hitherto been the D.W's. stores organization. The E.-in-C. and D.W. still remained responsible for specifying the types and the quantities to be ordered. The new Director of Stores was responsible for ordering these specified quantities either in France or from England or for their manufacture in his workshops.

The evolution of this system of supply and distribution

of engineer stores throughout the theatre of war in France will now be traced year by year from 1914 to 1918 inclusive.

On completion of disembarkation of the Works Directorate by mid-August, 1914, the only R.E. unit at the disposal of the D.W. for handling the supply and distribution of stores was the 29th Fortress Company, as the 20th and 42nd Fortress Companies which had been allotted to him were almost immediately removed from his control for work under the Engineer Adviser at G.H.Q. There was no unskilled labour.

The 29th Fortress Company, after retreating and re-embarking, disembarked again at Nantes, but returned northward in October and established its two mobile workshops at Havre and Boulogne. The stores sections were distributed between those places and Abbeville and St. Omer, the last to work under G.H.Q.

The D.W. arranged for supply of stores by sending his demands to his liaison officer (Major R. L. B. Thompson and later Colonel D. Brady) F.W.5 in the office of D.F.W. at the War Office (see Chapter III) ; by establishing Colonel C. W. Davy as his purchasing officer in Paris ; and finally by placing contracts in France. These measures required time to bear fruit. 1914, and even early 1915, was therefore a period of haphazard individual efforts to find stores in France, a period of scramble which has been described in the last chapter.

GROWTH OF THE STORES ORGANIZATION DURING 1915

The efforts of the Director of Works were soon, however, to bear fruit. On 26th December, 1914, an advanced R.E. park had been opened at Strazeele for the Second Army, commanded by a quartermaster and small staff, and administered by the D.W. In March, 1915, another advanced park was opened at Berguette and the administration of the parks of both armies was transferred from the D.W. to the C.Es. of armies. By that time C.Es. of armies and corps had transformed the individual scramble into an organized system under their

control for procuring, receiving and distributing the stores. They had also opened workshops.

In April, 1915, the 32nd Advanced Park Company, R.E., under Major A. V. T. Robinson, R.E. (now A.V.T. Wakely), arrived at Havre to work under the D.W., who reorganized it as a base workshop company, with an established workshop. In May, 1915, the 1st Fortress Company arrived from Gibraltar under Major J. W. S. Sewell, to act as an advanced park company, but was stationed by the D.W. as a base park company at Calais. At the same time the 24th Fortress Company arrived from Malta and was stationed first at Boulogne, and later moved to Rouen. In 1915, a special depot for mining stores was established at Les Attaques, near Calais under the control of the Inspector of Mines in the E.-in-C's. office.

As a result of the work of the R.E. intelligence branch in the E.-in-C's. office, and their study of communications in enemy occupied territory, details of bridges which might require reconstruction after demolition, if the B.E.F. were to advance fifty miles, were obtained and orders placed for a stock of 500 suitable bridge spans and piers. These were gradually collected at Havre under the charge of Lieutenant and Quartermaster J. Lyons, R.E. Many of these bridge spans were designed by Professor C. E. Inglis of Cambridge University and the type was given his name. Other bridges were designed in the drawing-office of F.W.4c at the War Office (Lieut.-Colonel R. Oakes, R.E.) who placed all orders for their construction.

In November, 1915, the construction was begun of a wharf at Rouen and of a base depot at Abancourt (a junction for trains from Havre, Rouen and Dieppe). The 24th Base Park Company was transferred from Boulogne to Abancourt, which became the principal southern base depot for engineer stores and material.

In July, 1915, the D.W. appointed an A.D.W. (Stores) to organize and supervise workshops and stores depots at Havre and Calais with stores officers at each place. In August, he established a separate stores branch in his office under Major H. G. K. Wait.

The office of the Deputy E.-in-C. forecast requirements

of armies monthly and sent the forecast to the D.W., who added the requirements for the I. of C. and arranged to procure either by manufacture in base workshops, by purchase in France or by indent on the War Office.

In 1915, demands for stone for road-making and maintenance increased rapidly. Some of the Marquise quarries near Boulogne were allotted to the British, and stone was also obtained from contractors at Caen. Labour was collected from various sources and Lieut. Colonel Palmer, R.E. was made responsible for the supply of road metal. The D.W. also arranged for supplies from Guernsey and from Penlee in Cornwall to be delivered by a fleet of small ships first to Boulogne and later to Dunkirk and Le Tréport. By December, 1915, the supply of stone averaged 2,350 tons per day.

France has a government forestry department controlling many forests. The D.W.'s first demands on this department were for 3,800 tons of timber monthly for engineer work. The A.S.C. demanded the same quantity for fuel. These demands rapidly increased to 12,000 tons.

Up to the end of 1915, the French forestry department supplied the D.W.'s demands from stock, afterwards they allotted forest areas in which the D.W. made his own arrangements for cutting and transport. For this a considerable amount of skilled and unskilled labour had to be collected. By the end of 1916, thirteen officers, five R.E. companies and three and a half labour battalions were employed in the French forests.

Contracts (known as Foden contracts) were also placed for 4,000 tons monthly (later increased to 12,000 tons) from the Bordeaux forests whence it was shipped to the Channel Ports. Orders were also placed through F.W.5 for large quantities of scantlings of many sizes from Canada and some from Great Britain.

STORES SUPPLY DURING 1916

The large increase in the size of the B.E.F., and the heavy fighting in the battle of the Somme from July to December, 1916, inclusive, caused the demands for engineer stores to rise in

proportion, necessitating a further expansion of the organization.

By early 1916, a depot system had, as we have explained, been established ready for the expected operations. Base store depots and workshops had been established at Calais and Dunkirk, concentrated mainly at Les Attaques near Calais from which the three northern armies and L. of C. (north) were supplied. Base store depots at Havre and Rouen, and occasionally Fécamp and Dieppe, fed Abancourt which supplied the two southern armies and L. of C. (south). Fécamp was a small port with berths for two ships allotted exclusively to R.E. stores.

Throughout 1916, and to the end of the war, the 1st Company R.E. was stationed at Les Attaques and Calais, the 24th at Abancourt and Rouen and the 32nd at Havre. All three were base park companies, the establishment of each being increased by five officers and seventy-seven other ranks.

In addition six stores sections each of three officers and ninety-seven other ranks had been raised, and the number of stores officers on the general list under the D.W. was increased to eighty-five.

On 20th July, 1916, all stores officers and personnel under the D.W. were organized into two groups—North and South—each under a C.R.E. (stores officer) (Lieut.-Colonels J. S. Sewell and R. H. Lewis) with H.Q. at Les Attaques and Abancourt respectively. At the end of 1916, the D.W. appointed a Deputy-Director of Works for Stores—Colonel W. Baker Brown.

The creation of the Transportation Directorate on 1st December, 1916, under a Director-General, Sir Eric Geddes, released the D.W. from the responsibility for production and supply of stores for roads, and for the unloading of stores and material at ports. Nevertheless the great increase in demands from armies and communication areas for stores for extensive military operations and works services in fact caused a net increase in the work of the stores organization.

By the end of 1916 the depots and workshops of the stores organization were located as follows :—

For the service of the northern armies and communication area :

Les Attaques near Calais opened 1st January, 1916- -a yard and workshop covering 62 acres under Lieut.-Colonel J. W. S. Sewell, C.R.E. (S.O. north).

For the service of the southern armies and communication area :

- (i) Havre, a principal base workshop, a store yard and a bridge depot covering an area of 32 acres.
- (ii) Soquenie near Havre, store yard of 12 acres.
- (iii) Rouen, large depot of 134 acres for storing timber, and a wood-working workshop, under Captain Kenworthy.
- (iv) Quévilly, just below Rouen, a store yard of 20 acres under Captain Vaughan.
- (v) Abancourt, near the big railway regulating station of Robescamp, a workshop and central store yard of 32 acres, the latter under Lieutenant and Quartermaster A. W. Richard.

All were under Lieut.-Colonel Spencer C.R.E. (S.O. south), whose H.Q. were at Abancourt.

Mining stores, from port to front line, were obtained and distributed by the Inspector of Mines in the E.-in-C's. office.

As already stated two R.E. Parks had been formed early in 1915 for the First and Second Armies. With the expansion of the B.E.F. and the increased scale of operations more parks were formed in army areas, until in 1918 there were twelve. These were allotted to armies by the E.-in-C. in accordance with the tactical situation. They fed corps dumps which in turn fed divisional dumps.

Towards the end of 1916, an estimate was made of the probable *daily* tonnage of all the requirements of the army that would have to be moved by the Transportation Directorate in the forthcoming year. It was as follows :—

R.E. Stores and Material

General	...	...	...	1,129	
Timber, bricks, gravel	...	...	...	3,782	
Stone...	...	...	...	12,000	
Railway	...	...	...	1,500	18,411
Supplies	...	...	...	...	10,425
Ammunition	...	...	...	...	8,600
Ordnance	...	...	...	...	1,513
Miscellaneous	...	...	...	...	1,276
Total					40,225

It will be noted that stores and material to be utilized by the R.E. represented 46 per cent of all the requirements of the army in the whole theatre of war.

Up to the end of 1915, troops, when not in the trenches, had been accommodated in villages, and on the L. of C. personnel lived either in billets or in tents; but when the expanding British army spread southward into the Somme area, sufficient winter accommodation was not available. At the end of 1916 Captain Nissen, having designed in the E.-in-C's. office a very suitable wood and curved corrugated iron hut, an order for 27,000 was placed in England by F.W.5. A few months later a further order for 20,000 was placed, to be ready for the winter of 1917/18.

By the end of 1916, the supply of timber from imports into France arranged by F.W.5 at the War Office and from the French forests totalled 24,000 tons a month. This was delivered to the R.E. yards at Rouen and Abancourt and then distributed to armies and to the communication area.

The expansion of the B.E.F. and the area of their operations in 1916 caused a great increase in the construction of roads. In October, 1916, the daily supply of stone was:—

From Channel Islands	...	...	860 tons
From Caen	...	...	420 tons
From Andrehem	...	...	70 tons
From Marquise	...	...	1,900 tons
Total			3,250 tons

On 1st December, 1916, the Director-General of Transportation took over from the D.W. the responsibility for supply of stone and the construction and maintenance of roads.

WATER-SUPPLY, PLANT AND STORES

In Chapter XIX, when describing the water supply for fighting formations we have explained that in 1916 there were greatly increased demands for water supplies on a large scale in divisional, corps and army areas. In Chapter XXII on the Works Directorate in France we have referred to the large water supply schemes that had to be carried out in the communications area. The supply of plant and stores for this purpose thus became a very important branch of the R.E. stores organization.

The D.W. began by placing his own orders for the stores he required for the communications area, but as the major part of such plant and stores was wanted for schemes to supply water to the fighting formations, it was mainly the responsibility of the E.-in-C., exercised by his Deputy, to specify types and quantities. Consequently the Deputy E.-in-C. in consultation with the water-supply officers of C.Es. of armies took in hand the specification of types and patterns of plant and piping and other water-supply stores to be ordered.

In 1914, and for a great part of 1915, there had been as with other stores, a scramble among divisions and corps for whatever type of pump or piping could be obtained in France, and orders reached England from several sources. Towards the end of 1915, and more particularly in early 1916, the Deputy E.-in-C. set to work to standardize pumps and water-supply plant so as to reduce the number of types. So long as supplies were limited and the demand great any type had to be accepted, but in time the types were reduced in number. The first large demand was sent to the War Office in the last week of 1915 in preparation for the Somme battles.

In 1916, the following system of co-ordination was established by the E.-in-C.: Forecasts of requirements received from C.Es. of armies were summarized by the Deputy E.-in-C. and

types and patterns specified. The D.W. forecast requirements of the L. of C. and conformed to the E.-in-C's. specifications. The main channels of supply were :—

- (a) Pumps and machinery were purchased by the War Office on the order of E.-in-C. (D.W's. order included), and allotted by E.-in-C. to armies and to L. of C. Once installed all machinery remained fixed as area machinery, so could not be taken away when units and formations moved from area to area.
- (b) Tarpaulins (for tanks), pipe tools and other vocabulary stores, were drawn from Ordnance, mainly by indent of officers in charge of advanced R.E. Parks.
- (c) All other water-supply stores, including piping, were ordered by D.W. (on E.-in-C's. and D.W's. forecasts) and were distributed by D.W. to meet demands in accordance with E.-in-C's. allotments.
- (d) Stores not obtainable from army sources were bought locally in France.

Between 1st March, 1917 and 11th November, 1918, the number of pumping plants of various types issued to fighting formations (excluding supplies to L. of C.) was 1,041.

In the Volume dealing with water supply in *Work of the R.E. in the European War, 1914-19*, published by the Institution of R.E., will be found much valuable information on pp. 29-47 about the types and quantities of water-supply plant and stores obtained and used.

The War Office placed very large orders for water-supply plant, piping and stores in America, as Britain could not supply in time the quantities required.

FURTHER EXPANSION DURING 1917

The unexpected withdrawal in March of the Germans from their Somme salient to the Hindenburg Line, and our follow-up through a completely demolished and devastated area, caused unusual demands for engineer stores and material.

These demands were increased by a 20-mile extension of the

British front southwards to the Amiens-Roye road. The continuous large-scale battles from May to the end of December fought at Arras, Passchendaele and Cambrai, severely tested the stores organization but with satisfactory results.

There was unusually heavy and continuous frost throughout January, February and early March, 1917. This caused transport by rail and road to be reduced to a minimum, and canal traffic was stopped. Ships, however, continued to be unloaded at ports, so that a satisfactory stock of engineer stores accumulated in readiness for the big demands that were to follow.

On 1st January, 1917, the control of the disposal of stores to armies and to the E. of C. throughout the theatre of war was taken over by the Engineer-in-Chief, who delegated this work to his Deputy, Brigadier-General W. A. Liddell, assisted by Lieut.-Colonel C. H. Hogg, R.E. (succeeded in August, 1918, by Lieut.-Colonel G. H. Addison).

Monthly allotments were made to Chief Engineers of armies and to the D.W. based on estimates submitted by them and returns of stocks available. In times of emergency it was not possible to adhere rigidly to these monthly allotments and considerable variations had to be made. By August, 1918, the accumulated records of these monthly estimates and allotments provided most valuable data from which could be worked out the normal monthly requirements of any formation. From these figures, supplemented by secret information from the General Staff concerning forthcoming operations, the staff of the E.-in-C. could calculate future requirements, and it was found possible to dispense with the monthly demands submitted by formations.

In March, 1917, the D.W., as we have seen in the last chapter, was relieved of responsibility for the supply of timber by the creation of a separate Directorate of Forestry directly under the Q.M.G. Lord Lovat, an expert in forestry, became the new Director and Major R. J. E. Thompson, R.E., from the staff of the D.W., was appointed Deputy Director with the rank of Colonel.

It was now fully recognized by the Ministries in England

that the demands of the communications organization of the B.E.F. for personnel and resources must be generously met. The Forestry Directorate, like that of Transportation, benefited by this welcome change of attitude. The headquarters of the Directorate acquired a staff of twenty-three officers. Forestry companies of skilled labour and battalions of unskilled labour were made available, with the result that the monthly output of timber rose by the end of 1917 to 75,000 tons delivered to R.E. timber yards, and 25,000 tons to transportation stores yards. The average monthly supply throughout 1917 to R.E. timber yards was 51,000 tons. The timber was supplied by the directorate in bulk, after which its distribution, conversion and manufacture were the responsibilities of the D.W. and the D.G.T. respectively.

In the last chapter mention has been made of the creation of seven electrical and mechanical companies to meet the great increase in that type of work. Their activities, of course, required the provision and distribution of considerable quantities of plant and stores.

In the spring of 1917 a failure in the supply of hemp for tentage caused a decision to replace as many tents as possible by huts in rear areas and on the L. of C. It was estimated that for this purpose hutting accommodation would be required for 375,000 all ranks and 42,000 hospital beds. All R.E. workshops concentrated on the production of a type known as "sausage hutting," cut to lengths as required. The contracts for Nissen huts placed by the Engineer-in-Chief produced accommodation for 20,000 men. Colonel Davy in Paris after some months' negotiation arranged with the French to supply hutting for 100,000 men and 40,000 hospital beds. He was also to purchase 1,800 huts in Switzerland made to designs prepared in the D.W.'s office.

The operations in the mud at Passchendaele produced a very great increase in the demand for trench boards. These were produced partly in R.E. workshops and partly by very large contracts in France. During the single month of August, 375,000 were sent to the front—sufficient to make 400 miles of pathway.

In 1917, a great drive was made to collect stores and material from the battlefields and L. of C. areas and to repair them in workshops. For this purpose an additional store section (three officers and ninety seven other ranks) was added to each of the 1st and 24th Companies.

The expansion of R.E. workshops continued in 1917 at Rouen, and a new workshop was opened at Vendoux in the northern L. of C. area. There was a great increase in power-driven saws and machine tools in all workshops, which of course involved the supply and distribution of a large quantity of machinery of many types not only on the L. of C. but also in army areas.

EVENTS OF 1918

The outstanding events which influenced the work of the R.E. stores organization in 1918 were :—

- (a) The extension in February of the right of the British line southwards to Noyon.
- (b) In March, April and May the German offensive which pushed the British Fifth Army back to Amiens ; followed by attacks on the Second Army in which Mont Kemmel was lost and Ypres nearly lost.
- (c) In August the beginning of the victorious advance of the B.E.F., extending till the Hindenburg Line was broken and the enemy pursued into Belgium where the Armistice brought it to a halt.
- (d) The subsequent advance of a portion of the B.E.F. across the Rhine.

The first event caused urgent demands for R.E. stores to strengthen the front taken over by the Fifth Army. The second event caused hasty evacuation of stores, plant and installations to the depots at the bases. The usual stores traffic to the front was in fact reversed. There were, of course, considerable losses, especially among stores held in corps and divisional dumps, e.g., sandbags and barbed wire. When operations changed to a victorious advance there was a great drop in demands, since the defensive absorbs far more engineering material than the offensive, though all bridge spans in the

depots had been sent forward before the date of the Armistice, and water supply stores were still called for. The advance to the Rhine and across it affected only a portion of the B.E.F. and being on a peace footing along undemolished communications did not call for much engineering work and stores until the force settled down in the bridgehead at Cologne and began to demand engineer services, the stores for which were dispatched from England via Antwerp and Rotterdam.

The heavy casualties of the year 1917 caused a crisis in manpower. Reinforcements for France were being held back in England. There was a drastic combing out of the fittest men from L. of C. for drafting into fighting units. The stores branches were allowed to keep only a small proportion of men higher than C medical category. Greater disorganization would have resulted had not many of the Chinese labourers who had now been employed for a long time shown themselves quite capable of taking over the work of many British storemen and supervisors.

During the first quarter of 1918 stores and material were passing out of R.E. store yards at the rate of 140,000 tons per month.

While the German offensive was in full swing Lieut.-Colonel Sewell was lent by the D.W. to the Engineer-in-Chief to help in handling the serious stores situation in army areas. Temporary dumps were opened at Herdin and Abbeville. By June the situation was stabilized and the stores organization had settled down to normal working again. During the German offensive the workshops in army areas had been hastily dismantled and sent down to Les Attaques, Vendoux, Abancourt and Havre, where they were incorporated in the base workshops. When the situation improved Chief Engineers of armies asked for their workshops to be returned but it was decided that it would be better to keep them at the bases.

Early in 1918 the Engineer-in-Chief reviewed the question of the number of bridges that would be required in case of a successful offensive. There were at this time, as already stated, 650 bridge spans in the two bridge depots, but it was decided to place an order in England for another 1,000 of which the

maximum length was increased from 85 ft. to 120 ft. Throughout the victorious advance of the B.E.F. depots were very busy loading up and sending to the front bridge spans and material. By the day of the Armistice, the last of the 650 spans in depots had been dispatched and none of the 1,000 spans ordered in 1918 from the War Office had yet arrived in France.

The new Q.M.G.* decided to make the R.E. stores and material organization a separate Directorate under his own control. Lieut.-Colonel Sewell became the Director with the temporary rank of Brigadier-General, and took up his appointment on the 1st July. Both the Engineer-in-Chief and the D.W. then ceased to have any responsibility for supply and distribution of R.E. stores and material while retaining responsibility for specification and quantities ordered. The new Director was responsible from the base up to the rear boundary of divisions and for distribution to divisional dumps. His office was established at G.H.Q.

TRANSPORT OF ENGINEER STORES AND MATERIAL

Throughout 1914, 1915 and 1916 the French railway authorities insisted that as far as possible, stores arriving at ports should be loaded direct into trucks and transported to railhead. This was by no means convenient, as R.E. stores had to be sorted before distribution, in accordance with demands. However, a determined effort was made to meet the wishes of the French and a considerable measure of success was achieved.

When, however, the British Director-General of Transportation took over the administration of the ports and railways serving the B.E.F., the more convenient and sound system was adopted of sending all stores from ports to depots at which they could be sorted and loaded in suitable consignments to a number of different destinations. Barge transport on rivers and canals was used where practicable.

For a long time the B.E.F. had lived from hand to mouth,

* Lieut.-General Travers Clarke had succeeded Lieut.-General Sir Ronald Maxwell (late R.E.) as Q.M.G. in March, 1918.

engineer stores being issued to meet demands almost as soon as they arrived, and no reserve could be accumulated. But, as we have seen, the exceptional frost which lasted without interruption from 1st January, to mid-March, 1917, reduced all forms of transport and work in France to a minimum. The stores arriving at ports during the frost therefore created a permanent reserve in base depots, a reserve which was maintained at a satisfactory level.

There were always four large categories of stores competing for transport by railway, inland water and road: supplies, ordnance stores (including enormous quantities of ammunition), engineer stores and finally the Transportation Directorate's own stores. At times of pressure R.E. stores did not receive the consideration that their volume and importance justified. During battles consuming large quantities of ammunition and for which tactical railways and roads were under construction it was difficult to obtain transport for R.E. stores required for the same battles, battles in which commanders were urgently pressing for engineer work. With the reserve accumulated at the base in early 1917, any lull in fighting operations was seized upon by the R.E. to fill up corps dumps at the front, and thus to tide them over succeeding emergencies. Such emergencies were only too common, for instance, in September, 1918, owing to other demands from the front, no R.E. stores whatever were moved into and out of Rouen and Havre, except bridging spans and material for which special priority was obtained.

During military operations mechanical road transport was always very scarce for R.E. work. Lorries had to be obtained by C.Es. and Cs.R.E. from the Q staff, usually with great difficulty. C.Es. and Cs.R.E. had no transport permanently at their disposal with the exception that divisional Cs.R.E. had their horsed pontoon wagons which, when the pontoons were removed, were useful for carrying certain types of material.

An engineer planning his work has to consider five factors which must be duly proportioned. First and foremost in war, the time available which will govern the quantities required of the other four factors, i.e., (a) skilled labour, (b) unskilled

labour, (c) plant, stores and material, (d) transport. The military engineer throughout the war often found his working parties at a standstill because the Q staff had switched away, to meet other demands, the transport on which he relied for (a), (b) and (c), and for completion of the work within the time demanded by his commander.

QUANTITIES OF STORES REQUIRED

Some idea may be obtained of the quantities and variety of the stores required by examining the figures of some only of the items exported from England to France during the single month of February, 1917:—

	Tons
Cement, 30,000 barrels	5,455
French wire entanglement, 40,000 lengths ...	468
Corrugated steel sheets, 1,000,000	9,500
Roofing felt, 50,000 rolls	1,750
Screw posts, 400,000	1,256
Wire netting, 20,000 rolls	560
Wire weaving for trench boards, 240,000 sq. ft.	91
Steel shelters, 5,000	3,826
Water piping, 175 miles	2,111
Water tanks, 1,775	194
Expanded metal sheets, 20,000	352
Rolled steel joists, 26,000	8,000
Total	<hr/> 33,563 <hr/>

In the volume on the Supply of Engineer Stores and Equipment, of *Work of the R.E. in the European War 1914-19*, published by the Institution of R.E., the reader will find on pp. 38-40 the quantities of 156 items (selected out of many more) provided to all theatres of war by arrangements made by the Director of Fortifications and Works at the War Office. These quantities are not, however, subdivided among separate theatres of war.

On pp. 92-103 of the same volume will be found :—

- (i) A list of the machinery installed at R.E. Base workshops at Les Attaques and the number of personnel employed there.
- (ii) The output in July and August, 1918, of the workshops at Les Attaques.
- (iii) The quantities of twenty-seven items issued to all five armies from all R.E. base workshops during the months June, July and August, 1918.
- (iv) The total issues of hutting stores from all bases (twenty-four items) during 1917. Of these we will mention here that the average monthly issue of doors was 2,800, windows 3,700 and iron sheets 9,200.
- (v) The quantities of thirty-six items issued by the Stores Department to fighting formations (excluding L. of C.) in each of the years 1916, 1917 and 1918.

From the last table we select the totals in three years of a few items to indicate the magnitude of the task.

Cement	...	...	694,112 barrels
Corrugated iron	...	...	1,393,894 bundles
Shelters, large	...	...	51,697
Sandbags	...	...	729,558,442
Barbed wire	...	...	81,363 tons

The quantity of timber supplied rose to 100,000 tons per month by the end of 1917.

CHAPTER XXIV

TRANSPORTATION ON THE WESTERN FRONT, INTRODUCTION

Introduction—Three phases of transportation during the war—
Pre-war agreement with the French concerning railways,
roads and ports—Comparison of the British and French
systems for controlling railways in war.

THE Editor has compiled the following eight chapters
(XXIV-XXXI) from three main sources of information:—

- (a) The volume of the *Official History of the War 1914-18*, written by Colonel A. M. Henniker (late R.E.), which deals with this subject under the title *Transportation on the Western Front* (referred to herein as *M., T.W.F.*)
- (b) An article written by Colonel L. Manton, D.S.O., O.B.E., (late R.E.) for this history (referred to as *H., T.W.F.*)
- (c) A paper entitled *The Work done by Railway Troops in France during 1914-19*, by Colonel David Lyell, C.M.G., C.B.E., D.S.O., M.I.C.E., read before the Institution of Civil Engineers on 23rd March, 1920 (referred to as *L., W. by R.T.*).

Source (a).—This volume contains a most exhaustive study of the subject in 526 pages, with seventeen sketches and fourteen maps. It is not only a history of this great work in the war of 1914-18, but it is also a treatise, almost a text-book, dealing with the main principles still applicable (1945) to the working of railways in war to ensure their utmost service to armies. Many of these principles had been established in previous wars (see Chapter VI). They were confirmed throughout the war of 1914-18 and are likely to be operative in future wars. Consequently Colonel Henniker's book is of the utmost value to all students of this intricate subject, so essential to victory. It must be a great gratification to him to know that the information contained in this work, produced by his Herculean

labours, has since been of the greatest use not only to our own High Command, but was also deeply studied for their guidance by the members of the Supreme Headquarters of the Allied Expeditionary Force (S.H.A.E.F.) which directed the invasion of Europe in 1944.

Source (b).—Colonel Manton's article, although restricted by the Editor to sixty-six pages of typescript, not only covers much of the ground dealt with in detail by Colonel Henniker, but adds other information about the work of the R.E. It is a valuable supplement, to which the Editor is much indebted.

Source (c).—Colonel Lyell's paper is also a useful work of reference and has been of much assistance; it refers to the cordial relations between the regular officers of the Corps and those many civilian engineers and railway officials who joined the corps temporarily to give their services to the army as engineering and transportation experts.

The Editor has frequently quoted verbatim from these three sources.

The study of this enormous subject must suffer severely from excessive compression into the very restricted space available in the history of the Corps of R.E. In that space it is impossible to do more than to impress on the reader the paramount importance of the transportation work throughout the war, the main principles which were followed, the very great difficulties encountered and the success with which they were surmounted.

The history of our Corps would suffer severely if its very prominent part in this great work did not receive as much notice as space permits. As already explained in Chapter VI, although the proportion of regular R.E. of all ranks employed on transportation during 1914-18 was small in relation to the large number of civilian experts and others temporarily commissioned or enlisted, yet, owing to their training and experience in peace-time in railway work and also in army work and administration, regular R.E. officers held some of the most important positions in the transportation organization. That organization, for reasons explained and justified, had to be cast in a military mould in which the regular R.E.

personnel was a valuable and necessary element in the resulting very strong amalgam.

The reader's attention is again directed to the Introduction to this volume because transportation work was very seriously hampered at the start by pre-war arrangements and regulations, and by the fundamentally false appreciation of the duration and type of war to be expected.

The following abbreviations will be used :

A.D.G.T.	Assistant Director-General of Transportation.
A.D.R.T.	Assistant Director-General of Rail Transport.
C.E.	Chief Engineer.
C.R.C.E.	Chief Railway Construction Engineer.
D.A.	<i>Directeur de l'Arrière.</i>
D.A.D.R.T.	Deputy Assistant Director of Rail Transport.
D.C.F.	<i>Directeur des Chemins de Fer.</i>
D.D.	Director of Docks.
D.D.G.T.	Deputy Director-General of Transportation.
D.D.R.T.	Deputy Director of Rail Transport.
D.G.M.R.	Director-General of Military Railways.
D.G.T.	Director-General of Transportation.
D.Rds.	Director of Roads.
D.R.	Director of Railways.
D.R.T.	Director of Railway Transport.
E.-in-C.	Engineer-in-Chief.
F.S.R.	<i>Field Service Regulations.</i>
G.H.Q.	General Headquarters.
G.Q.G.	<i>Grand Quartier Général.</i>
G.S.	General Staff.
H.,T.W.F.	Colonel Henniker's book <i>Transportation on the Western Front.</i>
I.G.C.	Inspector-General of Communications.
I.W.T.	Inland Water Transport.
L.R.	Light Railways.
L.,W. by R.T.	Colonel Lyell's book <i>Work done by Railway Troops in France during 1914-18.</i>
M.,T.W.F.	Colonel Manton's article <i>Transportation on the Western Front.</i>

Q.M.G.	Quartermaster-General.
R.C.E.	Railway Construction Engineer.
R.O.D.	Railway Operating Division.
R.T.O.	Railway Transport Officer.
R.T.E.	Railway Transport Establishment (The Intermediary Staff).

THREE PHASES OF TRANSPORTATION DURING THE WAR

A study of the sources of information referred to brings out clearly that there were three definite phases in transportation work on the western front :—

Phase I. —August to October, 1914, inclusive.

Phase II. —November, 1914, to September, 1916, inclusive.

Phase III.—October, 1916, to the end of 1918.

During Phase I railway organization on the western front was shackled and disorganized by serious major faults in the *Field Service Regulations* (reprint 1913), and also by our pre-war arrangement with the French Government concerning the working of the railways in France. As a result of the latter the British Director of Railways (designate) and his staff were not allowed to act in France during this phase.

During Phase II, the Director of Railways and his staff, having arrived at G.H.Q. on 29th October, 1914, and having been made responsible not to the Inspector General of Communications (I.G.C.) as *F.S.R.* had directed, but to the Q.M.G. at G.H.Q., were able to give a new start to the organization of the intermediary British staff (now (1944) known as Movement Control) working with the French, whose control of their railway system was not questioned, but the liaison between British and French military and technical railway personnel was now satisfactorily organized on the well-proved main principles referred to in Chapter VI followed by France, Germany, Austria and Italy, with, of course, minor variations due to national idiosyncrasies and nomenclature.

In this Phase II we also find the French gradually realizing, and finally insisting upon, the necessity for, at first minor,

but soon, very great assistance in the technical repair, construction, reconstruction and operation of French railways, without however impairing the central co-ordination by the French of the working of their whole railway system.

To meet these rapidly increasing demands not only from the French for assistance, but also from the British army staff for much greater railway facilities, we find the Director of Railways and his staff building up a large and efficient organization for the execution of his functions under the following headings :—

- (i) An intermediary (movement control) British Staff between the British army and the French technical railway staff (later also British technical staff), for ensuring that the British requirements in railway traffic were met. This intermediary staff was called the Railway Transport Establishment.
- (ii) The technical operation of more and more of existing or newly constructed railways in France, handed over piecemeal to British working by the French from time to time.
- (iii) The ever-increasing repair or reconstruction of existing railways and the construction of new lines, or doubling of existing lines, by arrangement with, and later by the urgent request of, the French, and under their general technical procedure.
- (iv) The provision, working and maintenance of a rapidly increasing number of locomotives.
- (v) The provision of ever-increasing numbers of railway wagons and other rolling stock.
- (vi) The provision of railway material, plant and stores in ever-increasing quantity.
- (vii) The construction and working of light railways in the forward areas of British armies.

During Phase II other transportation work was also done by the British as follows :—

The repair and construction of roads by the Chief Engineers of armies and of corps and by the Director of

Works, as described in previous chapters, although the French had undertaken to do this work.

The creation and working of an inland water transport system.

During Phase III a great reorganization and increase was made in the establishment and resources of the transportation service to meet a crisis that had been impending during the last year of Phase II and which culminated during July to September 1916, reaching such a stage that only the most drastic measures could restore the situation and provide for the future.

The causes of this crisis were:—

- (i) During 1915 and 1916 the B.E.F. in France was increasing at a phenomenal rate.
- (ii) Their front was extended with a consequent increase in the lines of communication.
- (iii) During 1916 the work of the Ministry of Munitions was bearing abundant fruit. The supply of munitions of all kinds, but particularly of guns and ammunition, was at last reaching a satisfactory scale.
- (iv) The type of warfare to be supplied was stationary siege operations demanding large stocks of munitions.
- (v) The volume of traffic had consequently increased far beyond what had been contemplated when the French Government, before the outbreak of war, had agreed to carry all the traffic required by the British army for what was expected to be a mobile war of short duration, in which the British army would be small.
- (vi) Large numbers of peace-time technical French railway personnel had been mobilized in combatant units. Those who remained on the railways were trying to handle a volume of traffic much in excess of peace-time records, while railway track, rolling stock and plant were wearing out, and the personnel were tiring under the strain.
- (vii) The condition of the roads was even more critical. They could not stand up to the volume of solid tired

motor transport traffic, and maintenance could not keep pace with the damage.

- (viii) The congestion at the base ports and docks was such that the delays in the discharge and release of ships were abnormal. At the same time the German submarines had created a shipping crisis which foreboded complete disaster.

If matters continued to drift, strategic troop movements by rail would cease, and the ever-increasing flow of personnel, munitions and rations would fail to reach the front.

In 1916 the British were giving (as we shall describe) great assistance in constructing, maintaining and operating French railways, but it was obvious that they would have to do very much more. The story of Phase III describes how this was accomplished.

We will relate the history of Phases I, II and III in sequence, after we have dealt with pre-war arrangements and preparations for transportation on the Western front.

PRE-WAR AGREEMENT WITH THE FRENCH CONCERNING RAILWAYS, ROADS AND PORTS

The following are the principal points in the pre-war agreement: For the disembarkation at ports and the concentration of the B.E.F. in the area north and east of Busigny, a detailed schedule of trains in England, ships, and again trains in France to the concentration area, and their timings, was worked out by a joint Anglo-French Staff during the years 1913 and 1914.

For this concentration and for subsequent maintenance traffic for the B.E.F., or for strategic or tactical moves, the following arrangements were agreed.

At each port of disembarkation a *Commission de Port* comprising French and British members would be formed, the French to be responsible for entry and berthing of ships, the British for disembarkation of personnel and the discharge of cargo. The base ports were to be Havre, Rouen, Boulogne and possibly Calais, with the advanced base at Amiens.

The entire railway service in France was to be manned and controlled by the French who undertook the work of construction, repair, maintenance, traffic management and protection, not only in French territory but beyond the frontier.

COMPARISON OF THE BRITISH AND FRENCH SYSTEMS FOR CONTROLLING RAILWAYS IN WAR

On mobilization all railways in France passed to the control of the military authorities. Railways in the zone of the armies were under the C.-in-C., those in the zone of the interior under the Minister of War. The C.-in-C. exercised his control through his *Directeur de l'Arrière* (D.A.), to whom the *Directeur de Chemins de fer* (D.C.F.) with his railway directorate, was responsible. The Minister of War controlled railways by his 4th Bureau. Both the C.-in-C. and the Minister of War adhered unswervingly to two main principles:—

1. In the zone of the armies all railways form one indivisible system and must be under the control of a single authority. They cannot be subdivided among armies or areas, but must remain as a tool in the hands of the C.-in-C. controlling all the armies.
2. Efficiency is only obtainable by a union of the military and technical elements, each safeguarding its own interests but neither acting independently of the other.

Towards the end of the war the zone of the armies was merged in the zone of the interior, the whole being placed under the control of the Minister of Public Works and Transport, who complied with the demands of Marshal Foch's *Directeur Général des Communications et Ravitaillement* at Supreme Allied Headquarters.

Control, and the necessary union of the military and technical elements was obtained by *Commissions* who were the sole authorities for issuing executive orders to the technical railway personnel. In each *Commission* there was one *Commissaire Militaire* and one *Commissaire technique*. For each

separate railway system, e.g., *du Nord* or *de l'Est* there was a *Commission de Réseau* on which the *Commissaire Militaire* was a senior staff officer.

For each army in the field, (say) about twenty divisions, there was a *Commission Régulatrice* sitting at the regulating station somewhere between the army served and the base supplying it, but always nearer to the army than to its base. On this *Commission* the *Commissaire Militaire* was a staff officer charged with supply and movement duties. Each station dealing with military traffic, including each port, had its *Commission de Gare* or *du Port*. Representatives of each army department were in touch with the *Commission Régulatrice*.

The French in their arrangements with the British emphasized very strongly that no request for rail transport should ever be made to a civilian railway official but always to the military member of the appropriate *commission*.

These main principles of military control and civilian technical working of railways in war are those already referred to in Chapter VI as having been (with different national nomenclature) evolved by all the big continental nations from their previous war experience. They were also the principles applied by the British successfully in the South African War. In that war the C.-in-C. had his Director of Railways at G.H.Q. The D.R. had his Deputy Directors at the technical headquarters of separate railway systems, e.g., of the Cape or Natal, or a railway system taken over from the enemy, Assistant Directors of Railways, D.A.Ds.R. and finally Railway Staff Officers were alongside technical traffic managers, assistant traffic managers and station masters.

We shall henceforth refer to these *Commissaires Militaires*, whether French or British, as the "Intermediary Staff" on the railways. They were, in 1914, called the "Railway Transport Establishment" (R.T.E.) and have since come to be known as "Movement Control."

Let us now turn to the British regulations for control and working of railways in a theatre of war to ascertain how far they conformed to or departed from the continental system which had been successfully applied in the South African War.

F.S.R. contained the following regulations for control and working of railways in an overseas theatre of war. In Chapter VI we have explained another system adopted in the United Kingdom.

For overseas *F.S.R.* provided for an Inspector General of Communications (I.G.C.) to be appointed and provided with a staff, established at a headquarters on the Lines of Communication. The general system for the movement of all supplies and munitions was for these to proceed from bases to railheads selected by the I.G.C., after he had been notified by the Q.M.G. at G.H.Q. of the places selected by him as "rendezvous." From railheads transport of the type selected and controlled by I.G.C. would proceed to the rendezvous, pick up there the guides sent by the commander of a formation and be guided to a "refilling point" selected by that commander. There the loads would be transferred from I.G.C.'s transport to that of the formation which carried it to the formation's units. The I.G.C.'s responsibility terminated at the refilling point.

F.S.R. made the I.G.C. responsible throughout the whole of the L. of C. "for the punctual movement of the army's requirements, by whatever means were best adapted to the end in view, between the bases and the refilling points inclusive." He co-ordinated all forms of transport, including inland water, on the L. of C.

The Q.M.G. at G.H.Q. was required to co-ordinate all administrative arrangements between the I.G.C. and commanders of formations, and to settle the precedence of conflicting demands.

F.S.R. provided for the appointment of a Director of Railway Transport (D.R.T.) and made him responsible for the "provision of railway transport and its personnel, control, construction, working and maintenance of all railways." The Intermediary Staff, whose personnel was designated as the "Railway Transport Establishment," were placed by *F.S.R.* under the orders of the D.R.T., who was *responsible to the I.G.C.* for the efficiency of everything connected with railway transport.

There was no provision for R.T.E. functioning at base ports.

at which the base commandant was responsible for disembarkation assisted by military landing officers and A.M.L.Os. The base commandant was the sole channel of communication between the British army and the French authorities at the port, and he had no R.T.E. at his disposal for liaison with the French railways. There was no mention of "regulating stations," so necessary for railway traffic in war.

The Director of Transport was responsible to the I.G.C. for the provision and distribution of all transport other than railway transport. He was responsible for inland water transport.

In addition to these standing *Field Service Regulations*, special detailed instructions were issued for the carrying out of the very carefully prepared programme for the journey to France and concentration of the B.E.F. north and east of Busigny.

F.S.R. provided for the repair and maintenance of roads to be undertaken by the Director of Works, and of bridges by divisional engineers.

Thus we see that the British regulations differed from those of the French and of other big continental nations in the following very important particulars.

The control of railways by means of an intermediary staff was not centred at G.H.Q. under the D.R.T. responsible through the Q.M.G. to the C-in-C., but was delegated to the I.G.C. whose headquarters were on the L. of C. at some distance from G.H.Q.

The D.R.T., unlike other directors, had no direct access to G.H.Q., since he was under the I.G.C.

At base ports the commandant and not the D.R.T.'s representative was the intermediary between the British army and the French technical railway staff.

The pre-war agreement with the French government concerning responsibility for the transportation services for the B.E.F. thus differed both radically and in detail from the organization prescribed in the British *Field Service Regulations*, in which there were some fundamental faults.

We shall see the effects of this discrepancy when we now

proceed to relate Phase I of the history of transportation on the Western front. Though great improvements were made in organization, the discrepancy continued to operate, though in diminishing degree, till the end of the war. The British fully agreed with the French contention that it was imperative that they should co-ordinate and control the working of all the French railways as one system supplying all the allies, but the French were slow in realizing that they would have to have very great assistance and collaboration from the British to whom a large portion of the tasks of transportation must be delegated without however upsetting French co-ordination and general control.

CHAPTER XXV

TRANSPORTATION ON THE WESTERN FRONT— PHASE I (UP TO OCTOBER, 1914)

Work of the Intermediary Railway Staff (R.T.E.)—Visit to France of Sir Percy Girouard—Construction and repair of railways.

The principal events of the war in this phase which influenced the tasks imposed upon the Transportation Service were as follow :—

The concentration of the B.E.F. in the area north and east of Busigny.

The retreat of the allied armies from Mons to the Seine with the consequent withdrawal of the British bases from Boulogne, Havre, Rouen and Amiens to St. Nazaire, Nantes and Le Mans.

The advance of the allied armies, beginning 5th September, 1914, from the Seine to the Marne and thence to the Aisne, with the consequent repair of railways, roads and demolished bridges.

The strategic move of the B.E.F. from the Aisne to La Bassée and Ypres in Flanders.

The arrival at Marseilles of a corps from India, their advanced base being established at Orleans.

WORK OF THE INTERMEDIARY RAILWAY STAFF, (R.T.E.)

The carefully prepared schedule worked out some months before the outbreak of war by a joint Anglo-French staff for the concentration of the B.E.F. in the Busigny area was carried out punctually and smoothly according to plan. Throughout the war it was not these great strategic moves that strained Transportation and its personnel, but the day-to-day maintenance of the large forces with the great variety

and constant changes in their innumerable demands for rail and road transport.

On the outbreak of war it was at once apparent that the British *F.S.R.* had been fundamentally modified by our agreement with the French Government concerning the control and working of the French railways. That agreement reserved to the French *Directeur des Chemins de fer* practically all the duties allotted by our *F.S.R.* to the British *D.R.T.* All the French required from us was that all demands by the British for railway transport should be communicated only by named British officers to their *Commissions de Réseau* or *Regulatrice* or *Gare* and by no one else. Consequently it was decided that the British *D.R.T.* designate, Colonel J. H. Twiss (late R.E.) and his staff should not proceed overseas, but remain at home pending any further developments that might call for their presence in France. Colonel Twiss had been Deputy Director of Railways under Colonel Sir Percy Girouard in the South African War.

To provide the intermediary staff required to communicate to the French the British demands for transport one *A.D.R.T.*—Colonel A. M. Henniker (late R.E.), six *D.A.Ds.R.T.* (of which four were R.E.) and twenty-four *R.T.Os.* proceeded to France. They and the other ranks of the *R.T.E.* were distributed by the general staff to railheads, with a *D.A.D.R.T.* at each port, but owing to French sensitiveness about any possibility of interference with their control by British officers with experience of railway working, Colonel Henniker was expressly ordered not to take any active part as an intermediary staff officer, nor to control the *R.T.E.* Even the *D.A.Ds.R.T.* were to be lookers-on, presumably to draw the attention of the *I.G.C.* and his staff to the causes of any hitches. Colonel Henniker was under the *I.G.C.* at his headquarters as his adviser but not executive. The twenty-four *R.T.Os.* at railheads were under the orders of Major Marr-Johnson, R.A., a *G.S.O.2* at headquarters of the *I.G.C.*, and later with the *A.Q.M.G.* at *G.H.Q.*

Consequently with a stroke of the pen at the outbreak of the war we may say that we scrapped our *F.S.R.*, except that

portion of them which conflicted with the fundamental principles of railway working in war which the French were following, in that we centred control by the intermediary staff in the I.G.C.'s office and not in a D.R.T. under Q.M.G. at G.H.Q., while at the ports the base commandants controlled our demands for rail transport without any R.T.Os. to help them.

Needless to say, once the concentration schedule had been completed, and the retreat from Mons had begun, conditions became chaotic and paralysis of rail transport was only averted by the superhuman efforts of Major Marr-Johnson, on the I.G.C.'s staff, and Captain H. de C. Martelli, R.A. (one of the D.A.Ds.R.T.) working under him, and twenty-four R.T.Os., and by the willingness of the French railway *Commissions* and technical staff (who received requests through many channels) to do their best to understand and to comply with what we apparently required in the way of rail transport. It was not an organization but hard-working individual improvisers showing initiative and readiness to take responsibility, who contended successfully with the task. That thirty-one British officers, supported by fifty N.C.Os. and men as clerks, checkers and batmen, were an entirely inadequate establishment to deal with the work of an intermediary railway staff, was proved by the fact that they worked day and night with only a few hours' sleep snatched occasionally, that the base commandants commandeered officers from units passing through to act as R.T.Os., and that by 10th October, 1914, it had been found necessary to increase the R.T.E. employed on this work to seventy-five officers plus some regimental officers on loan.

Directly operations began the Q.M.G.* discovered that it was impossible for the I.G.C., too far away to be cognisant of the military situation, to select railheads in time to operate before the situation changed. He therefore placed this responsibility and the control of mechanical transport beyond railheads upon his A.Q.M.G., and found it necessary to borrow Major Marr-Johnson from the I.G.C. temporarily, but that officer never returned to the I.G.C. The Q.M.G. almost at

* Lieut.-General R. Maxwell (late R.E.).

once (20th August) realized that the responsibility for railway transport ought to be placed on himself and not upon the I.G.C., and that an expert officer with an expert R.T.E. under him was required to carry out the work and to be responsible to the Q.M.G. He tentatively suggested to the I.G.C. that Colonel Henniker should be transferred to the Q.M.G.'s office, but the I.G.C., being responsible under F.S.R. for railway service, did not agree.

The D.R.T. who had remained in England, paid a visit to France, arriving on 17th September, 1914. He conferred with the I.G.C. and Q.M.G. and with the French *Directeur des Chemins de Fer (D.C.F.)* and others, after having seen for himself what was happening.

Space does not permit us to go into the details of the work of the R.T.E. in the confused situation caused by the evacuation of the northern bases and their temporary establishment in the region of the Loire, nor of the return of the I.G.C. and his bases to their original sites in the north after the Channel ports had been freed by the advance of the B.E.F. We are here concerned to follow up the evolution and work of the organization of the British intermediary railway staff during the first phase.

On 15th October, the I.G.C. moved to Abbeville, the *Commission Régulatrice* to Rouen Sotteville, and the *Commission de Réseau* to Amiens.

As a result of the D.R.T.'s visit and conferences, by 10th October the strength of the R.T.E. had increased to seventy-five officers exclusive of officers at headquarters and regimental officers temporarily lent. Also an important step in organization was made when, on 2nd October, Temporary Lieut.-Colonel (later Major-General Sir Henry F. E.) Freeland, R.E. was appointed A.D.R.T. at the headquarters of the I.G.C. where he opened a traffic office; and henceforth all D.A.Ds. R.T. and R.T.Os. on the L. of C. took their orders from him. Before the war he had been holding a senior post in the Traffic Department of the N.W. Railway in India. In the area of railheads R.T.E. officers took their orders from Major Marr-Johnson who was in the Q.M.G.'s office at G.H.Q.

On 4th October, seven R.E. officers with railway experience in India arrived at Marseilles. Some were placed at the disposal of the D.R.T. in England, and some with A.D.R.T. at the I.G.C.'s headquarters.

This improvement in the organization, functions and strength of the R.T.E. came just in time for them to carry out their duties during the strategic move of the R.E.F. from the Aisne to the north, the cavalry by march and the rest of the force by rail. Of course the technical executive work of the railway movement was done by the French railway service on timetables prepared by them. The railway move began on 5th October and the last train departed from the Aisne area on 19th October. Detrainments were in the neighbourhood of Abbeville, St. Omer and Hazebrouk. The Indian Corps moved by rail from Orleans to the neighbourhood of Lillers, Merville and Berguette, starting from Orleans between 26th October and 27th November.

VISIT TO FRANCE OF SIR PERCY GIROUARD

The difficulties caused by the faulty organization and regulations under which the railway service in France had been carried on during August and September having become known at the War Office, Lord Kitchener sought the advice of the man who had been his Director of Railways during the South African War—Lieut.-Colonel Sir Percy Girouard, K.C.M.G., D.S.O. (late R.E.). For some years Girouard had been managing director of the great engineering firm of Armstrong at Newcastle. In October, 1914, he was therefore very busily involved in munition manufacture, but at Lord Kitchener's request he went to France and arrived at the headquarters of the I.G.C. on 17th October accompanied by Colonel Twiss and his Deputy Director, Lieut.-Colonel (afterwards Brigadier-General Sir V.) Murray, R.E. Having discussed matters with the I.G.C., the Q.M.G., the French D.C.F. and the *Commissaire Militaire* of the Nord Railway, Girouard made a report dated 24th October to the Q.M.G. at the War Office. His report dealt not only with the French system and the British organization laid down in

August, 1914, and the alterations therein effected by October, but also suggested a reorganization, which could be extended when the Belgian Railways had been brought into the picture by the expected allied advance. He also commented on the working of the organization at the base ports used by the British. He stressed the necessity for the French railway staff to have the executive direction of all the French railways, including those serving the B.E.F., but the equal necessity for the British to have "a co-ordinating staff to inform their French colleagues of the requirements of the British army."

He recommended that the full control of British railway traffic should be at G.H.Q. (not with the I.G.C.) and that the British D.R.T. should be at G.H.Q., that a conference should be held between British, French and Belgians about the repair and working of Belgian railways, and the control and working of the ports placed at British disposal. Finally he stressed the co-operation required between the Home railway authorities and those on the Continent. He recommended the appointment of an "Inspector-General of Railways in the Field" to take general charge of railway work in the theatre. As we shall see, another two years were to elapse before a Director-General of Transportation in France was appointed and before transportation in England and in France were completely co-ordinated.

Nevertheless, Girouard's report immediately bore good fruit in that the D.R.T. (Colonel Twiss) and his Deputy, Lieut.-Colonel Murray, arrived on 29th October, at G.H.Q., where the D.R.T. took up his proper function under the Q.M.G. On 6th November, the C.-in-C. in France reported to the War Office that he had found it necessary to depart from the procedure laid down in *F.S.R.* and to transfer control and co-ordination of railway traffic from the I.G.C. to a D.R.T. under the Q.M.G. at G.H.Q. Thus ended the organization for railway service laid down in *F.S.R.*, but another two years were to elapse before it was discovered that an I.G.C. to administer directorates on the L. of C. was a redundant appointment which could be abolished.

When the D.R.T. took up his duties at G.H.Q. the urgent matter was the organization of the intermediary railway staff.* Many other tasks, still entirely in the hands of the French, were very soon, however, to require his attention.

CONSTRUCTION AND REPAIR OF RAILWAYS

As already stated, the French had undertaken to repair and to construct all railways in France, and up to the middle of September they would not allow any British railway construction unit to touch the French railway system. But the allies were expecting to advance through Belgium. Consequently Lieut.-Colonel W. D. Waghorn, R.E. (the acting General Manager of the Indian N.W. Railway, who was fortunately on leave in England) took up, as a D.D.R.T. under Colonel J. H. Twiss, the study of Belgium railways and waterways, bridging, etc. to estimate the amount of reconstruction that might have to be done in following up an advancing army. Major (later Lieut.-Colonel) T. R. Kellner (of the Finance Dept. N.W.R. India, who was also on leave) collaborated and subsequently took charge of stores under Colonel Waghorn, who was designated Chief Railway Construction Engineer.

Also in October, 1914, Colonel Waghorn in collaboration with the Railway Executive Committee in England studied the question of raising military railway construction units. As explained in Chapter II, a large number of railway units were raised in this way but did not begin to become available until 1915. The first new Army Railway Construction Company, R.E., arrived in France 24th December, 1914. In Chapter VI we have explained how it was that in August, 1914, there were in England only two regular railway companies, the 8th and 10th, with a previous history of excellent work in the Sudan Campaign and in the South African War, and three railway companies of the Royal Monmouth and Royal Anglesey R.E. (S.R.).

* R.E. officers were a minority in the R.T.E. which was composed of officers of all arms, while the rank and file were all R.E. The organization and control of R.T.E. was, however, in the hands of R.E. officers with railway experience.

In view of the fact that the French did not want our railway units, only the 8th Company* was allowed to go to France in August, arriving at Havre on the 15th with only 30 tons of tools and equipment and no stock of railway material and plant. For more than a month it was debarred from doing any work. It was not administered by, or placed at the disposal of, the A.D.R.T. at the I.G.C's. Headquarters, but was placed under the orders of the General Staff at Havre.

By 17th September the B.E.F., advancing after the battle of the Marne, had left its railheads thirty to forty miles behind. There was a feeling at G.H.Q. that the French had not the resources available to repair the railways behind with sufficient rapidity, and the matter was raised with the French *D.C.F.* On 17th September, the French Government telegraphed to the British Government accepting British railway units for repair. This gave a stimulus to the recruitment of such units in England. The immediate effect in France was that, on 21st September, the 8th Railway Company began the reconstruction of the demolished Pont de Metz bridge near Salceux, which it reopened to traffic on 8th October. This was the first item in a vast programme of new construction, reconstruction and repair of French Railways carried out, as we shall relate, during the next four years by British railway units.

The French had also undertaken to construct and maintain all roads required by the British, but, as we have explained in Chapter XXII, when the B.E.F. moved to Flanders from the Aisne the British engineers had to undertake this work.

* This company was, and is, naturally proud of its number and previous history, but was rechristened for the period of the war No. 1 Railway Company, R.E.

CHAPTER XXVI

TRANSPORTATION ON THE WESTERN FRONT— PHASE II (NOVEMBER, 1914 TO SEPTEMBER, 1916)

Operation of railways in 1915—Construction and repair of railways—Provision of rolling stock—Tramways and roads in 1915—Inland Water Transport—Intermediary Staff (R.T.E.)—Organization of D.R.T.'s. Office in 1915—Preparations for the battle of the Somme—Abortive demands for track and rolling stock—Tramways, Light Railways and I.W.T. in 1916—Congestion at the ports.

DURING this period the principal events of the war that influenced the tasks imposed upon the Transportation Service were as follows :—

The preparations based on the hope of a big allied advance.

The first and second battles of Ypres, and the battles of Neuve Chapelle, Festubert and Loos in 1915.

The long battle of the Somme in 1916.

The large increase in the strength of the B.E.F., and the extension of the front and, in consequence, of the L. of C. area behind.

The increase in the supply of munitions.

OPERATION OF RAILWAYS DURING 1915

From November, 1914 to December, 1915, events caused new tasks to be imposed upon the D.R.T. As the war settled into stationary siege operations and as it became obvious that it would last for a long time, the French gradually realized that in their contract to undertake all transportation for the B.E.F. they had promised more than their resources in men, material and plant could carry out. They returned to us many of our demands for new construction of sidings and railway installations with the request that we would build them ourselves, under their own general co-ordination. Thus the D.R.T. found during 1915 that either British G.H.Q. or the French

D.C.F. required him to carry out all the tasks specified at the beginning of Chapter XXIV (p. 577).

For a long time there was considerable optimism and a hope that trench warfare would break up and be followed by a big advance in which the British would pass through Belgium. This optimistic theory exercised its influence for two or three years in supporting the contention that work to improve the conditions on the existing front would be wasted. The railway administration of Belgium had ceased to exist as a result of the enemy's occupation, involving the capture of a large number of railway personnel and a quantity of locomotives and rolling stock, though some had escaped to France. We had to expect considerable demolition of railways and roads as the Germans retreated.

During the winter of 1914/15 an Anglo-Franco-Belgium commission known as the "Calais Railway and Canal Commission" was established to study the reconstruction and working of railways, roads and canals behind allied armies advancing through Belgium, to estimate requirements in personnel, locomotives and rolling stock, to allot responsibility for zones among the allies, and to divide available resources.

Their study confirmed the necessity for British military railway units for operating railways as well as for repairing and constructing them. But the pressure of events in France during the winter of 1914/15 caused a demand to arise, which was at first resisted, but later tentatively welcomed by the French, for a few British *operating* units to be employed in France, but not to be allowed to touch their main lines.

In January, 1915, it was, therefore, decided to raise British railway operating units. In March their organization was fixed, and in April approval given to recruit them. In June the first of these units began work in France, taking over the marshalling yards and depots at Boulogne.

There were three types of operating units, all grouped into the Railway Operating Department (R.O.D.) :—

- (i) A standard-gauge operating unit, about 270 strong, containing men of both locomotive and traffic trades.

- (ii) An engine crew unit composed wholly of running-shed staff, drivers, firemen and cleaners.
- (iii) A workshop unit, containing men of many trades.

By December, 1915, there were five standard-gauge operating units working in France, together with the twelve railway construction companies under the C.R.C.E. already mentioned, and also seven sections of R.T.E. under the D.D.R.T. Traffic. They totalled 319 officers and 4929 other ranks.

Mr. Paget, Superintendent of the Midland Railway (later Lieut.-Colonel Sir Cecil Paget, Bart., C.M.G., D.S.O.), was appointed O.C., R.O.D., at first with the rank of Major, and later of Lieut.-Colonel. He refused promotion to higher rank, although by 31st December, 1916, there were in France fifteen standard-gauge operating units and three wagon erecting companies. These with the units under the Chief Railway Construction Engineer and some labour and stores units, totalled 611 officers and 13,714 other ranks. In Phase III we shall note a great increase in these numbers. No. 1 Workshop Unit, after occupying two or three temporary sites, settled down for the duration of the war at Audruicq, where workshops expanded over a considerable area.

The operating units took over more and more marshalling yards and depot sidings and on 1st November, 1915, took over the working of the Hazebrouck-Ypres railway which had been doubled. Later we shall find the R.O.D. operating a much greater mileage.

CONSTRUCTION AND REPAIR OF RAILWAYS DURING 1915

For this work Lieut.-Colonel W. D. Waghorn (later Brigadier-General Sir William Waghorn), was responsible to D.R.T. as Chief Railway Construction Engineer (C.R.C.E.) to which post he was appointed on 9th December, 1914, having done preparatory work in England and during Phase I in France as already described. He appointed a Mechanical Engineer to be responsible to him for erection, operation and maintenance of special construction plant, e.g., large mobile break-down

cranes, pile drivers, bridging gantries, railway bridge girders, machinery in construction workshops, etc.

In the winter of 1914/15 the important decisions were taken that the B.E.F. must have sufficient railway repair troops for hasty repair of two main lines of advance, also that the disorganization of the Belgian railway administration by the enemy's occupation of Belgium might throw upon the British the task of maintaining lines of communication right across Belgium. It was also decided that a reserve of material should be accumulated for 150 miles of standard-gauge railway track, and $1\frac{1}{2}$ miles of bridging. As a matter of fact, it was some time before this reserve accumulated, because as fast as the material arrived it had to be issued for urgent work.

Considerable new construction work by the French and British was constantly in hand to make the French railway system capable of handling the volume of military traffic in accordance with the strategical and tactical situation. By the middle of 1915 there were eleven British railway construction companies in France; they were engaged in doubling the Hazebrouk-Poperinghe line, building a new line from Candas to Acheux, laying sidings at Abbeville, Calais and Blargies, and building the railway stores at Audruicq. By the end of 1915 some 105 miles of track had been laid (see Transportation Map in pocket at end of this volume).

At the end of Chapter XXXI will be found a table giving year by year, from 1914 to 1918 inclusive, the mileage put into new lines and sidings or into reconstruction, total 2,639 miles; also a table giving particulars of railway bridges constructed annually during the same period, total 536 bridges of a total length of 37,917 ft.

All new construction, except spur lines to carry heavy guns on railway mountings to their firing sites, had to be referred to the French, because only they could say whether their railway system could deliver or receive traffic to and from new lines or sidings.

On 16th November, 1914, the 10th (regular) Railway Construction Company arrived in France, and one railway reconnaissance section, also two companies of the Monmouth and one

of the Anglesey R.E. (S.R.). At that time the situation in the first battle of Ypres was still critical so the three S.R. companies were lent to the Brigadier-General, R.E. at G.H.Q. for defence work and they did not return to the D.R.T. until March, 1915.

Railway construction companies as they arrived in France were formed into groups of two or three under Railway Construction Engineers (R.C.E.) who held the rank of Lieut.-Colonel. R.C.Es. were responsible for all standard, metre and 60-cm. gauge construction, and they took their orders direct from C.R.C.E. Several of these companies lived in trains, divided into four sections so that any section could be easily detached with its own living wagons and tool vans.

The first two Canadian overseas railway construction companies arrived in France at the end of 1915. Later further Canadian railway units were organized in battalions, each commanded by a Lieut.-Colonel, and a G.O.C. Canadian Railway Troops was appointed. British reconnaissance, mechanical and signalling sections, R.E. were also attached to R.C.Es. as required.

All departments of the railways required much unskilled labour. As with most other personnel the initial supply was small but was increased rapidly. In 1914, one A.S.C. railway labour company was provided. This was followed by a R.E. labour battalion. By November, 1918, the total unskilled labour employed by the British Railway Directorate in France was 27,000. *H., T.W.F.* contains some very sound remarks about the value of continuity of employment of unskilled labour at the same type of work by which a considerable proportion become skilled. See also page 54, *L., W. by R.T.* as regards output.

Every railway construction company had to be capable of operating its own traffic of construction materials from the station beyond which the line was not yet fit to be handed over to general traffic. A proportion of urgent traffic, e.g., ammunition, was frequently allowed to use the line under construction, and had to be operated by the construction company, sometimes for several miles. Even spur lines for heavy guns, although often laid out with gradients and curves most unsuitable for

general use, frequently carried such traffic under the control of the R.C.E. Consequently construction companies carried on their establishment a certain number of drivers, firemen and guards, but it was never expected that they would have so much operating of traffic forced upon them, especially on gun spurs.

Traffic worked by the construction companies on standard-gauge lines often travelled right up to the front line, though sometimes in the last mile or two of the danger area the locomotive would be detached and the train pushed by men. The result was that the normal traffic worked by R.O.D. tended to creep nearer and nearer to the front with great advantage in the reduction of wear and tear on roads.

R.C.Es. were responsible not only for construction of gun sidings but also for hauling heavy guns on railway mountings and their ammunition to their firing positions, and for withdrawing them when ordered. The guns became heavier and heavier, culminating in the 14-in., which with its mounting and railway vehicle weighed 243 tons, imposing an axle load of 17 tons. This weight created problems not only in bridge construction but also in track maintenance. The C.R.C.E. assumed the responsibility for the repairs of mountings, and for the remounting of re-tubed gun barrels. This work was at first comparatively light but during 1917/18 occupied one-fifth of the base shop working hours.

PROVISION OF ROLLING STOCK DURING 1915

In October, 1914, the first ambulance train provided by the British began to run in France. Twenty-nine more were provided before the end of the war.

In March, 1915, the French made their first request that the British should provide railway wagons. Orders were placed for 2,800 wagons to be manufactured in Britain and 2,500 in Canada. The first of these was not running in France until April, 1916.

In April, 1915, the D.R.T. managed to borrow 300 refrigera-

tor wagons from the British railways for running on British supply trains in France.

These arrangements were the beginning of very large importations in 1916, and subsequent years of locomotives and rolling stock by the British for traffic on the French railways, as we shall relate farther on.

TRAMWAYS AND ROADS DURING 1915

In 1915 there were four links in the chain of transport from the base to the front line (i) standard-gauge railway from base to railhead, (ii) lorries from railheads to M.T. roadhead, (iii) horse transport by roads and tracks to the farthest points safe for wagons, (iv) carrying parties of men into the trenches.

Carrying parties were tedious, slow and limited in capacity, so divisional engineers began to scour their areas for French tramway track of 9-lb. to 16-lb. rail. Isolated tram systems thus began to appear worked under brigade arrangements by human or animal power, but practically no mechanical tractors were in use. The C.R.C.E. helped the Engineer-in-Chief in the development of tramways by obtaining and supplying track, and by standardizing supply, adopting 16-lb. rail and 60-cm. (23½-in.) gauge. Trucks were made locally by divisional R.E. units, often with wooden wheels, and some were supplied from the workshops of C.R.C.E.

The winter of 1914/15 had caused many miles of roads to break up under the weight and volume of our lorry traffic. It is necessary to remind the modern reader (1951), who only knows the low-pressure pneumatic tyred lorry, that the lorries of 1914/18, with their hard and narrow, solid rubber tyres, were most efficient road-destroying weapons, and that their cross-country capacity was almost nil even in dry weather, and absolutely nil in wet. Only the hardest dry ground would carry lorries away from the roads. Their system of springing was much inferior to that of 1939/45 lorries. When pot-holes appeared, unless mended at once, convoys would bounce from hole to hole, like heavy pile drivers hammering on the roads. Only roads with a minimum of twelve inches of soling and

six inches of metalling well rolled down in two layers could stand up to mechanical transport, and only then if well maintained by large working parties.

A vast amount of quarrying, transport, man-power and plant was required to produce the stone for many miles of such roads. The belt of the battle area in which armies fought under an ever-growing volume and range of shell-fire, as both sides rapidly increased their masses of artillery and ammunition expenditure, became deeper and deeper, and more and more shell cratered. Distribution of supplies, ammunition and all types of war material, forward and laterally in this large battle area was a more difficult problem than bringing them from the base to standard gauge railhead. In 1914 and 1915 our armies made very small advances, but even these showed up the difficulty of building either standard-gauge railways or roads fit for lorries across ground thoroughly cratered by shell-fire, which had broken up the drainage system. Not until we relate the events of 1916-1918 shall we hear of the extensive measures adopted to overcome the difficulty of distribution in the large area occupied by armies and for carrying forward feeder railways and roads during a big advance.

But in September, 1915, with another winter approaching, the G.M.C. laid down certain principles by directing that the isolated tramway systems at the front should be developed laterally, and co-ordinated and extended as far as possible to the rear. At the same time standard-gauge railheads were to be advanced as far as practicable. Extension of tramways would reduce the labour of carrying parties, while advance of railheads would tend to eliminate the lorry link between railhead and horsed transport. Not until 1916 do we come to the story of "Light Railways," and the further development of tramways and the traction on them.

As already stated, the French had undertaken all responsibility for the upkeep of roads, but in Belgium this responsibility had been accepted by the British from the outset (see Chapters VII and XXII). Soon, however, behind the British front the French also asked for assistance. The British had, of course, already relieved them from this work in tactical

zones where it was done under C.Es. of corps and Cs.R.E. of divisions. In December, 1915, the French called upon the British to provide all stone required for all the roads they used.

INLAND WATER TRANSPORT DURING 1915

Both France and Belgium possess highly developed systems of inland waterways, which in peace carry a heavy traffic. But throughout the greater part of the war the connexions between the northern system, the Somme and the Seine were behind the German lines. There were thus three separate systems in the hands of the allies connected only by the sea. Nevertheless, before long the I.W.T. organization was dealing with a very large volume of traffic, besides undertaking a variety of valuable miscellaneous services unforeseen in its inception.

It was in December, 1914, that this service began to be created by Commander G. E. Holland, C.I.E., D.S.O., a retired officer of the Royal Indian Marine. At the time of the outbreak of war he was Marine Superintendent of the London and North Western Railway. With the idea that the I.W.T. would partly supplement, and partly be a substitute for railway transport, Commander Holland was placed as a Deputy Director under the D.R.T. with the rank of Colonel. The regimental officers and other ranks of the service were commissioned or enlisted as Royal Engineers.

The main work of I.W.T. was the carriage inland, from the ports, of bulky traffic of no great urgency, e.g., hay, oats, timber and bricks, and also ammunition for building up reserves during quiet times. In Chapter XIX we have referred to the floating pumping and filtering installations erected on mobile barges. Barges were also fitted out for carrying wounded.

In practice there was little connexion between the administration of Railways and that of I.W.T., so in October, 1915, the D.R.T. was relieved of the responsibility for I.W.T. and Commander Holland became a director responsible to Q.M.G. Nevertheless, we shall find him returning to the Directorate-General of Transportation at the end of 1916.

PROVISION OF RAILWAY MATERIAL, PLANT AND STORES DURING 1915

We have already referred to the decision in the winter of 1914/15 to accumulate a reserve of the above, as a result of which Major Kellner was appointed Chief Stores Engineer under the C.R.C.E.

In 1914, and up to March, 1915, stocks of railway material, plant and stores were retained at Ashford in Kent, but in that month a Railway Stores Depot was opened at Audruicq in France by an officer and twelve other ranks of the 10th Railway Company, a very modest beginning of a depot which was about to grow to great dimensions as we shall relate.

In September, 1915, a Railway Stores Park of 165 other ranks was sanctioned to which were also attached a hundred men of an A.S.C. railway labour company.

Dunkirk became the port at which railway material, plant and stores were landed.

INTERMEDIARY STAFF (R.T.E.) DURING 1915

This staff was concerned with the *use* of the railways in France by the B.E.F. in the area behind the front they held. They were not a mere post office to transmit British demands to the French ; their business was to have a detailed knowledge of every kind of movement being, or likely to be, made, how each was or might be effected, and to devise schemes which, on the one hand, would be within the capabilities of the technical railway service and acceptable to the French military railway control, and on the other, would meet British requirements to the fullest extent possible. At the same time, it was for the R.T.E. to suggest how the capabilities of the railways might be increased, and to keep a continual watch so that no action by the troops or army services reduced these capabilities by hampering the technical working.

Throughout the war no strategic movements of troops could be made except under the authority of French G.Q.G., but for

tactical purposes within the deep belt of battle an arrangement was made by which the French Railway Administration kept an agreed number (changed from time to time) of trains of various types stabled at stations, selected and agreed with the British, in the area of the railheads. The use of these trains was arranged direct between the British D.R.T. and the French *Commission de Réseau*.

As regards the system of strategic railways and the main feeder lines traversing the areas between bases and railheads, we must again emphasize that it was agreed that the whole of this system in France must be co-ordinated and controlled by the French as one complete entity, which could not be subdivided and placed permanently at the disposal of various French or British armies. On the other hand, within the areas occupied by armies at the front (the deep battle belt), the demands of each army headquarters for railway services or for new construction were so numerous, varied and often very urgent that G.H.Q. would have been swamped if they all had come to them, and much delay would have been caused. Consequently as the B.E.F. expanded to four and later five armies, the movement control staff was required to arrange direct with the appropriate French or British railway organization for the traffic demands *within* its own army area. As regards demands by an army headquarters for new railway construction within its area, the C.R.C.E. delegated authority to R.C.Ea. to undertake minor or very urgent new work.

Questions of railway strategy and policy, strategic new construction or improvements on a large scale and big strategic moves were arranged between British G.H.Q. and French G.Q.G. using their respective G, Q and Transportation staffs for these purposes.

In December, 1914, Dieppe was taken into use as a port, and in May, 1915, a British base was established at Calais. Depots and various installations sprang up very fast in these areas. In July, 1915, the British Third Army was formed and the front of the B.E.F. extended.

At the end of November, 1914, there were three R.T.E. units in France. By June, 1915, this number had been doubled.

By January, 1916, the strength of each unit was increased. By October, 1916, there were eleven units with an effective strength of 280 officers.

ORGANIZATION OF D.R.T.'S. OFFICE IN 1915

The D.R.T. had begun work at G.H.Q. on 29th October, 1914. By July, 1915, he had gradually built up an organization of five Departments. With these he was carrying out all the functions of a Director of Railways. During 1915 the attitude of the French *Directeur des Chemins de fer* had changed from his original dread of interference by the British Director and British railway units to one involving increasing requests for their assistance, and the delegation to them of tasks of increasing scope and importance. Consequently in November, 1915, the title of the appointment was changed from Director of Railway Transport (D.R.T.) to Director of Railways (D.R.), and Colonel J. H. Twiss was promoted to Brigadier-General. One must pay tribute to his tact and persistence, in that he was not discouraged during the first three months by the attitude of British and French headquarters in not giving him a free hand from the start of the war, and for the speed with which, when once allowed to start, he reorganized the R.T.E. and built up the operating and construction troops.

By October, 1915, the French railways generally were faced with a volume of traffic greater than in peace-time, and this had to be moved by a reduced personnel with a diminished and worn equipment of locomotives and wagons. Consequently, we shall find their demands for British assistance growing more and more pressing, and even insistent.

By December, 1915, there were twelve railway construction companies working under the C.R.C.E. and 105 miles of standard-gauge track had been laid; there were five R.O.D. operating units under O.C., R.O.D. and seven sections of R.T.E. under D.D.R.T., Traffic. The total strength amounted to 319 officers and 4,929 other ranks.

PREPARATIONS FOR THE BATTLE OF THE SOMME

In October, 1915, it became obvious that the French battle for the Vimy ridge, its British supplement, the battle of Loos, and the great French offensive in Champagne, had all failed to achieve any important results. So from November, 1915, onwards, the plans and the preparations for the battle of the Somme began to be studied and put into execution.

The B.E.F. had grown. In 1916 it was organized in four armies and a reserve Army, the Fifth, and its front had extended southward to the River Somme. It had acquired a mass of artillery including the heaviest guns and an ample supply of ammunition.

By 1916 four strategic double line routes, well equipped, existed between the southern bank of the Somme and the eastern French frontier :—

- (i) Longueau — Montdidier — Ormoy — Le Bourget (a suburb of Paris) — Nancy.
- (ii) Longueau — Creil — Ceinture de Paris — Toul — Pont St. Vincent.
- (iii) Amiens — south to St. Omer au Chaussée — Beauvais — inner Ceinture de Paris — Epinal — Belfort.
- (iv) Abbeville — Longroy — Gamaches — Le Tréport — Abancourt — Serqueux — Pontoise — outer Ceinture de Paris — Toul — Epinal — Belfort.

All four passed over some portion of the Ceinture de Paris and three out of four touched Amiens.

North of the Somme up to the end of 1916 there were only two double line routes available :

- (i) Dunkirk — Hazebrouk — Calais — Abbeville — Amiens.
- (ii) Hazebrouk — Chocques — St. Pol — Canaples — Amiens.

After the battle of the Somme a third main line was completed from Longueau to Arras.

The need of ample communications running north and south was clear from the first, and works for the improvement of the

line Amiens-Canaples-Doullens-Frévent-St. Pol-Béthune, were begun as early as 1914.

With these improvements strategic moves behind the front and maintenance traffic from and to the bases were well provided for, but the railway facilities immediately behind the front on which the Somme battle would be fought, and a great offensive launched, required improvements. At the end of December, 1915, it was decided to build an entirely new standard-gauge line running east from Fien-Villers-Candas on the Canaples-Doullens to Acheux railway, some seventeen miles. On 1st April the British R.O.D. took over the operation of this new line which provided four or five railheads to serve the battle. Three more railheads were provided by the construction of another new line ten miles long from Daours on the Amiens-Albert line to a large ammunition depot at Cantay. This was completed by the end of May, 1916. The main double line from Amiens to Arras was available only as far as Albert where it came under shell-fire.

Fifty-five miles of new railway sidings were constructed to serve the battle of the Somme, and during the first fifteen weeks after the opening of that battle on 1st July, 1916, 170 miles of standard-gauge track, 630 turnouts and 423,000 sleepers were issued.

It was, of course, expected that a great victory would be won which would break up trench warfare and be followed by a big advance that might necessitate the extension of communications to a limit which could not be estimated but must be generously provided for.

French G.Q.G. therefore arranged beforehand that the responsibility for repair and reconstruction should be apportioned between French, British and Belgians as follows: the French undertook to carry out this work up to and including the lateral line Hazebrouck-Lille-Orchies-Valenciennes-Maubeuge.* North-east of this line repairs behind the First and Third British Armies were to be effected by the British railway construction troops.

* Again the French were too optimistic. They had to call on the British for much assistance.

It was estimated that the Third Army would require daily twenty-eight trains and the Fourth Army thirty-one, but at times these figures might rise to fifty-eight and seventy respectively.

ABORTIVE DEMANDS FOR TRACK AND ROLLING STOCK

The Q.M.G. and the Director of Railways realized that demands must be made in England to supply railway material, locomotives, rolling stock and personnel in time to be ready for the military operations that were planned to begin in the spring (but did not actually start till 1st July). They also realized, in fact the French pressed upon their attention, the difficulties which were overwhelming the French railway system and the need for British help.

At home the crisis caused by lack of munitions had concentrated attention from the spring of 1915 onwards upon the creation of a Ministry of Munitions in charge of Mr. Lloyd George. This ministry, of course, required some months (in fact a year) in which to step up production to the high level that had been proved to be necessary. The policy was to blast the Germans out of their defences with masses of artillery, including a large proportion of the heaviest, and with a vast supply of ammunition. Upon that policy the attention of the Government and the resources of the country were concentrated. The Ministry of Munitions acquired control of raw materials, and their powerful minister had a dominant position in the Cabinet where the priority of demands of the various services was decided.

The result was that demands for railway material and rolling stock to be sent to France received replies such as: "There is no labour available"; "The Ministry of Munitions will not allocate the steel"; "The Board of Trade say that the rolling stock cannot be spared." The Railway Directorate in France had to be satisfied with such proportion of their demands as were met. The *Official History* states that on 1st July, 1916, when the battle opened, the reserve of rails in France sufficed for only ten miles of track. By September, 1916, 397 miles of

standard-gauge track had been received but much more was required. Had there been a victory on the Somme, the railways would have been hard put to it to follow up.

In May, 1916, only fourteen locomotives arrived from England. In June the first of the seventy small tank engines ordered from America arrived. Previously the British S.E. & C. Railway had lent seven small shunting engines for work in Boulogne port area. By the end of 1916 only sixty-two locomotives had been imported and were actually hauling traffic in France. Of the 5,300 wagons ordered in 1915, only a few had come into traffic by April, 1916.

In contrast to the foregoing disappointing response to demands for railway material and rolling stock there was a steady increase during 1916 in the number of military railway units for construction and repair and for operating the railways. By the end of 1916, twenty-two British railway construction companies had arrived in France. During the year 1916, 417 miles of standard-gauge railway track and over eighty miles of light railway track were laid. In July, 1916, the Director of Railways applied for more Canadian railway construction troops. In Phase III we shall note the satisfactory response to this request not only from Canada but also from other Dominions. The R.O.D. increased during 1916 to fifteen operating units, and at the end of the year was working 241 locomotives.

TRAMWAYS, LIGHT RAILWAYS AND I.W.T. IN 1916

We have mentioned the Q.M.G.'s memorandum of September, 1915, which ordered tramway feeder lines to be extended backwards from the trenches to meet, if possible, the limit of horse transport.

The winter of 1915/16 more than emphasized the difficulties encountered in the previous winter in making and maintaining roads rapidly that would stand up to the volume of lorry traffic. In February, 1916, the condition of the roads for distribution at the front being serious, the matter was again considered by the Q.M.G. and orders were issued that 60-cm.

tramway feeder branches were to be constructed from standard-gauge railhead stations forward to meet if possible the extension back from the trenches previously ordered in September, 1915. This development was still confined to tramways, which were not light railways, because as late as the early summer of 1916 traction was still by animal or man-power, in fact only about six small petrol-driven tractors were working on the whole front. Between May and August, 1916, however, there was a radical change towards developing the 16-lb. rail 60-cm. track of the tramways into a real light railway (L.R.) system, by using light locomotives or tractors, and by increasing considerably the number of wagons. Between May and August, orders were placed for 600 miles of track, 120 tractors and locomotives and over 1,600 wagons. Not all of it had been received when experience in the battle of the Somme emphasized the necessity for L.R. The Q.M.G.'s. circular of 4th August, 1916, ordered that L.R. were to be used along the whole front for the carriage of traffic in the following order of priority: (a) heavy gun ammunition, (b) lighter ammunition, (c) engineer stores, (d) supplies.

The experience of the Somme battle showed that on a 12-mile front 20,000 tons had to be distributed daily beyond railheads. On 1st September, 1916, on roads of the Fourth Army alone there were 4,671 lorries, 1,145 cars and ambulances and 1,636 motor cycles. It was highly desirable that as much as possible of this transport should be replaced by L.R. for distribution beyond standard-gauge railheads.

It was also now realized that the operation of these L.R. was a technical matter, in fact the L.R. system must be operated on the same lines and procedure as a standard-gauge railway system. The R.O.D. was therefore ordered to take over their operation. The C.R.C.E. at D.R.'s. headquarters allotted railway track, and the O.C., R.O.D. allotted locomotives and rolling stock for Light Railways in each Army area, where the local R.O.D. officer and the forward R.C.E. dealt with local demands for light railway traffic or construction.

We may say that this stage of development of L.R. and the principles of working them had been decided and were well

forward in practice by the end of Phase II, which we take as terminating at the end of September, 1916.

Inland water transport had carried by the end of April, 1916, about 800,000 tons, operating on 207 miles of navigable waterway in France. At the end of September, 1916, they had in use fifty-eight tugs and 590 barges of various types, with a carrying capacity of 76,000 tons. They worked in agreement with the French canal commission—the *Commission Internationale des Voies Navigables*.

CONGESTION AT THE PORTS

The arrangement with the French was that they would provide certain areas of covered and open spaces for stacking stores and material unloaded from the ships. Every army department thus established depots, steadily increasing in size, within the area of the port. The rate of discharge from the ships could not exceed the rate at which the cargo was deposited on land ever farther and farther from the ships. The result was that there was more and more delay in bringing ships alongside. This delay, amounting to several days in turning ships round, was a very serious matter at a time when submarines had caused a menacing shipping crisis. Moreover it restricted the rate of flow of cargo to the front.

In June, 1916, a Shipping Commission visited France to examine the reasons for the delay to shipping. Among other causes they named as the principal one that transit sheds at the quaysides were not being used for the purpose of dispatching cargo to various depots which should be well away from the port area, but that these sheds, and big areas beyond them, were being themselves used as depots and thus congesting the port and the transit of cargo through it. It was realized, however, that to move all the depots to new sites would be a great undertaking. The Commission also noted that the ports were not equipped with the necessary plant to handle the great volume of traffic trying to pass through them.

CHAPTER XXVII

TRANSPORTATION ON THE WESTERN FRONT— APPOINTMENT OF THE D.G.T.

Visit of Sir Eric Geddes to France—His dual appointment as D.G.M.R. and D.G.T., B.E.F.—Organization of the new Directorate-General of Transportation.

VISIT OF SIR ERIC GEDDES TO FRANCE

WHEN a nation is waging total war, and especially when its pre-war preparations for such an emergency have been meagre, a vast expansion of its organization for war must be made as rapidly as possible. In that difficult process bottlenecks, as we called them in 1939-45, suddenly become apparent in succession, now at this point, now at another point in the organization. The expression "bottlenecks" is not a very appropriate simile, and it would be better to liken them to successive restrictions, in a long pipe-line, from reservoir to destination.

In 1914 it first became obvious that a great reservoir of trained fighting men must be created. As these reservoirs in Britain and the Dominions began to fill up, it soon became equally obvious that great reservoirs of munitions were also wanted. It was not till these munition reservoirs were filled that the existing channels of communication from Britain and from overseas to the war fronts were found to lack the capacity to carry the flow of traffic. Here and there the communications were found to be choked. As each point of strangulation was disclosed a rush would be made to install new channels to bypass the congested section. Such action immediately disclosed the next section of the system that was the most congested. Not until large channels had been provided throughout from reservoirs of man-power and munitions to the fronts in all theatres of war did congestion cease to occur in one part or

another of the Empire's war organization. As the C.-in-C. in France, Sir Douglas Haig, said in 1916: "For the waging of war, men, munitions and movement are required." In mid-1916 the men and munitions were being provided rapidly in the reservoirs but the pipe-lines to the fronts were constantly becoming overloaded.

We have noted that, in early 1915, Mr. Lloyd George had taken up the task of creating a Ministry of Munitions to multiply production, and that by early 1916 the munitions were beginning to be available in greatly increased quantities. In June, 1916, occurred the lamentable death at sea of Earl Kitchener, Secretary of State for War. Within a week or two Mr. Lloyd George had succeeded him at the War Office. With his wonderful flair for appreciating the essential points in any situation, he appears to have realized that all his work at the Ministry of Munitions would be wasted if deficiency in transportation prevented munitions, and men to use them, from reaching the fighting front.

At the Ministry of Munitions, one of his principal departmental directors had been Sir Eric Geddes, who had impressed Mr. Lloyd George by his capacity for organization and exceptional driving power. Mr. Lloyd George now remembered that prior to the war Sir Eric Geddes had been General Manager of the North Eastern Railway in England. On 7th August, 1916, he sent him to France to investigate the whole transportation situation.

Sir Eric took with him Colonel O. Mance (late R.E.) from the War Office Railway Department, and in France Colonel H. F. E. Freeland (late R.E.) was placed at his disposal to provide information. He also took Mr. Nash, a mechanical engineer from the British North Eastern Railway. Of course, he found, as we have already described, that there was congestion at the ports, that the French Railway system was overloaded with demands to carry traffic, that its locomotives, rolling stock, track and personnel were wearing out, in all of which there was also a lamentable shortage, and that the roads were deficient in mileage and being destroyed by the volume of motor transport using them far faster than they could be main-

tained. Like Sir Percy Girouard nearly two years earlier, he at once realized that it was not only in France that one must look for causes. It was necessary to examine all channels and methods of transportation from the sources of production in England to the fighting front in every theatre of war, and to inquire into the quota of production allotted to the Service of Transportation. Sir Eric Geddes caused estimates to be made of the total tonnage that would have to be moved in the near future from production centres in Britain to the armies in France, by all types and methods of transportation. He found that at the front 200,000 tons must be distributed weekly. He estimated that the total capacity of the transportation channels would have to be increased by 92 per cent without any bottle-necks. In making the latter recommendation he had considered the demands of other theatres of war. It was essential that ports, roads and canals should also have their capacity increased. To carry out this stupendous task he recommended that one man should be made responsible for transportation both in Britain and in France.

DUAL APPOINTMENT OF SIR ERIC GEDDES AS D.G.M.R. AND D.G.T., B.E.F.

The British Cabinet on the urgent representation of Mr. Lloyd George, accepted Sir Eric Geddes' conclusions and recommendations. On 18th September, the Army Council approved his appointment as a Deputy to the Q.M.G. at the War Office with the title of Director-General of Military Railways (D.G.M.R.) responsible for the provision of personnel and material for railways, canals, docks and roads (excluding M.T. vehicles) with the right of direct access to the Secretary of State for War and of attending meetings of the Army Council when matters pertaining to his department were under discussion. On 21st September Sir Eric Geddes accepted the post.

Almost simultaneously he undertook, on the invitation of the C.-in-C. in France, to reorganize the transport services of the B.E.F. On 20th October he was gazetted Director-General

of Transportation in France (D.G.T.), with the temporary rank of Major-General. Previously on 10th October, G.H.Q. had sent out a circular explaining the status of his appointment and that he would have direct access to the C.-in-C., to whom he would be directly responsible, and not to the Q.M.G. In *H., T.W.F.* the reader will find an interesting discussion upon this departure from normal G.H.Q. organization, for which there is no space in this history. The first direct result was the abolition of the redundant post of I.G.C. It was laid down that the Q.M.G. would tell the D.G.T. what was to be carried, and when and where, and if the D.G.T. could not carry the whole of it the Q.M.G. would settle priority. The D.G.T. would make his own arrangements for the provision of the personnel and material he required.

In view of Sir Eric's dual appointments at the War Office and at G.H.Q. in France, a Deputy D.G.M.R., Sir Guy Granet (General Manager of the Midland Railway) was gazetted on 20th October to represent Sir Eric on the Army Council when he was absent from London.

Sir Eric Geddes now held a position of most unusual authority and power with direct access to any minister or high authority. As a previous director in the Ministry of Munitions, he knew all the secrets of that ministry, from which replies to demands from G.H.Q. France had been of the nature of "no steel is available for rails or rolling stock." As a previous General Manager of the North Eastern Railway, he knew all the buttons to press to get rolling stock, rails and other equipment from the British railways. He had the backing of the whole Cabinet and notably of Mr. Lloyd George, its most powerful member, and about to become Prime Minister. The poachers at the Ministry of Munitions, Lloyd George and Geddes, had now become the gamekeepers at the War Office, the Rt. Hon. Lloyd George, Secretary of State for War, and Major-General Sir Eric Geddes, D.G.M.R. and D.G.T., B.E.F.

No Q.M.G. or Brigadier-General of Railways in France would ever have been allowed the power and the resources now showered upon Sir Eric Geddes. Fortunately he had all the qualifications, particularly the organizing capacity and excep-

tional driving power, to use this unlimited authority and to grapple successfully with a stupendous task.

The last quarter of 1916 was a period of transition, during which Sir Eric was laying at great speed, the foundations of his new organization in France, and preparing to accept responsibility for all transportation from the 1st January, 1917.

In describing his organization in France, we have no space to deal with initial variations in the first draft, as related in *H.T.W.F.* We shall explain the organization as it emerged after it had settled down to work in the early part of 1917. In Chapter VI we have already explained the D.G.M.R.'s organization at the War Office.

ORGANIZATION OF THE NEW DIRECTORATE-GENERAL OF TRANSPORTATION

The newly appointed D.G.T. in France did not sweep away all the organization or the personnel that he found ready to serve him. On the contrary, there was very much in that organization of which he approved, and he found the officers were mostly the right men in the right places, but he realized at once that they required reinforcement and greatly increased resources.

He set to work to co-ordinate all forms of transportation—docks, railways, light railways, inland waterways and roads, and to create an expanded organization for that purpose. He particularly approved the programme already started for light railways to take traffic off the roads in the areas where distribution of traffic to the armies was required, but he increased the programme considerably.

He arrived in France at an opportune moment for modifying the pre-war agreement with the French about the working of railways serving the B.E.F. We have already described the serious difficulties confronting the French railway officials and their causes. As a result, in October, 1916, the French *D.C.F.* was asking for more British locomotives and was ready to accept any assistance from the British that they could give in the working, repair and construction of the French railways.

In November, 1916, Marshal Joffre as C.-in-C. formally denounced the pre-war agreement under which the French had accepted entire responsibility for the railway and road service of the B.E.F. Sir Eric thus had a free hand to give the French all the help he could and he set to work to do it.

He at once established a Director of Docks, Major R. Wedgewood, whose work we shall describe. Later also a Chief Engineer Port Construction, Sir Alexander Gibb (a well-known contracting engineer who had built Rosyth dockyard) reporting direct to D.G.T. The Director of I.W.T. was re-transferred from Q.M.G. to D.G.T. As explained in our chapter on the Directorate of Works, D.G.T. took over from D.W. the responsibility for roads from base ports up to what was called "the D.G.T. line" which was roughly defined as the rear of the area under fire of the enemy's medium artillery. Beyond that boundary the responsibility for roads remained with Chief Engineers of armies and corps. He appointed Mr. (afterwards Sir Henry) Maybury (Chief Engineer of the Road Board in England) to be Director of Roads. The D.W. and Chief Engineers retained responsibility for all road bridges.

As the D.G.T. particularly approved the scheme to transfer traffic from roads to light railways in the forward distribution areas of armies, he appointed a Director for that work, Mr. Harrison, an Engineer from the Cordoba Central Railway. He also appointed a Chief Mechanical Engineer for the erection and maintenance of imported locomotives and rolling stock.

The D.G.T. agreed entirely with the system of an intermediary staff (movement control) on standard-gauge railways responsible to himself. He also agreed that while G.H.Q. must co-ordinate the service by the standard-gauge railways, the distribution of that traffic on arrival at railheads and on transfer to light railways and roads in the forward areas of armies, and the decision as to what communications should be constructed in those areas, was a matter which could be delegated to headquarters of armies in consultation with A.D.Gs. who were the local agents of D.G.T. The two D.D.Gs.T. at his headquarters kept in touch with A.D.Gs.T. in army areas.

Every application from army staffs or departments or unit

commanders for transportation was therefore to be addressed to the appropriate D.D.G.T. or A.D.G.T., who made the necessary arrangements with the appropriate local and technical railway officials acting under the orders of their respective Chiefs.

Having created Directors of Docks, Roads, and Light Railways and taken in the I.W.T. it would have been a logical organization to keep the Director of Railways responsible to himself. But the railways were carrying the bulk of the traffic (95 per cent on trunk routes of the L. of C.) and were, as we have seen, far below the standard of capacity required. Sir Eric had accepted the responsibility for putting that right and to do it in the shortest possible time. He therefore wished to have direct contact with the head of each department of the railway organization to apply to each his own great driving power without a Director of Railways between them and himself.

In February, 1917, therefore, the transition from the organization of September, 1916, to the new D.G.T. organization having been completed and responsibility having been accepted by the D.G.T. from the 1st January, 1917, the appointment of Director of Railways was abolished and Brigadier-General J. H. Twiss returned to England, confident that history would do him justice for all the work he had done in face of the difficulties, described in Phases I and II, to overcome which he was never given the power or the resources.

In November, 1916, Colonel W. D. Waghorn had handed over the post of C.R.C.E. to Colonel D. Lyell in order to act as Director of Railways under Sir Eric Geddes while the existence of that appointment was under consideration. In January, 1917, the abolition of the appointment having been decided, Colonel Waghorn was transferred to become Chief Engineer of a corps. His organization continued on the sound lines he had laid down as the C.R.C.E., and he had accomplished more than could be expected from the limited means placed at his disposal. His organization had passed through difficult times since its creation *ab initio*.

Under his new organization the D.G.T. himself dealt direct with fourteen directors or heads of departments, and he was

also D.G.M.R. in London. Only a Hercules, such as Sir Eric Geddes most certainly was, could have handled this number and driven them all.

Although the D.G.T. did not accept complete responsibility till 1st January, 1917, he was throughout the last quarter of 1916 establishing the personnel of his organization and their offices at a great pace, and already using his wide powers to pour resources into the transportation system.

As a result of his representations the War Cabinet ordered drastic reductions in railway facilities at home, so as to release personnel, rolling stock and material for France. A considerable mileage of existing railway track in the United Kingdom was transferred, and Canada did the same with 300 miles of her track. The British railways sent many locomotives and 20,000 wagons to France and arranged to manufacture 7,000 more wagons, while 300 locomotives were to be manufactured in the U.K., Canada and the U.S.A. These countries also undertook to produce many other items of essential plant and material, e.g., permanent way, machinery for workshops, roadmaking and quarrying plant, machinery and cranes for ports, timber and coal.

CHAPTER XXVIII

TRANSPORTATION ON THE WESTERN FRONT DURING 1917

Docks in 1917—Railways—Transportation Troops Roads—
Inland Water Transport in 1917—Transportation Stores—
Calais Conference, March, 1917—Arras, Messines and Pas-
schendaete—Overland route to Italy and the Middle East.

The events of 1917 which may be said to have set the tasks for the Transportation Service were :—

An exceptionally severe frost set in early in January and continued without interruption through February almost paralysing transportation. The canals were frozen and the succeeding thaw broke up the roads and the ground generally.

The replacement of Marshal Joffre by General Nivelle in the High Command caused a complete change in the plans for operations in 1917. Whereas Joffre had intended to use mainly the British Army for a continued offensive in the Somme area extending to Arras, Nivelle's plan, approved on 16th January, 1917, was intended to use mainly the French Army in an offensive in Champagne across the Chemin des Dames, and to use the British Army only in a preliminary diversionary offensive at Arras. However the enemy caused operations to take quite a different course.

The German withdrawal at the end of February and during March from their Somme salient back to their Hindenburg line left a completely devastated and cratered area in which all forms of communication and water supply were demolished with unprecedented totality.

In February the British front was extended twenty miles south to the Amiens-Roye road, adding, of course, a communication area behind it.

In April the British carried out their offensive at Arras making an important limited advance.

In June the almost perfect British offensive of Messines made another important limited advance.

At the beginning of the same month the British left flank was extended to the sea at Nieuport with the communication area behind this extension.

At the end of June a new overland service was opened from Cherbourg through Modane and Italy to Taranto on the Adriatic to serve the Macedonian and Middle East theatres of war.

From 31st July to early December the long hard-fought offensive of Passchendaele dragged on.

On 6th November began the movement of five British divisions to Italy.

On 20th November the battle of Cambrai proved to be a greater success than expected, and caused a considerable forward bulge in the line, subsequently much reduced by German counter-attacks.

DOCKS IN 1917

We return to the work of the D.G.T. and his Transportation Service preparing for the foregoing events and playing their most important and essential part in them throughout 1917.

In order to reduce the congestion at the ports, orders were issued that depots were to be removed from the sites in port areas to sites some distance away and that the ports were to be used for transit only. It was long before this work was completed but the cessation of dumping in the port areas gradually created a vast improvement in the turn-round of shipping.

The distribution of responsibility and duties was that the Q.M.G. in France demanded from the War Office what the B.E.F. required, the W.O. arranged for its provision and shipment, the Ministry of Shipping allotted the vessels, the navy controlled their movements at sea to ensure safety, and the D.G.T. took over the cargoes on arrival and delivered them to the destination named by the Q.M.G. The principle was laid down that any man or animal that walked off a ship would continue as before to be directed by the naval authorities and base commandants, while anything that had to be lifted off a ship would be dealt with by the Docks Directorate.

The Docks Directorate was organized in two branches—

administrative and engineering. Between December, 1916, and December, 1918, the number of cranes on shore was increased from 121 to 314, and the floating cranes for light lifts were increased to thirty-six. Three large floating cranes were provided, one of 60-tons and two of 30-tons lift, operated by the navy. Six floating grain elevators were provided, and also two floating, and therefore mobile, electric power stations.

As a result of these improvements the import into France was increased from a weekly average of 160,000 tons to 224,000 tons, the maximum weekly import being 240,000 tons. The time spent by ships in ports was halved.

The appointment of a Chief Engineer for Port Construction became necessary for reconstruction of ports in France and in Belgium when we advanced. The post was under consideration in December, 1916, but negotiations with the Governments of France and Belgium were not concluded for some months.

The first actual work of this department was the construction of the termini at Dunkirk, Calais, Dieppe and Cherbourg for the Channel ferry which started from Richborough in England. These were not completed till early 1918, but the department was engaged meanwhile on a variety of works mostly for the Admiralty at Dunkirk.

A service of barges on the Channel ferry began to operate in December, 1916. During two years a fleet of sixty tugs and 160 craft delivered 10,000 barge loads at inland depots. The total deadweight tonnage delivered was 1,400,000 tons, of which 1 million were delivered at inland depots. This traffic was handled by the I.W.T. Dept.

RAILWAYS IN 1917

We have already referred to Sir Eric Geddes' efforts during the last quarter of 1916 to increase the quantity of locomotives and rolling stock in France. The first quarter of 1917 saw the arrival of a considerable number and the increase was maintained at a satisfactory rate throughout 1917 and 1918. At the end of 1916 sixty-two locomotives had been put into traffic. There was, however, an instalment of the orders

placed by Brigadier-General Twiss. By the end of 1917 the number had grown to 753 and by the end of 1918 to 1,205, to which figures must be added perhaps 200 locomotives rescued from the Belgian railways and hired by the British. Four hundred and fifty of the locomotives put into traffic in 1917 arrived on their own wheels having been taken off the railways of Great Britain as the result of the orders issued by the War Cabinet. Another result of these orders was the release from the British railways of 20,000 railway wagons. In November, 1916, the manufacture of 29,000 new wagons had been ordered by the D.G.T. but of course it was months before they were in traffic. By the end of the war about 34,000 railway wagons had been imported of which approximately 30,000 were part of the stock of the railways in Britain; 1,000 were privately owned and 23,000 were specially built. About 40,000 of these wagons were imported complete, the remainder had to be erected in France. The Chief Mechanical Engineer, Col. L. S. Simpson, established his main workshop at St. Etienne near Rouen, with a small shop at Borre. By December, 1918, he was employing five standard-gauge workshop companies and five miscellaneous trade companies. The wagon erecting and maintenance was done at Audruicq, manned by seven wagon-erecting companies of experienced personnel. The C.M.E. also had three electrical units. Of course, a large amount of machinery and plant was imported to equip the workshops. The British locomotives and also many French locomotives were operated in traffic by a British personnel of 10,000 to 12,000 men of the R.O.D.

The movement of armoured tanks created special problems for the Transportation Service owing to their width and weight (from 27 to 40 tons), and the difficulty of loading and offloading them. Special railway wagons had to be designed and 400 of them built for transport of tanks by rail.

The foregoing increase in locomotives and rolling stock of course produced a corresponding increase in the personnel required to operate them, which meant that far more help had to be given to the French. Whereas in March, 1917, the R.O.D. had been hauling ten trains per day over the French

main lines, in October the number was 341. In addition they had undertaken the operation of eight more depots and four sections of forward lines. They also operated between St. Pol and Arras, Doullens and Arras, Morris and Armentières, Candas and Doullens, Romescamps and Blargies, Rouen and Abancourt. They continued, of course, to operate the lines already taken over in 1915 and 1916. By December, 1916, the R.O.D. was moving 60 per cent of the loaded trains run for the B.E.F. The Light Railway Directorate was also working the traffic on all the L.R. laid by the B.E.F.

During the year 789 miles of standard-gauge track were built, as compared with 417 in 1916. Of this, 442 miles were laid during the three months March, April and May in preparation for the Arras and Messines offensives.

Before the arrival of the D.G.T. the D.R.T. had laid down a programme for the construction and working of 328 miles of light railway, of which eighty miles were in operation. Before the end of October 1916 the D.G.T. had ordered 1,000 miles of L.R. track and 480 steam locomotives. By April 1916, 200 miles were being operated. During 1917, 1,000 miles were laid. Whereas in January 1917, L.R. were carrying 1,300 tons and a few working parties daily, at the end of September 1917, they were carrying 20,000 tons and 30,000 men daily.

L.R. were organized, managed and worked as a complete railway system under a separate directorate, and by railway experts and experienced railway personnel. For this purpose they employed up to twenty-three operating companies, five train crew companies, two miscellaneous trades companies and three workshop companies. The number of construction troops (mainly Canadian) of course varied. Workshops were established at Berguette. L.R. operated approximately up to the Group Stations in the medium artillery zone, and beyond these, the tramways and ropeways under C.Es. took over.

TRANSPORTATION TROOPS IN 1917

The D.G.T. negotiated with the general managers of railways in Great Britain and Ireland to increase the number of military

railway units of all types recruited from their skilled personnel. We have noted that Brigadier General Twiss had in July, 1916, applied for railway units from Canada. The D.G.T. renewed this request, and increased the number asked for. The British Government raised this question with Dominion Governments who, as usual, responded generously and promptly. At the end of Chapter VI will be found a list of the military transportation units of all types in France in December, 1918. The main features of this satisfactory list may be said to be: sixty-five operating companies (standard gauge), of which fifty-four were from the United Kingdom, seventeen operating companies for light railways of which four were from the United Kingdom, thirty-four railway construction companies, of which thirty-two were from the United Kingdom, thirteen railway construction battalions from Canada, thirty-three companies of various types for workshops or for erection, maintenance and running of locomotives and rolling stock.

In describing Phases I and II we have given year by year, up to the end of 1916, the numbers of units of each type which arrived in France. The difference between these numbers and the order of battle in December, 1918, is considerable. Nearly all this increase occurred during the year 1917, and much of it during the first three months.

It is of historical and administrative interest to note that in the spring of 1917 an experiment was made of engaging on a three months' contract eight companies of civilian expert railway platelayers under the control of a civilian railway official. For the reasons given on page 223 of *H.T.W.F.* the experiment was not considered to have given satisfactory results and the engagement was not renewed at the end of the three months. A similar experiment had been tried in the Crimea in 1855, in Egypt in 1882 and in the Sudan in 1884 and in each case had proved unsatisfactory. On the other hand throughout 1915 and 1916 the system of arranging with civilian railway companies to recruit their expert personnel, to be organized in military units on military terms of commission and enlistment, and on various establishments agreed between the War Office and the Railway Executive Committee, had proved highly

successful and efficient, both from a technical and a military point of view. Such a system was therefore continued till the end of the war.

Prior to the creation of the Transportation Service under the D.G.T. the Directorates of Railways and I.W.T. together had employed sixty-two units of various types with a total strength of 17,500. In January, 1917, it was estimated that for all the transportation services, as they existed at that date, 66,000 personnel were required, and for the future, an establishment was drawn up for 345 units of all types, totalling 94,000. This was approved but never reached.

It is of historical interest to note that in May, 1917, the Adjutant-General at the War Office raised the question whether it would be advisable for all personnel employed on every kind of transportation duty to be transferred to a new and separate Transportation Corps. On pages 493-6 of *H., T.W.F.*, the pros and cons of this proposal are discussed. Here we will only say that a very large percentage of the personnel were engineers or engineering artisans, and prided themselves on this fact. They had been commissioned or enlisted in the Royal Engineers and were proud of belonging to a military technical Corps of considerable age with traditions from many previous wars. They were very averse to being transferred to a new corps the name of which did not contain the word *engineer*. The minority who were without expert or engineering qualifications had the same objections to being transferred to a new corps under another name. The proposal was dropped.

In addition to the foregoing figures the Transportation Service employed as much unskilled labour as all the other army services put together. On the date of the Armistice, labour units totalling 41,000 were being used on roads, 29,000 on railways, 11,000 by the Docks Directorate and 8,000 in other transportation departments. In Chapter XXII is explained the system whereby all labour units were placed in a pool for distribution from time to time to meet the varying demands for their services. In practice, however, the allotment of labour units to each type of work was disturbed as little as possible, because it was found that unskilled men soon learn

the elements of a trade and many of them become sufficiently skilled for upgrading or even for supervisory tasks.

By the end of August, 1917, the high rate of casualties had seriously depleted the strength of the B.E.F. Infantry units were 72,000 below establishment, and it was expected that by the end of October the deficit would be 100,000. The C.-in-C. therefore decided that there must be a comb-out of the men of physical category "A" from the L. of C. and bases for transfer to the infantry. The Transportation Service was expected to supply its quota, although it was 17,000, or 20 per cent, short of the numbers that had been estimated to be required. The comb-out, in the previous spring, of transportation men from combatant units was now to be reversed. A rigorous examination, however, revealed that transportation would be crippled if more than 3,300 men were given up, and this was the number eventually transferred, about half coming from railway construction and the remainder from the light railways.

ROADS IN 1917

In Chapter XXII we referred to the fact that the Director of Works handed over responsibility for roads on the L. of C. to the Director of Roads in the Transportation Service, but it was not till June, 1917, that the transfer of responsibility was complete. In army areas the responsibility of D.Rds. ceased at the D.G.T. line already defined. Beyond that C.Es. of armies and corps both made and maintained the roads in their own areas. Long before June, 1917, however, D.Rds. was importing plant, developing quarries and starting new work. The output of the quarries at Marquise, for instance, was trebled during 1917. During the winter of 1916/17 there was (as in previous winters) a crisis on the roads. In Chapter XXII it is noted that the D.W. had used wooden slabs for rapid road construction and had started work in the forests to supply these slabs. D.Rds. and Director of Forestry developed this system considerably, and half a million slabs were supplied for the purpose. To follow up an advance rapidly this was the only method which could produce results in a reasonable time.

During 1917, the new roads built and depot areas metalled were equivalent to 85 miles of 18-ft. roadway, while 190 miles were reconstructed. At the end of 1917, D.Rds. was maintaining 1,900 miles of roads in army areas, and 1,200 miles elsewhere. The extensions of the front of the B.E.F. to the south and north had of course added to the length of road to be maintained.

INLAND WATER TRANSPORT IN 1917

The extension of the front to Nieuport added the Dunkirk-Furnes and the Furnes-Nieuport canals to the charge of the I.W.T. Directorate. Large quantities of road metal and engineer stores were taken direct from sea-going vessels at Dunkirk and transported inland. Troops were carried by barge to the front and the wounded brought back. Floating filtration units were stationed at Bergues, and a service of water-barges was run to water-points on the Furnes-Nieuport canal.

In 1917, the traffic carried by I.W.T. was treble that of 1916. Their production and distribution of filtered water was quadrupled, up to 32 million gallons. The cross-channel traffic from Richborough to inland depots in France grew to 2,000 tons per day, of which half was ammunition.

TRANSPORTATION STORES

During 1914 and early 1915 the indents from the D.R.T. in France were dealt with by the Inspector of Iron Structures under the D.F.W. at the War Office. About March, 1915, a new branch under the Director of Movements took over the work of supplying railway stores to overseas theatres of war. In France up to the end of 1916 there was one Railway Stores and Material Depot at Audruicq. The I.W.T. depots were established in England at Richborough and Dover.

When the D.G.T. took all forms of transportation under his control and proceeded to expand their activities and resources enormously, the stores depot at Audruicq became the bottleneck through which an attempt was made to pump all this

vast inflation, and 1917 became a terrible year for the stores organization. The increased volume of demands swelled so suddenly that the existing stores personnel (less than 200 all told) were overwhelmed, not only by the demands (in February ten times as many as the year before), but also by the rapid increase in the arrivals of stores, which, however, throughout the year could never catch up with demands. It was easier to increase the personnel of the organization than the acreage of the depot and the vast mileage of railway sidings serving it. The personnel was quickly increased to a depot headquarters and eight stores companies totalling about 1,000 (skilled) of all ranks. Unskilled labour increased from 550 to about 3,500. A Chief Storekeeper Lieut.-Colonel T. R. Kellner with suitable staff was installed in the D.G.T.'s office at G.H.Q.

Not until the autumn of 1917 was the "new yard" extension completed at Audruicq. In the meantime, an overflow depot had been improvised at Zenghem, seven miles away, and that overflow also proceeded to grow. A depot was built at Berguette for light railways, at Aire for the I.W.T. and at Borre for the R.O.D. Another store depot was opened at Oisel near Rouen. The confusion at the depots during this period of expansion was considerable and caused many delays in meeting demands. Every transportation directorate was living from hand to mouth, and it was not until 1918 that the situation became really satisfactory, as we shall relate farther on.

THE CALAIS CONFERENCE, MARCH, 1917

Throughout the winter of 1916/17 there was continual French pressure for more railway assistance from the British culminating in one comprehensive claim that the British should undertake the movement and working of all the traffic required by the B.E.F. In January and February there were conferences between French and British to decide the amount of traffic required for the coming British offensives and the amount that the French said they could carry. As this question affected the date on which the operations could begin, a conference between members of the two governments, including

the respective Prime Ministers accompanied by their transportation experts, was arranged to take place at Calais on 26th February. When the conference assembled, however, Mr. Lloyd George sprang a surprise containing very disturbing and far-reaching proposals for the reorganization of the High Command in France. The statesmen forthwith lost all interest in railway problems and left them to their respective experts to discuss and settle, and they, of course, were the best people to deal with the matter.

Sir Eric Geddes was as anxious as the French that the British should undertake to work all traffic required by the B.E.F., and in fact had already fixed this as the goal to which he was working; but even a magician could not by a wave of his wand, produce this result immediately. Sir Eric Geddes was able to prove, however, that he had already taken all the necessary steps to reach the desired goal at the earliest possible moment. As a matter of fact, it was not until the last three months of 1918 that the British were moving and working all the traffic of the B.E.F. The French were obliged to adopt a *non passamus* attitude concerning the tonnage of traffic they could handle. The upshot was that the French stated the maximum that they could move to railheads for the B.E.F. as 180 trains per day, but that during an intensive effort lasting one fortnight (at a date to be selected) they would increase this to 200 trains per day. This was agreed as the transportation ration for the B.E.F., subject to various conditions. Subsequently it was found that the British could manage with less tonnage than they had asked for and the French were able to deliver more than they had promised, so all was well.

The German withdrawal from the Somme salient to the Hindenburg line, beginning late in February and accompanied by total demolition of all communications, did in fact throw a great strain on the Transportation Service at a time when they were already being pressed to carry out preparations for the Arras and Messines offensives. Fortunately the expansion of their organization and resources was already producing appreciable results.

ARRAS, MESSINES AND PASSCHENDAELE

The offensive at Arras opened on 9th April, 1917, Messines on 7th June, and the battle of Flanders restarted on 31st July, culminating in the battle of Passchendaele. The battle of Cambrai in November was a later improvisation.

In the preparations for these offensives which began to be considered in November, 1916, and were somewhat altered by the adoption of General Nivelle's plan on 16th January, the broad idea was to improve railway facilities first on the southern part of the front, especially behind the Third Army (Arras) and the First Army, and later behind the northern front. The Somme front behind the Fifth Army was by now fairly well served. The German withdrawal made it also possible to repair and reopen traffic on the Seine-Somme canal for a length of seventeen miles, a reconstruction that required eight weeks to complete.

In early 1917, the strength of the B.E.F. had reached its peak—eighty-two divisions, and the supply of artillery (including large numbers of heavy guns and lavish ammunition) and of all other types of equipment and stores was approaching the maximum it ever attained in the war, but before the end of the year the serious number of casualties produced, as we shall describe later, a crisis in man-power.

As soon as the fronts on which the offensives were to be launched had been selected, it became necessary to increase the number of railheads. The sector chosen for the Arras offensive was served by only two single lines from St. Pol and from Doullens, and it was found necessary to construct an additional sixty-five miles of standard-gauge line including sidings. In the Messines sector ninety-miles of standard-gauge railway had to be built, although the system on this front had been continuously developed and improved from 1914 onwards. By the date of the Messines offensive, both the standard and light railway systems were adequate.

The following figures show the average number of standard-gauge trains run daily during the months in which the 1917 battles were being fought :—

Month	To Rail-heads	On the L. of C.	Total	Operations during the month
April	121	74	195	Arras
June	127	98	225	Messines
August	149	96	245	Ypres III
October	160	101	261	Passchendaele
November	135	93	228	Cambrai

THE OVERLAND ROUTE TO ITALY AND THE MIDDLE EAST

During 1916, enemy submarines had caused serious losses to shipping in the Mediterranean. At the same time it had become very desirable to give opportunities for leave home to men serving in Macedonia, Egypt and Mesopotamia. On 3rd January, 1917, the Prime Minister instructed Sir Eric Geddes to consider the possibility of an overland route from a French port to southern Italy, and thence, after crossing the Adriatic, to Salonika. After a preliminary report by the D.G.T. recommending investigation of a route from Cherbourg via Modane to Taranto, Sir Guy Calthrop, General Manager of the London and North Western Railway, accompanied by some staff officers and representatives of army services, went to Paris and Rome to investigate and discuss the proposal. On 7th February, they produced a definite scheme and on 27th March, 1917, the Cabinet ordered work to proceed.

The main difficulties were lack of locomotives and rolling stock, and the considerable amount of work required at Cherbourg and Taranto. The British provided and worked the trains for the French on their northern system, the French continued as far as the Italian frontier, where Italian trains took up the service in return for British coal which was so much needed both for railways and industry. From Cherbourg to Taranto was 1,450 miles. At the same time the British in Macedonia developed a route thirty-six miles long from the head of the gulf of Corinth to Bralo and thence to Salonika (200 miles)

by the Athens-Bralo-Larissa-Salonika railway. Considerable work was necessary on rest camps at Cherbourg and Taranto, and at halting places along the route.

The first personnel train left Cherbourg on 28th June, 1917, and the first consignment of goods on 8th August, but not until the week ending 27th October, were two trains a day running regularly. On 30th October, however, the service had to be suspended because the Italian defeat at Caporetto required the French railway system to start, on 6th November, the movement of five British and five French divisions to Italy and to maintain them after arrival. In January, 1918, the service from Cherbourg to Taranto was resumed and by the end of March it was running two and a half trains a day. The serious military situation in France during March and April caused another gap in the service, but it was resumed at the end of April and reached three trains a day in June, 1918, when it had to be reduced to one train a day.

By the end of 1918, the overland route had carried 174,000 tons deadweight, nearly all of it southward, and 142,000 passengers southward and 182,000 northward. The saving in shipping and the benefit of leave for the men in the Middle East had certainly justified the establishment of the service.

The responsibility for opening the route in conjunction with the French and Italians and for supervising the British arrangements was at first placed on British G.H.Q., France, and the D.G.T. there. It was later transferred to the War Office, but when we had a force in Italy the arrangements were again placed under the D.G.T., France, as far as Modane, where the D.D.G.T. of the British force in Italy took over. Sir Eric Geddes had placed Brigadier-General Grey in charge of the opening of the whole route to Italy, and when the War Office took over he was promoted to Major-General, as G.O.C., Mediterranean L. of C. When G.H.Q., France, resumed control in France, Major-General Grey became D.D.G.T., Italy.

On 24th October, 1917, the Italian front was broken at Caporetto, and a scheme, previously worked out for reinforcing Italy from the battlefield in France, was put into force. The maximum capacity of the coast route via Ventimiglia was

twenty trains a day, and of the route via Modane and the Mont Cenis tunnel twenty-one trains a day, with a net load of 260 tons per train on each route. The transport by rail of the five British divisions was undertaken by the French and Italians. The British intermediary staff was established on the route and *haltes repas* and depots for the British arranged by the G.O.C., Mediterranean L. of C.

CHAPTER XXIX

TRANSPORTATION ON THE WESTERN FRONT IN EARLY 1918

Preparations to meet the German spring offensive—Roads in early 1918—Shipping situation—Preparation for demolitions and withdrawal—Summary of Transportation situation on 20th March.

THE events which were to set the tasks for the Transportation Service during the first half of 1918 were :—

A further extension of the British front to the south in January, 1918.

The defensive preparations up till March to meet the anticipated German attack.

The German offensive against the Third and Fifth Armies, which opened on 21st March and halted just short of Amiens on 4th April.

The appointment of Foch as Generalissimo on 26th March.

The German offensive against the First Army (including the Portuguese) on 9th April, extending to the Messines and Ypres front of the Second Army and halted just short of Hazebrouk, on 29th April.

The cessation of German offensives against the B.E.F. at the end of April.

The German victory on the Chemin des Dames on 27th May, producing a large enemy bridgehead south of the Marne, but halted on 2nd June.

The French counter-attack under General Fayolle towards Mery against the Western flank of the German salient on 11th to 13th June.

The unsuccessful German attack on both sides of Rheims on 15th July.

PREPARATIONS TO MEET THE GERMAN SPRING OFFENSIVE

The year 1918, in strong contrast to the three previous years of siege warfare, produced a war of manœuvre. At first powerful assaults by the Germans caused deep retreats by the

allies on several sectors, then a period of stabilization of the allied front was followed by a general advance and pursuit which defeated the entire German Army and caused them to sue for an armistice. During these events the Transportation Service proved itself to be a strategic weapon in the hands of the C.-in-C. as it had been, but not so obviously to all, when warfare had been static and offensives limited in scope.

In the preparations to meet the anticipated great spring offensive the importance of the Transportation Service, and especially of the standard-gauge railways, was fully recognized and taken into full consideration in preparing strategic and tactical plans. Surveying the whole front from the sea to Switzerland the main aims of the allies were threefold—to prevent the enemy from separating the British and French forces, to cover Paris and to cover the Channel ports. The avowed intention was to maintain the existing front and to make no voluntary withdrawal, but provision had to be made for retirement supposing the enemy succeeded in making deep penetrations.

A scheme, therefore, was prepared to vacate all ground north of the Somme and to construct new defences along the valley of that river. In connexion with such a wholesale withdrawal it was essential to delay as long as possible the arrival of the enemy at the Channel ports so as to give as much time as possible for the evacuation of the vast accumulation of munitions and supplies in the northern area. Greater depth was therefore added to the defences covering the ports by constructing a G.H.Q. defence belt in rear of the First and Second British Armies.

The transportation system was examined afresh to ascertain whether trunk feeder lines from bases to the front were sufficient in number and capacity, whether lateral communications behind the whole front for large strategic movements of reinforcements were sufficiently far back to be unhindered by even deep penetrations, whether lateral communications between the army areas sufficed for big tactical movements and whether the distribution service within army areas had the required capacity.

A detailed scheme was prepared for a large strategic move of twenty French divisions from the French front to reinforce the British front and vice versa. A detailed scheme was also prepared for bringing back to the front in France the British and French divisions in Italy, plus an Italian corps.

In the course of these investigations it became apparent that, when, on 30th January, 1918, the Fifth Army under General Sir Henry Gough had extended the British front southward by relieving the French Tenth Army as far as to Barisis, they had taken over an area in which trunk feeder lines from British southern bases to the front were scarce and their capacity insufficient. It also became clear that the Compiègne-Noyon Tergnier line of supply was of great importance to the Fifth Army. The direct route from British southern bases to this line ran from Serqueux via Gournay and Beauvais, with a capacity of only twelve trains per day. A large amount of work would thus be needed at Serqueux and on the Gournay-Beauvais section. Many minor works were also necessary in the forward portion of the Fifth Army area. Elsewhere the front of the B.E.F. was considered to be adequately served by trunk feeders, but in the Third Army area a new line was being constructed from a junction on the Candas-Achiet line to near Le Transloy to serve the southern part of the area; and to increase the safety of communication within the army area a direct line was being laid from Péronne to Etrécourt.

For the very important purpose of large lateral strategic movements of troops we have already explained the system of lateral trunk lines existing in 1916 in rear of army areas and the work then undertaken to add to them and to increase their capacity. Many other works for that purpose had been continuously in progress since then, but the D.G.T. had to draw the attention of the staff to the fact that four-fifths of the traffic from north to south and east travelled through Amiens itself or its outskirts, and that if the enemy penetrated far enough to threaten Amiens the main lateral communications behind the allied fronts would be endangered. Early in March it was decided to widen this bottleneck by the con-

struction of a line $9\frac{1}{2}$ miles long, but when the offensive began less than three weeks later this line had not been completed, and the railway units working on it were used to construct defences. When we describe the results of the enemy's offensive it will be found that far more comprehensive railway construction had to be hastily improvised to give adequate lateral communication well in rear of Amiens, and to provide sufficient railway crossings over the Somme and connexions to the northern system.

For tactical lateral moves between armies some improvements were found to be necessary. In such moves the light railways were able to supplement the standard-gauge, but they were short of operating personnel. By the middle of March, 1918, a lateral light railway had been constructed about three miles behind the front trench system to connect up the light railway systems of all the armies. In January, 1918, it had been decided to construct another L.R. main lateral about seven miles behind the front trenches with certain feeders running westward, but this work was not completed when the enemy offensive began. As regards distribution in the army areas the service by standard-gauge railways supplemented by L.R. was, generally speaking, adequate.

It is not within the scope of this history of what was actually carried out, to embark on a discussion of the interesting technical question whether it would have given a better, speedier and cheaper service to extend the standard-gauge system along many of the routes where light railways were in fact constructed.

ROADS DURING EARLY 1918

By 1918 the demands for maintenance of roads and for construction of new ones, especially the metalling of yards at railheads each equivalent to several miles of road, had grown out of all proportion to the amount of stone available, although the output of local quarries and the import of road metal had increased threefold. The Director of Roads was maintaining 1,600 miles of roads, and Chief Engineers of corps and armies were also responsible for very long distances. In the winter

of 1917/18 there was again, as in previous years, a road crisis due to weather combined with the destructive effect of the large number of 3-ton lorries with their narrow solid rubber tyres.

In order to curtail additional demands the General Staff issued a plan of the roads to be maintained. In October, 1917, they had selected the roads required for strategic movements, including two lateral roads approximately parallel to and extending along the whole front *then* held by the British. The forward lateral was generally about ten miles, but for a long stretch only four to six miles behind the front trenches. The rear lateral in the north was about fifteen miles, and in the south was as much as forty miles behind the front.

In January, 1918, G.H.Q. took further control of demands for roads and their maintenance by issuing a map showing the strategic roads to be maintained in army areas, and they delegated to army commanders the selection of one road for each division from railhead and one lateral road connecting divisional areas. Other types of roads and yards were also specified.

We have already seen that the construction of L.R. for distribution in army areas had been started in the hope of reducing road traffic. Although by the beginning of 1918 there was a large mileage of L.R. system in operation in forward areas, the traffic on the roads had not, however, been reduced; on the contrary it had increased, in spite of the great help being provided by the light railways.

By March, 1918, the I.W.T. was able to carry all the traffic offered to them on the canals available.

SHIPPING SITUATION IN EARLY 1918

Although during 1917 the submarine menace, which in April and May had threatened to bring about the starvation of the British people, had been mastered and, by January, 1918, was being rapidly reduced, yet the shipping situation was still serious owing to the very heavy demands from all theatres of war. In France the great increase in transportation capacity

had had the same effect upon the army as the construction of roads and railways has upon any country in peace-time. Supply creates demand. In 1917 and 1918 the production of munitions at home was abundant, and as the facilities for their transport to the front had, as we have shown, been greatly increased, the B.E.F. in France, which in munitions of all kinds, had lived like a pauper in 1914 and early 1915, was now in these respects fighting a war *de luxe*. There is no doubt that after tightening their munition belts in 1914-15 they had become munition gourmets by 1918. Most of the expenditure was justifiable and was having a wonderful effect upon the winning of the war, but there was certainly a tendency to be wasteful and to make unreasonable demands for munitions and therefore for their transport. In January, 1918, G.H.Q. issued a circular to all armies to curb this tendency to waste. In this circular they laid down programmes for roads and light railways and required demands for extensions of or additions to the standard-gauge system to be referred to them, with the single exception of gun spurs which remained an army responsibility. Though G.H.Q. could thus exercise some control of their own armies' demands for traffic, they could not control the demands which the enemy was about to force upon our transportation service in order to serve the large-scale defensive operations of 1918. We should also remember that in 1918 we enjoyed a still further increase to our heavy artillery and its ammunition and to our tank forces. These required specially difficult services from Transportation.

The estimates which were made of the volume of traffic required by the B.E.F. in 1918 and its distribution among armies are given on pp. 356-9 of *H.T.W.F.* Early in 1918 the R.O.D. took over the working of certain of the Nord lines near the front.

PREPARATION FOR DEMOLITIONS AND WITHDRAWAL 1918

Towards the end of 1917 G.H.Q. had called for schemes to be prepared for demolitions. Discussion ensued whether transportation engineers or army engineers were to be responsible for preparing for the destruction of railway bridges, track and

rolling stock which could not be evacuated and transportation structures and equipment. Also, should transportation or army engineers fire the charges, and by whose orders and when? If a railway bridge over a road were destroyed it might hinder the movement of troops, while a road bridge might easily fall upon and block an important railway line. There were several similar questions, and at the end of February 1918, G.H.Q. gave a general ruling that for the demolition of railway bridges, breaking up of railway track and destruction of rolling stock that could not be evacuated, the local R.C.E. would be responsible and would carry out the demolition when ordered by army headquarters. We shall presently see that the results obtained by this system were not satisfactory and that G.H.Q. instructions had to be amended (see *L.W. by R.T.*, pp. 40, 41).

The E.-in-C. and the I.W.T. Directorate studied the subject of inundations in the area between St. Omer and Watten. Two new barrages were constructed across the river Aa to make the flooding possible, but Marshal Foch reserved to himself the power to order the operation of this scheme.

Arrangements for withdrawal and evacuation of areas were worked out in great detail. It was the duty of R.C.Es. to arrange for the haulage of heavy guns on railway mountings from emplacement to emplacement, and in a withdrawal the R.C.E. was made responsible for moving them back. The withdrawal scheme provided for the evacuation of establishments such as ordnance workshops and casualty clearing stations to new positions, the withdrawal of labour and of personnel not part of fighting formations, and the withdrawal, reduction or expenditure of dumps of supplies, ammunition and engineer stores, and the places at which new dumps were to be built up. Lists were prepared of each category of personnel and units, including unskilled labour, showing who would issue orders for withdrawal. The evacuation of civilians was the responsibility of the French or Belgian authorities, but the armies were concerned in the avoidance of congestion on roads and railways. The scheme, of course, included the evacuation of railway rolling stock and establishments.

SUMMARY OF THE TRANSPORTATION SITUATION ON 20TH MARCH
1918

Surveying the situation from north to south we may briefly summarize it as follows :—

Second Army area.—The standard-gauge and light railways were in thorough working order, and new construction in hand was almost complete. The roads were up to a high standard of repair.

First Army area.—Some important works in progress in the northern part had not been completed and much work on light railways was not ready. In the centre the new line under construction from Lillers to Marles-les-Mines was not complete. In the southern part of the area the railway system was well developed.

Third Army area.—The standard-gauge and light railway systems and the roads were in a very satisfactory condition. Much use had been made of timber slabs in constructing tracks across the battle-torn and devastated area behind the army.

Fifth Army area.—Only seven weeks had elapsed since the army had completed the taking over of this area from the French on 30th January. When they arrived on the 10th January it was apparent that for a defensive battle the transport facilities as a whole were not organized in sufficient depth and that over a great part of the front the railway facilities were inadequate. A considerable programme of new construction had been undertaken both for standard-gauge and for light railways. No new roads were built, but those in the rear areas were put in order. By 20th March, the more important works were ready for use but another week or ten days was required before the transportation situation could be considered satisfactory.

It was not until early in March that responsibility for the demolition of railway bridges had been definitely transferred from army to transportation engineers. The structures to be prepared and manned by demolition parties were numerous ; for instance, demolitions carried out by R.C.E. alone amounted

to 110 miles of track, twenty-two bridges and four water supplies. It is clearly shown in *L. W. by R. T.* p. 41, that the destruction of our railways had, when the time came, a material effect in bringing the German advance to a halt.

We must again remind the reader that the authorized establishment was short in strength by 19,500 men. Thus with a strength 20 per cent below that considered necessary the Transportation Service was about to undertake operations which far exceeded all expectations.

CHAPTER XXX

TRANSPORTATION DURING THE GERMAN SPRING OFFENSIVES, 1918

The attack on 21st March—Threat to the railway centre at Amiens—The German offensive against the First and Second Armies—Transportation tasks under schemes for withdrawal from the north—Transition period 30th April to 22nd July—Change in status of D.G.T.

THE ATTACK ON 21ST MARCH, 1918

ON 21st March the long-expected German offensive opened by attacks on the right of the Third Army and on the whole front of the Fifth Army. History has recorded that the attack was in such overwhelming strength that the Fifth Army, extended over a length too great for its numbers, had to make a hard fighting and prolonged retreat, inflicting great casualties on the enemy. This fighting retreat continued until the 4th April, by which time the enemy was exhausted and had failed to reach Amiens, their great strategic objective. The Fifth Army was also exhausted having sacrificed itself in this great effort, but had saved the four vital railway routes in the neighbourhood of Amiens and had made subsequent victory possible. The right of the Third Army had also of course been heavily involved.

In the Fifth Army area the first advance of the enemy was so rapid that the Transportation Service concentrated on the withdrawal of rolling stock. On the right of the Third Army the penetration was neither so deep nor so sudden, and the light railways continued to operate for a time in distributing ammunition before the rolling stock began to be withdrawn. Eventually, however, over 300 locomotives and tractors had to be disabled by removal of essential parts. All the heavy railway guns of the Third and all but two of the Fifth Army were saved.

The depth and rapidity of the enemy's penetration very soon showed that the instruction that orders to fire demolition charges must come from corps or even army headquarters would have to be modified. Authority was soon delegated to divisions, but still orders often failed to reach the demolition parties, and the C.R.C.E. advised his R.C.Es. to carry out the demolition as soon as our field guns came back to the site or the enemy was in view. In both the Third and Fifth Armies most of the standard-gauge railway bridges were demolished and 110 miles of railway track were destroyed in the Somme area. The expenditure of explosive was unexpectedly great and in some cases supplies did not reach the sites in time.

After the experience of firing demolitions in March and April, G.H.Q. issued a circular to armies cancelling previous instructions and directing that the Transportation Service was responsible for the demolition of all railway systems including permanent way, tunnels and bridges, other than those for which the French assumed responsibility; in the case of railway bridges over roads the transportation representative was to act in consultation with army headquarters, while in case of road bridges over railways the representative of the Engineer-in-Chief was to act in co-operation with the representative of the Transportation Service; in the destruction of railway water supplies, if they were also used for troops, the transportation engineer would consult with the army engineer. The Transportation Service was also responsible for demolition of locks on canals. The Director of the Army Signal Service was responsible for the destruction of that system. Armies were responsible for all other demolitions. The circular does not appear to have amended previous instructions concerning the difficult question of by whom and when the order to fire demolitions would be given. The instructions in this circular were never tested as there were to be no more large retreats on the front of the B.E.F.

Throughout the battles the traffic on standard-gauge railways reached an unprecedented intensity, augmented by the evacuation of railway personnel, material and equipment, and the dismantling of the workshops at Longueau and Amiens.

The prearranged railheads in depth proved invaluable. All the lines worked by the R.O.D. to the east of the Amiens-Arras main line were evacuated by 26th March as all the railheads had been overrun.

The outstanding difficulty for Transportation during the retreat was the passing of information and orders, owing to the cutting of telephone lines by bombardment. When orders failed to get through executive officers had to act on their own responsibility, and great use was made of dispatch riders. A.Ds.R.T. endeavoured to keep railway officials in touch with the military situation and army formations in touch with the railway situation.

We have previously referred to the importance of the neighbourhood of Amiens through which passed four-fifths of the allied traffic between north and south and east. By 27th March all stations in that area were being heavily shelled and bombed from the air. The question of improvising alternative routes was taken up with the French, and an extensive scheme for improving existing railway lines and constructing new ones was approved on 24th April, the biggest item being a new double line fifty-five miles long. By 30th April this had been pegged out on the ground, and construction began on 2nd May. By 15th July it was through and was ready for traffic by 15th August—a very remarkable feat. When the entire scheme was completed it provided three separate double railway routes across the Somme with a combined capacity of 144 trains a day in each direction. The British part in the execution was mainly the extension of works already begun for the use of British traffic—works involving much heavy construction.

If, however, the Germans had broken through at Amiens the scheme could not have been carried out, and even by the time it was completed it had become a luxury because the tide had turned. An unjustifiable risk had certainly been taken. It was the old familiar story. Thinking ahead, planning and issuing orders should be a much shorter process than constructing. In practice the reverse is often the case and it is the engineers who are expected to make up the time lost in the

council room. They frequently, but not always succeed in doing so.

On the 23rd March, G.H.Q. had arranged for a rear defence belt to be constructed from Marcelave to Cambignoul to cover Amiens. Railway units as well as many other units on the L. of C. were put on to this work, and the construction of the Amiens-avoiding railway line was stopped. Three Canadian railway battalions and the I.W.T. Repair Section moved on to this defence work. Later, on the evening of 24th March, these orders were cancelled and construction parties moved back to make a defensive belt west of Amiens. Twenty-seven miles of this belt from Flixecourt to Pas was to be constructed by personnel under the D.G.T. Brigadier-General Stewart, Deputy D.G.T. (Construction), was put in charge, and all railway units that could be made available reported to him. As none of them had been trained in such work the defences were laid out and specified by officers representing the E.-in-C. On 4th April, Brigadier-General Stewart had under his orders sixty-seven different units totalling 22,400. By 9th April the work was practically finished and the units returned to their normal employment.

THE GERMAN OFFENSIVE AGAINST THE FIRST AND SECOND ARMIES

Having been brought to a halt on the fronts of the Third and Fifth Armies, the enemy on 9th April switched his offensive to the left of the First Army on the Lys and extended it northward next day to the front of the Second Army. They broke through the sector held by the Portuguese on the First Army front and advanced very rapidly. One supply train and one heavy railway gun were captured, otherwise withdrawal of both light-railway and standard-gauge stock was effected successfully. Some barges on the canal system were also evacuated. On the Second Army front the enemy's advance was again very rapid, and evacuation of railway material and ammunition and the demolition of railway track was begun.

The arrangements worked well, and all the lines and yards east of the Ypres canal were dismantled and rail fastenings salvaged.

Four French divisions were detrained behind the Second Army, but on 23th April they were driven from Kemmel Hill. On the 29th April the arrival of British reinforcements halted the Germans just short of Hazebrouk. During the retirement the salvage of railway material and equipment was again very successful, but of course was beginning to produce congestion in the stores depots. For instance, by 21st April Audruicq had received 21,000 tons and had made no issues, and receipts continued at the rate of 2,000 tons per day.

In general the transport arrangements for the maintenance of the northern armies during the German offensive worked well, although there was again great difficulty in communicating orders and information.

Whereas behind the southern part of the British front there were few large British depots, in the north on the other hand there were great quantities of stores and many installations of all kinds. As the withdrawal of the front proceeded these were moved back by rail—ammunition to Zeneghem, Audruicq and Dannes Camiers, supplies to supply depots, engineer stores to Les Attaques, and ordnance stores to Vendronx or Outreaux near Boulogne. The railway workshops at Borre, Berguette and Aire were dismantled and evacuated.

The German attacks caused the most intensive movements of troops of the whole war by strategic and tactical trains (forty-six divisions), by bus and by march (see pp. 393-7 *H.I.W.F.*). That such movement was possible was due to the great work carried out continuously for three and a half years by the French and British in constructing and organizing a strategic and tactical railway and road system.

On 14th April, Marshal Foch, who had been appointed Generalissimo of all allied armies in France on 26th March, ordered the inundations, already arranged, to be carried out in three stages.

TRANSPORTATION TASKS UNDER SCHEMES FOR WITHDRAWAL
FROM THE NORTH

On 26th March there was a meeting under the Q.M.G. to consider measures to be taken if the enemy succeeded in separating the British and French forces. On 31st March, G.H.Q. communicated to the G.O.C., L. of C. a "Scheme X" for disposal of personnel, animals and stores that might have to be evacuated from the Amiens-Abbeville-Blargies-Dieppe area. Later this developed into "Scheme Y" with accompanying evacuation schemes for Calais and Dunkirk and for the Abbeville-Blargies-Dieppe area. During April the policy was adopted of maintaining a continuous front with the French, even though it might involve abandoning the whole area north of the Somme. A scheme for this purpose was prepared which became known as "Scheme Z."

In Scheme Z the personnel to be transferred southward numbered over 1½ millions, the stores and material were roughly estimated at 650,000 tons, and there were about ninety heavy railway guns to be moved. As a preliminary, and while the scheme was being worked out, action was taken at once to reduce stocks in depots in the north by transfer back to England. Even so, it was estimated that five-sixths of the reduced stocks would have to be destroyed owing to lack of time to remove them. The withdrawal was to be made in five stages totalling not less than twenty-eight days. It was not until early June that it was possible to co-ordinate all the departmental schemes into one Scheme Z, which even then was not complete. In the middle of July the scheme was amended and brought up to date, but by that time it had become unnecessary. Had the enemy succeeded in enforcing withdrawal from the north during the month of April, as he came very near to doing, there can be little doubt that an attempt at evacuation must have been a chaotic affair and the losses of personnel and stores would have been stupendous. In comparison, "Dunkirk" in 1940 would have been considered a minor operation. A very large amount of work required under Scheme Z was actually put in hand on railways and roads, and

in preparation for demolition of 250,000 tons of stores (see p. 406 of *H., T., W., F.*).

TRANSITION PERIOD FROM 30TH APRIL TO 22ND JULY, 1918

To the historian, and to the reader to whom all the information concerning the events of 1918 is available, it seems quite obvious that the German offensive against the British front had ceased by 30th April, that their May offensive against the French front had ceased with the German disaster at Rheims on 15th July, and it also seems obvious that the French successful counter-attack on 11th June, followed by the Australian success at Hamel on 4th July, and the German withdrawal across the Marne on 27th July marked the turn of the tide. But to Marshal Foch, the Supreme Allied Commander, and to Generals Haig and Pétain, commanding the British and French forces respectively, these events unfolded gradually and time was required to appreciate their consequences. On 30th April the British could not know for certain that they would not be seriously attacked again, and so for some time they went on working out their Scheme Z, and strengthening the line to which they had been forced back, to meet further attack, and very serious risks. Not till the French victory of 15th July at Rheims and the beginning of the German withdrawal on 20th July could Marshal Foch be certain that the time had come to prepare for an offensive. It was on the 23rd July that he issued orders for such preparations, and even then he could not have known what great success awaited him.

Consequently between 30th April and 23rd July the British were working strenuously at tasks of which many proved to be unnecessary. One cannot switch over several million men from the defensive to the offensive by a stroke of the pen. There must be a time lag. Yet, as the offensive began early in August, that time lag was by no means great, and the interval was one of strenuous work. We now relate the events of this period of uncertainty—30th April to 22nd July.

The retreat in varying depths along the whole front of the B.E.F. to the positions it held on 30th April caused a vast amount of work in reorganizing the transportation system.

The evacuated workshops and other railway installations had to be re-established on new sites, and new railheads had to be constructed in every army area. All departments opened new depots, the sites of which required railway spurs and marshalling yards. A new system of strategic and tactical roads had to be constructed, new airfields etc. required road access and the yards at the new railheads and depots had to be metalled. Personnel required accommodation on new sites. It was not until September that the D.G.T. was able to report that practically all this work was complete.

The threat of compulsory further withdrawal from north of the Somme still appeared to be imminent, so that all the work for Scheme Z was being hastened. Preparations were made for the destruction of 250,000 tons of transportation stores and equipment which there seemed little possibility of removing during a retreat, however deliberate. Schemes for the demolition of the railways during retirement had also to be prepared. Reconstruction or new construction of roads for a retreat on a large scale from north to south were put in hand over a mileage which totalled 1,170, of which 700 miles had not hitherto been maintained by the British. The scheme already referred to for providing by new construction and reconstruction a railway system of great capacity well to the west of Amiens to connect the north and south railway systems was being pushed on at great speed.

Near the end of June, as it was now probable that the B.E.F. would occupy the same front during the following winter, it was decided that the time had come to consider a light railway system for the whole front.

The German thrust across the Marne towards Paris was another serious threat to the connexion between the French and British. If it could not be stopped it would soon cut two or even three of the main routes, while a close investment of Paris would cut the fourth and last, for south and west of Paris no main double line route had been organized. As a result the number of trains moving on some portion of the Ceinture de Paris during the height of these operations varied from 146 to 181 per day.

The German offensives against the B.E.F. in April and then against the French in May and June, caused Foch to use his railway system constantly for large strategic moves. Between 17th April and 15th May, twenty-nine divisions were moved by rail, and between 27th May and 31st June, eighteen divisions, in both cases large numbers of corps and army units being of course included. There were also many local and tactical moves by rail.

All the foregoing operations had thrown a great strain on the French railway system, rolling stock and personnel; and the arrival of large American forces in 1918 increased the load. Although the Americans set to work with great energy to improve port and railway facilities it was some time before the benefit of their efforts was felt, and again it was necessary for the British to increase their assistance to the French by every means in their power.

In June, 1918, the R.O.D. took over the entire working of a group of lines round Hazebrouk and another system of lines round Frévent and Doullens. They continued as hitherto to provide traction for British trains from base ports and also for all British divisional movements. They were furnishing crews for 1,000 locomotives, and were continuously importing more rolling stock. In November, 1918, the R.O.D. numbered 18,000. During July to October they moved 89 per cent of the traffic of the B.E.F.; in October the percentage had risen to 96 and in November to 100.

CHANGE IN STATUS OF D.G.T. AT G.H.Q.

We should here note that after Sir Eric Geddes had carried out the reorganization of the transportation system, which was producing the wonderful results we have related, he was recalled to England to become First Lord of the Admiralty. He was succeeded as D.G.T. in France by his Deputy, Major-General Sir Philip Nash, K.C.M.G., C.B., who in June, 1918, passed on to become a member of the Inter-Allied National Transport Council. He was succeeded as D.G.T. by Major-General Sir Sydney Crookshank (late R.F.), K.C.M.G., C.B., C.I.E., D.S.O.,

M.V.O., but with a different status. After much consideration at the War Office and at G.H.Q., it was decided that the time had come to revert to the normal organization by placing the D.G.T. under the Q.M.G. It was realized that Sir Eric Geddes could never have carried out his great reorganization unless he had been responsible directly to the C.-in-C. As a collaborator with the Q.M.G. and A.G., but not a subordinate, the D.G.T. could save much time in settling the establishments and numbers of transportation units, and their accommodation and movement, and also in making provision for stores and equipment; but now in June, 1918, the whole machine was running fast and smoothly, and, rightly or wrongly, it was deemed desirable to place the D.G.T. in his normal position as one of the directors under the Q.M.G.

In June, 1918, Marshal Foch as Generalissimo established a *Direction Générale des Communications et des Ravitaillement aux Armées* (D.G.C.R.A.). This did not alter the system and organization of control. The *Directeur de l'Arrière* (D.A.) remained on the staff of General Pétain, C.-in-C. of the French Armies, for French military traffic but under Marshal Foch for joint allied and French traffic. The D.G.T. continued to exercise his functions for British traffic and other railway work.

CHAPTER XXXI

TRANSPORTATION DURING THE FINAL ALLIED OFFENSIVE

Railway situation in July, 1918—Plans for reopening captured railways and roads—Reconstruction of railways during the advance—Lack of roads suitable for mechanical transport—Transportation statistics—Some of the regular R.E. officers who held important transportation posts in France.

ON 23rd July Marshal Foch ordered Field-Marshal Sir Douglas Haig and General Pétain to resume the offensive as early as possible, and began to concert schemes with them for that purpose. In the almost continuous offensive that followed, the principal events affecting the tasks of the Transportation Service were :—

The battle of Amiens and victory of the Fourth Army, 8th to 11th August.

The British attack south of Arras, 21st August.

The advance of the Third Army to Bapaume, 23rd August.

The fighting advance of the Fourth Army to Péronne, 23rd to 29th August.

The storming of the Drocourt-Quéant line by the First Army, 2nd September.

The crossing of the Canal du Nord by the Third Army, 4th September.

The shattering of the Hindenburg line by the First, Third and Fourth Armies at the end of September.

The advance into Flanders by King Albert's group of armies—the Second British and the Belgian Armies with French divisions, on 28th September.

The British advance to Le Cateau, 6th to 16th October, The advance from the Ypres salient by King Albert's group of armies, 14th October.

The Fourth Army's advance to the Sambre-Oise canal at the end of October.

The advance of the First and Third Armies to the Valenciennes area, 2nd November.

The German general retreat and allied pursuit beginning 5th November.

The Armistice, 11th November.

THE RAILWAY SITUATION IN JULY, 1918

On the 23rd July when preparations for an offensive were ordered, there were several important railway junctions and sectors of line under the enemy's shell-fire as a result of our recent retreats, e.g., St. Omer – Hazebrouk – Béthune; the Amiens–Arras line had always been close to the front. There were several other sectors which caused our forward lateral strategic route to be liable to serious interruption. It was necessary that our offensive should free this lateral in the first instance, but the most important railway strategic centre in danger was Amiens, hence the choice of that area for our first great offensive battle, 8th to 11th August.

From the beginning of June and especially during the latter part of July, twenty-eight battalions from Salonika and Egypt arrived in France via Taranto and eighteen battalions and other units via Marseilles. These were moved up to the front held by the B.E.F. There was also considerable lateral movement of British and French divisions and Army units along the whole front caused by regrouping for the offensive.

PLANS FOR REOPENING CAPTURED RAILWAYS AND ROADS

We had already had plenty of experience of the thoroughness with which Germans demolish communications and devastate areas when compelled to withdraw, and they fully maintained this reputation in their great retreat in 1918. It was known, therefore, that extensive and thorough preparations must be made for reconstruction and reopening of communications by rail and road. A memorandum by Marshal Foch's *Direction Générale des Communications* laid down that from time to time, according to the amount of demolition to be encountered and the selection of routes to be reconstructed, each of the allied

armies would be allotted a zone in which that army was to repair and work the railways and roads.

British G.H.Q. laid down that the use of light railways to follow up a general advance of many miles was unsound, as the labour would be far more profitably employed in extending the standard-gauge lines along routes to be selected by G.H.Q. according to the progress of operations. As a matter of fact, however, when the advance was made, we found ourselves traversing areas in which the German and our own former light railway systems could be utilized after some repair, in order to supplement the standard-gauge, but it is doubtful, even so, whether the labour would not have been more profitably employed on increasing the rate of progress of the standard-gauge. It was recognized that the opening up of new railheads could not keep pace with the advancing front, and the Q.M.G. accordingly built up a reserve of mechanical transport for bridging the gap.

RECONSTRUCTION OF RAILWAYS DURING THE ADVANCE

The map in the pocket at the end of this volume, from *Official History—Transportation Western Front*, does not (as Colonel Henniker explains) show all the many alterations and additions to the pre war railway system made by new construction, nor all the reconstruction which had to be done. A very large scale would be necessary to include so much detail. But the map enables the reader to obtain a general idea of the amount of work done before 8th August, and during the advance from that date until the Armistice. Nor is space available to describe the details of the work, which would need a volume to itself. (See Colonel Lyell's description in *L.W.* by R.T., pp. 21-35 and Colonel Henniker's in *L.T.W.F.*, pp. 432-61.) Here we can only hope to give a general idea of how the work was planned and carried out, sufficient, we hope, to enable the reader to grasp its magnitude. Even so, it was insufficient to produce the density of traffic required to maintain the continued exploitation of victory in the face of hard fighting and strong rear guards. It is the invariable

rule of war (confirmed again in 1939-45 in spite of great improvements in transport) that, if an enemy can avoid collapse and maintain a degree of resistance, a rapid retreat will eventually impose a halt on his pursuers for the purpose of repairing demolished communications and for restocking.

As long as there were any British troops south of the Somme the reopening of the Chaulnes-Péronne railway was a British task; farther north the attack of the Third Army on 21st August freed the whole length of the Amiens-Arras main railway. Work was begun at both ends, first as a single track, later doubled. On 9th September the R.O.D. began operating the whole double line, but work was not completed before 30th September.

By the end of August the enemy was being forced back along the whole line from south of Ypres to Soissons, but up to that date heavy fighting had prevented any railhead from being advanced more than twelve miles and many of them far less. The pace was about to quicken. On 31st August, the Q.M.G. decided which lines it was intended to reconstruct, and on 9th September G.H.Q. issued an important memorandum, laying down the feeder lines from the base ports to army areas as follows:—

1. Dunkirk and Ostend — Bruges — Ghent — Antwerp — Aeschot — Bilsen — Maastricht.
2. Dunkirk — Ypres — Roulers — Courtrai — Audenarde — Brussels — Louvain — Tirlemont — Tongres.
3. Calais — Béthune — Lille — Tournai — Ath — Englien — Manage — Ottignies — Gembloux — Landen — Liège.
4. Boulogne — Arras — Douai — Valenciennes — Mons — Namur.
5. St. Quentin — Busigny — Maubeuge — Charleroi — Namur.
6. Laon — Hison — Givet — Dinant.

These lines were to be the skeleton on which developments would be built up. Thereafter whenever armies were informed what railways would be constructed or reconstructed it was always indicated whether the line was permanent, temporary,

or for technical railway purposes only. The General Staff memorandum of 9th September went on to name the lines in an area of primary importance which would have to be developed, and if the operations were successful the next area to be developed (see p. 438 of *H., T., W., F.*). This information incidentally indicated some important strategic objectives. For instance, Berlaimont was to the Germans what Amiens was to the Allies, for one mile east of it is the junction of Aulnoye, where the main trunk line from Germany (via Liège-Namur-Charleroi and Maubeuge) crossed the main lateral (Lille-Valenciennes-Hirson-Mezières). A break-through at Berlaimont would thus cut the German front in two.

The enemy supplemented his extensive and thorough demolitions with delay action mines placed on railway tracks and roads and in all types of installations, yards, depots, etc. These mines were particularly effective in dislocating traffic and imposing delay (see p. 42 of *L., W., by R. T.*).

By 14th October the armies' advance had cleared the whole of the St. Quentin-Busigny and Cambrai-Busigny lines; single track was open to a place five miles north of St. Quentin; the line from Péronne was open to Marcoing and doubled nearly the whole way; the Roisel-Hargicourt line had been relaid to standard gauge; a railhead was open half-way between Cambrai and Busigny. By the 20th the armies had crossed the Selle and Le Cateau and Wassigny were in the hands of the Allies; by the 23rd October the front ran approximately Valenciennes-Lequesnoy-Landrecies.

At a meeting of the British and French railway authorities at Busigny on 28th October, progress reports and estimates for the future disclosed that up to the 10th November at the earliest the Fourth British Army would be working from railheads far behind their front. On the Busigny-Maubeuge line a viaduct 200 yds. long and 80 ft. high had been destroyed, and at least three weeks were necessary to cross this gap. At this meeting it was agreed that the British should put in a single line deviation round the St. Bénin viaduct; the French would reconstruct the Busigny-Wassigny-Hirson line with some British help; and the British would reconstruct the

Wassigny-Le Cateau line. Railhead did not reach Wassigny till 8th November.

On the morning of 23rd October the First Army had reached the western suburbs of Valenciennes where a gap of 130 ft. had to be bridged. Valenciennes was clear of the enemy by 2nd November. There was a wide choice of routes to be reopened to give railway access to this town. It was decided to double the shorter route via Raismes, and that the Somain-Lourches and Lourches-Denain-Valenciennes railways should be restored as single lines.

By 6th September the Germans had evacuated their Lys salient and the general line of front ran Givenchy-Neuve Chapelle-Nieppe-Ploegsteert-Voormezele. The surface of the whole of the area to the east and south-east of Ypres had been so cratered and churned by the battles of the previous four years that to reconstruct any form of communication would require very considerable labour for a long period. On 28th September King Leopold's group of Armies (including the British Second Army) advanced in Flanders and by 1st October a deep salient towards Roulers had been made. The restoration of sufficient communications, particularly roads, to enable the attack to be resumed took a fortnight. On 14th October, the offensive was restarted and it advanced so rapidly that railheads for the support of the troops were left far in rear. Railhead reached Menin on 24th October and the station was working on 25th. At Comines and Wervicq railhead facilities were available on 31st. The route chosen in these parts for penetration towards Belgium from the base ports ran via Béthune and La-Bassée not via Hazebrouk.

A noteworthy instance of rapid work by the railway construction troops was the repair of the line to Lille. A new bridge was thrown across the Lys at Armentières in four days. Lille was evacuated on 17th October, and on 25th the first train ran in. Similar progress was made on the Cambrai-Péronne front where in many cases bridges had been twice or thrice destroyed and reconstructed.

We have seen that the general principle was laid down that light railways had not sufficient capacity to be relied upon as

main feeder lines between the bases and the front, and that therefore labour should not be diverted to their construction at the expense of work on the standard-gauge feeders. Nevertheless, it was found necessary in the battle-churned areas near Ypres and behind the Third and Fourth Armies while passing through the belts of British and German L.R. systems, to reconstruct some L.R. feeders in order to get the troops forward to the country beyond, and then to drop any L.R. reconstruction and rely only on standard gauge.

The reader will perhaps realize how thorough and widespread was the demolition of the railways by the Germans in their retreat, and also the great effort made and efficiency displayed by the British and Canadian railway construction troops, if he is informed that in the three months of August, September and October, 1918, no less than 1,050 miles of standard-gauge track, demolished in very numerous places, was restored for the running of traffic. To accomplish this it was necessary to lay 485 miles of new track and build 4,000 ft. run of bridging.

LACK OF ROADS SUITABLE FOR MECHANICAL TRANSPORT

The advance over country in which roads and railways had been so thoroughly destroyed caused increasing difficulty in distributing what the extending railways brought up. For previous offensives with short limited advances from long-prepared positions railheads had been dispersed laterally, but with the long rapid advances now being made by all the armies, railheads tended to become strung out one behind the other along main railway routes, with few roads fit for lorry traffic leading forward from them. Moreover the distances to be covered by M.T. columns grew longer, and the destructive effect of their solid rubber tyres became very noticeable, especially during the rains of late autumn. Congestion on the roads became acute, and the circulation of M.T. became slower.

The result was that in the early days of November when the front line ran approximately north and south, five miles east of Le Cateau, the heads of steel were at Avèsnès, St. Bénin and

Wassigny with makeshift railheads at Cattenières, Caudry, Busigny, Honnechy, Bohain, Frésnoy and elsewhere, but the bulk of the traffic for the Fourth Army was still being dealt with at Vermand, Templeuve le Grand, Hargicourt and Bellicourt, twenty to twenty-five miles behind the front. In the last week before the Armistice this army advanced another twenty-five miles, but the destroyed viaduct at St. Bénin held up any advance of rails. At the date of the Armistice the only reliable railheads for the Fourth Army were fifty miles behind the armistice line and, owing to the state of the roads, *horse transport* was being used to carry the loads forward.

The effect of conditions prevailing between August and November upon the volume of traffic reaching railheads, and beyond them to the front, was as follows :—

It had been estimated in 1917 that to maintain simultaneous attacks on the front of three armies, while merely holding the rest of the front would require 200 trains per day to railheads, but when the time came the number actually run had never averaged more than 160. During August and September when our armies were advancing well, but not rapidly, the average daily number of trains was 153 (of which forty were ammunition trains), and at the end of September the heaviest artillery had to be left far behind. During October the figure dropped to 133, but as we have described, early in November the railheads were receiving more than the available transport beyond them could carry, and the zone of country only passable by horse transport was rapidly widening. *It was no longer possible for the armies to advance at full strength.* Little more than a thin screen to keep touch with the retreating enemy could have been kept supplied. This had been the experience of both sides in several theatres of war, whenever an attempt was made to exploit a victory by rapid pursuit along thoroughly demolished communications.

TRANSPORTATION STATISTICS

Having given a general account of Transportation Services, the facts and statistics which follow will afford some idea of

the work done. Further data of this kind is included in both *H.T.W.F.* and *L.W.* by R.I.

Standard and Metre Gauge Construction and Reconstruction

Year	New lines and sidings Miles	Reconstruction of destroyed lines Miles	Total Miles
1914	1	—	1
1915	104	—	104
1916	417	—	417
1917	652	137	789
1918	709	589	1,298
1919	9	21	30
	<hr/> 1,893 <hr/>	<hr/> 747 <hr/>	<hr/> 2,639 <hr/>

The 8th Railway Company laid the first mile in 1914. In 1915 there were four R.C.Es., and by the end of 1916, when D.G.T. took over, there were six, and altogether 522 miles had been laid. In 1917, the organization expanded to seven R.C.Es. and an A.R.C.E., and, in addition to material laid during 1917-19 in reconstructing lines destroyed by the enemy, no less than 1,007 miles were reinstated and made fit for traffic. Thus, altogether 2,639 miles of new track were laid and a total of 3,646 miles dealt with; of these totals, the work in 1918 alone covered 1,298 miles laid and 2,290 dealt with. The peak of construction was reached when 104 miles were laid in September, 242 in October and 163 in November, 1918; the week ending 6th October, during the advance through Flanders, accounted for no less than sixty-three miles. On the average, about four sets of points and crossings were required per mile. The quantity of ballast used was $9\frac{1}{2}$ million cubic yards, and consisted of red or black mine earth, sand, chalk, gravel or ashes. This represents $3\frac{1}{2}$ times the excavation which would

he involved in building the Channel Tunnel. The average lead was about thirty miles and the all-in cost worked out at less than 3 francs per cubic yard.

RAILWAY TRACK AND STORES

The following account of receipts and issues in standard-gauge track is of interest (see p. 36, *L.W. by R.T.*) :—

	Miles
British new rails and fastenings (75 lb. F.F.)	2,063
Second-hand Canadian rails and fastenings (80 lb. F.F.)	459
Second-hand B.II. rails and fastenings from British railways	206.5
	<hr/>
	2,728.5
Issued to Allies	106.5
	<hr/>
	2,622
Rails and fastenings in store unused	322
	<hr/>
British material laid by British troops	2,300
Dismantled track relaid	339
	<hr/>
Total	2,639

In March, 1918, there were 700 miles of standard-gauge railway track in reserve in France, but this would not have been enough had not 206 miles of sidings or branch lines on the British railways, and 589 miles in France been pulled up and transported for railway extensions, a considerable labour. In addition, during 1917 and 1918, 339 miles of single track were dismantled and returned to store. 459 miles of second-hand rails came from Canada.

In 1918 the organization of the Stores Department had been perfected and worked smoothly and efficiently throughout this strenuous year, especially during the last six months when so much was required of it. On one night in August, twenty-two train loads, mostly permanent way, were dispatched from store depots.

CONSTRUCTION AND RECONSTRUCTION OF BRIDGES

Year	New Construction				Reconstruction				Doublings				Total		
	Over 18-ft. Span		Under 18-ft. Span		Over 18-ft. Span		Under 18-ft. Span		Over 18-ft. Span		Under 18-ft. Span		Year	No.	Lineal ft.
	No.	Lineal ft.	No.	Lineal ft.	No.	Lineal ft.	No.	Lineal ft.	No.	Lineal ft.	No.	Lineal ft.			
1914	1	34	—	—	1	53	—	—	—	—	—	—	1914	2	87
1915	3	84	—	—	—	—	—	—	4	107	2	27	1915	5	215
1916	13	1,128	11	299	1	155	—	—	4	105	3	36	1916	33	1,854
1917	60	6,172	28	474	35	3,042	2	56	2	72	1	11	1917	158	9,827
1918	54	5,273	12	169	232	17,968	13	300	2	206	—	—	1918	313	23,511
1919	—	—	—	—	28	2,110	—	—	—	—	—	—	1919	27	2,213
Totals	150	12,750	62	942	291	23,359	15	355	12	390	6	74		525	37,917

Total new construction: 212 bridges, 13,735 lineal ft.

Total reconstruction: 306 bridges, 23,715 lineal ft.

Total doublings: 18 bridges, 454 lineal ft.

Grand total: 536 bridges, 37,917 lineal ft.

Rolling Stock

By the end of 1918, the following had been imported into France :—

Locomotives					
From British railways	...	...	...	...	450
Others	...	...	...	...	755
Total	...	...	...	...	1,205
Wagons					
From British railways	...	...	...	...	31,000
Others	...	...	...	...	23,000
Total	...	...	...	...	54,000

About two-thirds of the locomotives and wagons arrived on their wheels, the remaining third was erected in R.O.D. workshops.

Railway Operation

At the end of 1916, the R.O.D. was working 160 kilometres of standard-gauge line, and by the end of 1917, 534 kilometres. After the enemy offensive in March, 1918, a number of lines had to be abandoned, and in May, 334 kilometres were being operated. Subsequently this rose rapidly to 1,312 kilometres by the end of 1918.

Loaded wagon-kilometres moved under R.O.D. working were as follows :—

	1917	1918
January-March	3,208,980	7,648,315
April-June	4,496,979	6,771,466
July-September	7,842,375	23,368,903
October-December	9,775,791	24,064,469
Total	<u>25,324,025</u>	<u>61,853,153</u>

Docks

The total imports for the army during 1917 and 1918 amounted to roughly 25,000 dead-weight tons per day. The annual totals were 9,398,000 and 8,870,000 tons respectively, ammunition alone amounting to 2,110,000 and 2,068,000 tons. Every effort was also made to salvage material and ship it home, and this traffic amounted to 326,000 and 411,000 tons in 1917 and 1918 respectively.

Light Railways

Except in the Somme and Ancre valleys, few light railways were built before 1917, and the following gives the mileage of new lines constructed during 1917 and 1918 :—

	1917	1918
	Miles	Miles
January-March	135	214
April-June	364	202
July-September	328	297
October-December	195	73
	<u>1,022</u>	<u>786</u>

Personnel

The establishment of all transportation units of the B.E.F., as approved in 1917, was 94,000, in 345 different units. The complete order of battle is included in the table at the end of Chapter VI. It should be remembered that these establishments were never actually reached, and when 3,300 men were transferred to the infantry in August, 1917, the service was already 17,000 below establishment.

The following table shows the establishments of the units of the B.E.F. employed on railways :—

RAILWAY UNITS, 1918

Directorate	H.Q. units	Other units	Officers	Technical other ranks	Other ranks attached
D.G.T.	1	1*	82	192	85
C.R.C.E. including Canadian troops	8	59	897	24,833	1,125
Chief Mechanical Engineer	5	25	101	5,934	141
Director of Light Railways	5	35	341	9,130	373
Director for Transportation	1	16†	422	2,486	486
O.C. Railway Operating Division	6	73‡	233	18,256	1,694
A.D.G.T. Stores	5	16	106	4,020	155
Total	32	225	1,182	64,911	3,999

* Base depot for transportation troops.

† Includes sections on Mediterranean L. of C.

‡ Includes schools.

Unskilled labour

The governing factor in the rate of construction of both railways and roads was nearly always the amount of unskilled labour available. On the date of the Armistice the unskilled labour employed on all types of transportation work amounted to :—

Road construction and maintenance	...	41,000
Railways	... ..	29,000
Docks	... ..	11,000
Other transportation departments	... ..	8,000
Total		<hr/> 89,000 <hr/>

SOME OF THE REGULAR R.E. OFFICERS WHO HELD IMPORTANT
TRANSPORTATION POSTS IN FRANCE, WITH THEIR PREVIOUS
EXPERIENCE

Brigadier-General J. H. Twiss	Deputy Director Railways, South African War.
Brigadier-General W. D. Waghorn	Acting General Manager, N.W. Railway, India. Chief Engineer, military railways, South African War.
Brigadier-General V. Murray	Acting General Manager, Eastern Bengal Railway. Assistant Director Rail- ways, South African War.
Brigadier-General H. F. E. Freeland	Deputy Traffic Superinten- dent, Indian State Rail- ways. Traffic Manager, China rail- ways, during Boxer War, 1900-2.
Brigadier-General S. D'A Crookshank	Public Works Department, India.

Brigadier-General C. Magniac	Acting General Manager, Madras and S. Mahratta Railway.
Brigadier-General A. Brough	Engineering Indian State Railways.
Colonel A. M. Henniker	Deputy Assistant Director Railways, South African War.
Colonel C. F. Birney	Assistant General Manager, N.W. Railway, India.
Colonel W. K. Russell	Executive Engineer, Oudh and Rohilkhund Railway.
Lieut.-Colonel G. B. Kensington	Traffic Manager, Woolwich Arsenal.
Lieut.-Colonel L. E. Hopkins	Executive Engineer, State Railways, India.
Lieut.-Colonel G. Lubbock	Executive Engineer, State Railways, India.
Lieut.-Colonel H. E. C. Cowie	Executive Engineer, State Railways, India.
Lieut.-Colonel C. Walton	Executive Engineer, State Railways, India.
Lieut.-Colonel G. J. Watt-Smythe	Executive Engineer, State Railways, India.
Lieut.-Colonel E. P. Anderson	Assistant Engineer, N.W. Railway, India.
Lieut.-Colonel A. H. L. Mount	Assistant Engineer, N.W. Railway, India.
Lieut.-Colonel G. Walton	Traffic Superintendent, Indian State Railways.
Lieut.-Colonel G. Rhodes	Assistant Engineer, N.W. Railway, India.
Lieut.-Colonel L. Manton	Assistant Traffic Superintendent, Eastern Bengal State Railway.
Lieut.-Colonel G. A. P. Maxwell	Construction of African Railways.

- | | |
|------------------------------|--|
| Lieut.-Colonel F. D. Hammond | Mechanical Engineering.
Military Railways South
African War and later in
Nigeria. |
| Major G. H. Stallard | District Traffic Superinten-
dent, Indian State Rail-
ways. |
| Major J. P. S. Greig | Regular R.E. Railway Com-
pany, England. |

**ROYAL ENGINEERS IN THE ITALIAN
CAMPAIGN, 1917**

CHAPTER XXXII

OPERATIONS IN ITALY

(See Sketch facing page 684, and Map in pocket)

British and French troops sent to Italy, 1917—Crossing of the Piave, 1918—The pursuit after the crossing of the Piave—Survey in Italy—Works Directorate in Italy—Works for the Mediterranean L. of C.—Works for the British Expeditionary Force in Italy—Transportation in Italy—Transportation work for the Expeditionary Force—Transportation work for the Mediterranean L. of C.—Officers of the Transportation Directorate in Italy.

BRITISH AND FRENCH TROOPS SENT TO ITALY, 1917

ITALY did not join the allies until 23rd May, 1915, when she declared war on Austria and undertook an active defence of her frontier, running up the Isonzo, north-west of Trieste, thence along the Dolomites to Lake Garda and thence northwards through the mountains to Switzerland. Operations were only possible on the Isonzo sector and in the less mountainous area, called the Asiago plateau, east of Lake Garda. For two years the Italians carried out a long series of not very successful offensives on these two fronts, offensives that were costly and dispiriting. Then in October, 1917, the Austrians, assisted for the first time by German divisions, attacked on a wide front at Caporetto at the northern and mountainous end of the Isonzo sector. The Italian Second Army broke, the whole force was withdrawn in confusion, failed to hold the line of the Tagliamento and finally halted behind the Piave. The loss of men, material and morale was terrific and it was quite clear that assistance was necessary to prevent the over-running of Italy.

Accordingly, six French and five British divisions were withdrawn from the Western front and concentrated in turn round Mantua, south of Lake Garda, where they arrived during

November and December, 1917. The British force was commanded by General Sir Herbert Plumer, the R.E. units being :—

General Headquarters

Chief Engineer	Major-General F. M. Glubb.
Director of Works	Brigadier-General G. E. Smith.
D.G. Transportation	Major-General W. H. Grey.

XI Corps

Chief Engineer	Brigadier-General H. J. M. Marshall.
5th Division	C.R.E., Lieut.-Colonel J. R. White, with 59th, 491st (Home Counties) and 527th (Durham) Field Companies.
48th Division	C.R.E., Lieut.-Colonel V. Giles, with 474th, 475th and 477th Field Companies.

XIV Corps

Chief Engineer	Brigadier-General C. S. Wilson.
7th Division	C.R.E., Lieut.-Colonel A. W. Reid, with 54th, 95th and 528th (Durham) Field Companies.
23rd Division	C.R.E., Lieut.-Colonel E. H. Rooke, with 101st, 102nd and 128th Field Companies.
41st Division	C.R.E., Lieut.-Colonel E. N. Stockley, with 228th, 233rd and 237th Field Companies.

L. of C. Troops

I.G.C.	Lieut.-General Sir Henry M. Lawson, late R.E.
Engineer Troops	158th, 285th, 290th and 8th (Monmouth) Army Troops Companies, No. 246 Base Park Company ; detachments of No. 32 Base Park Depot and of 13th Reinforcement Company ; 6th Field Survey Company ; 34th A.A. Searchlight Section ; Transportation Stores Company ; 5th Pontoon Park ; No. 2 Boring Section.

At the beginning of December, the 41st and 23rd Divisions moved into the front line with the 7th Division in reserve. They occupied the Montello sector on the Piave line in the Alpine foothills, about thirty miles from the sea. Towards the end of January the 48th and 5th Divisions moved into the line on their right.

During the winter and spring, the situation remained fairly quiet on the British sector, but there was considerable work to do upon the defences, which lacked depth and were quite devoid of machine-gun positions, shelters etc. The Italians supplied the labour for road making and water supply, with the result that the field companies could concentrate their efforts upon work required in the front and rear lines.

In the spring, it became quite clear that the great German offensive, strengthened by the troops freed from the Russian front, was to be directed against the Western front and not against Italy. After some discussion, it was, therefore, decided to withdraw two British and three French divisions from the Italian front, leaving the British forces in Italy, under General the Earl of Cavan, organized in one corps with certain G.H.Q. troops. The R.E. units were then as under :—

XIV Corps

Chief Engineer	Brigadier-General C. S. Wilson.
7th Division	C.R.E., Lieut.-Colonel E. Barnardiston, succeeded on 16th October by Lieut-Colonel W. A. FitzG. Kerrich.
23rd Division*	C.R.E., Lieut.-Colonel E. H. Rooke, succeeded on 28th October by Major R. A. Turner.
48th Division	C.R.E., Lieut.-Colonel E. Briggs.

The field companies and L. of C. troops remained as shown above, except that the 285th and 290th Army Troops Companies returned to France.

* Commanded by Major-General H. F. Thuillier, late R.E., from 15th October, 1918.

The XI Corps returned to France to its old sector at Armentières just in time to meet the German attack on 9th April (see Chapter XIV).

At the end of March the British troops took over a frontage of about four miles on the Asiago plateau, which is from 3,000 to 4,000 feet above the sea and forms a kind of step on the southern slopes of the Alps. Here again there was much work to be done on the defences in the wooded mountains and many improvements were required to the water supply and communications. The weather at first was bitterly cold and conditions quite new to the troops. Transport was largely by pack animals, supplemented by ropeways running up from the plain.

On 15th June the Austrians launched a strong offensive with attacks on four sectors of the front, one of them against the British. Heavy fighting ensued but counter-attacks regained all lost ground. In this fighting, the field companies, especially the 474th and 477th, were used for holding sectors of the line.

In August large scale simultaneous raids were made at many places by the British in conjunction with the French on their right. During these occurred the first recorded use of searchlights pointed upwards to produce artificial moonlight. The raids were very successful and resulted in the withdrawal of the enemy on a four-mile frontage to behind Asiago, a withdrawal which produced much engineer work on communications and defences.

THE CROSSING OF THE PIAVE, 1918

Allied successes in other theatres and the obvious weakening of the Austrians as the result of their disastrous attack in June tempted the Italians to plan a great autumn offensive. For this purpose the XIV Corps was moved down to the Piave front at the beginning of October, leaving the 48th Division on the Asiago plateau. Earl Cavan was given command of the Tenth Italian Army, consisting of the XIV British Corps and the XI Italian Corps; his XIV Corps Staff all became the Tenth Army Staff; Major-General Sir James Babington, commanding the 23rd Division, was promoted to the command of the XIV Corps, for which a staff was collected from various

sources: Major-General H. F. Thuillier, late R.E., was appointed to the command of the 23rd Division in place of General Babington. The Chief Engineer, XIV Corps, Brigadier-General C.S. Wilson, became C.E., Tenth Army, and Lieut.-Colonel E. Barnardiston, the C.R.E., 7th Division, became C.E., XIV Corps, his place as C.R.E., 7th Division being taken by Major W. A. FitzG. Kerrie, R.E., previously commanding the 51th Field Company.

The Italian Forces at the beginning of this battle, since known as the Battle of Vittorio Veneto, were disposed in six armies. From right to left they were the Third, whose flank rested on the Adriatic about twenty miles north-east of Venice, the Tenth, which included the British XIV Corps, the Eighth, Twelfth, Fourth and Sixth. The two last named were in the mountain regions, the Fourth, which contained one British division (the 48th) on the Asiago plateau, and the Sixth, which included one French division, in the Grappa area. The remaining four armies were along the line of the Piave. The main attack was to be made by the Tenth, Eighth and Twelfth, the two latter advancing northwards on Vittoria and Feltre, while the Tenth was to advance in a direction which would protect the right flank of the Eighth. These operations necessitated as a preliminary the forcing of the passage of the River Piave. This river, of which the bed is about a mile wide, runs in many channels of varying depths and widths among islands and sandbanks of all sizes. The bottom is hard and in dry weather it is easily fordable, even for transport, but a little before the battle heavy rains had brought it down in full flood. In this state many of the islands are submerged, the channels between become deep and unfordable and the current runs at a very great velocity. In consequence of the flood the attack had to be put off for two days, and the river had certainly fallen somewhat when the crossing was made, but was still running at about eight knots in the main channels.

On the front of attack a large island, called the Grave di Papadopoli, about three miles long and a mile wide at its widest part, lay along nearly the whole front of the XIV Corps at a distance of from 300 to 500 yards from the near bank.

This island was held by the Austrians as a strong detached post in front of their main position. Their main line ran along a *bund*, about twelve feet high, which confined the river floods on the opposite side. Between the farthest channel of the river and this *bund* was a flat space from 200 to 400 yards wide partially covered with tamarisk. The plan of attack for the XIV Corps was to capture the Grave di Papadopoli by a separate operation a few days before the main attack. Its capture would admit of a pontoon bridge being constructed from the near bank to the island at a locality where it would be concealed from direct enemy view by the trees and undergrowth on the island, which would then form an assembly position for an attack on the main line.

The 7th Division, to which was allotted the right sector of the corps front, was given the task of capturing the island. The point selected for the crossing was at the north-west, or up-stream, tip, on the front of the 23rd Division. Here lay the small island of Cosenza, already connected to the near bank by footbridges; between it and Papadopoli were two unfordable channels, each sixty to seventy yards wide, separated by a small island. The units selected for the operation were the 2nd Battalion, the Honourable Artillery Company, and the 1st Battalion, The Royal Welch Fusiliers, of the 22nd Infantry Brigade. The crossing began as soon as it was dark on the night of 23rd/24th October, the first parties being ferried across the swift stream by men of the 18th Company of Italian pontieri. The boats were small, flat-bottomed and pointed at both ends; each held seven infantrymen and the crew consisted of two pontieri, one at each end, who kept the boat at the proper angle with the current by means of punt poles, and let the current carry it across. Only twelve boats were available for the ferrying and the process was very slow. There were two channels to be crossed and in each case the point on the opposite shore reached by the boats was over a hundred yards below where they started; each boat had then to be towed up stream to a point an equal distance above the starting point, so that the return journey would bring it back. For these reasons the rate of ferrying by twelve boats was less than a hundred men per

hour. Simultaneously with the ferry crossing, two footbridges were constructed across the channels between Cosenza and Papadopoli by the remainder of the pontieri company, assisted by the 101st Field Company of the 23rd Division.

These bridges were made of boats similar to those used for the ferrying, spaced twenty feet apart and cemented by special strong duckboarding. Directly the bridges were complete, the remainder of the two battalions of the 7th Division crossed by them. Since the site of the footbridges was completely exposed to enemy view and machine-gun fire, they were dismantled before dawn and the equipment hidden in the undergrowth on the mainland for the day; they had, therefore, to be reconstructed each night.

The operation on the night of the 23rd/24th October was successful in taking the enemy by surprise, although some artillery fire was opened on the place of crossing as soon as it was detected by the beam of a searchlight which the Austrians had established on the opposite bank. The two battalions deployed across the island and advanced down it, driving the enemy back, and taking some 300 prisoners. By dawn on the 24th they had secured more than half its length. On the same night one company of the 11th West Yorkshire Regiment, 23rd Division, was put across to the north-west end of the island by the ferry service.

The main attack had been fixed for the morning of the 25th, but heavy rain fell on the 24th and the river rose again that night. The passage of troops across the ferry began again at dusk. After one company of the 8th Yorkshire Regiment (23rd Division) had been ferried across, orders were received from the XIV Corps to stop further crossing and to postpone the main attack. The troops marooned on the island were in an unenviable position, wet through and exposed to frequent shell-fire.

On the 25th October the rain ceased and that night the passage of troops was resumed, both by ferry and by the footbridges, as soon as they could be re-created. To hide the operation from the enemy, the beam of the Austrian searchlight on the opposite bank was blanketed by a beam of light

established by the 3rd Italian Searchlight Company (attached to the 23rd Division) at a point on the river bank some 500 yards up stream. This threw its beam parallel to, and in front of, the scene of the crossing and formed a perfect screen. The remaining two battalions of the 22nd Brigade (7th Division) and the headquarters and two more companies of the 8th Yorkshire Regiment (23rd Division) were thus able to cross. The 7th Division troops on the island completed the capture of the whole of it that night, and on the morning of the 26th repulsed a strong Austrian counter-attack upon it. On the 26th the river fell again, and orders were issued for the main attack to take place at 6.45 a.m. on the 27th.

It is necessary here to describe the problems met with in the construction of the pontoon bridge from the mainland to the Island of Papadopoli, which had been started on the 25th. The task there presented to the engineers was one of extraordinary difficulty. The distance to the island was about 1,600 feet, but the depths varied, and parts were sandbanks uncovered by water. Although detachments of the 4th and 5th Bridging Trains had been sent from France, the pontoon equipment would barely suffice for the crossing, having in view the fact that the channel on the farther side of the island had also to be bridged. This, too, was partly of fordable shoals but the width of the unfordable part was unknown. It was also doubtful whether the British pontoons would ride at anchor in the 8-knot current of the main channels. The Italian pontieri company attached to the corps had a certain number of pontoons, of the type used in the Italian service, bigger than the British, with higher freeboard, and also having a high scow bow, which enabled them to ride easily in the waters of the swift Alpine rivers. Another serious difficulty was that the field companies had had little or no training at pontooning, having been engaged continuously in trench warfare, and neither officers nor men had any experience of how to get the pontoons into position or to lay out anchors in such a rapid current, and of course they had no motor launches to assist them.

The site selected for the bridge was opposite the village

of Salletuol and below the tail of an island called Veneto, to which a crossing had already been made. The reason for its selection was that here the main current flowed inshore, and also that the island would permit of the laying down of kedge anchors with a view to letting down pontoons on long cables to their position in bridge. On the other hand, the site had the defect that the current ran at a considerable angle to the bank and to the line of the bridge.

The executive control of the bridge construction was in the hands of Lieut.-Colonel Kerrich, who from commanding the 54th Field Company had been made C.R.E. of the 7th Division only a few days before. He had at his disposal the 54th, 95th and 528th (Durham), Field Companies of his own division, the 128th and later the 101st Field Companies and all the pontoons of the 23rd Division, and also an army troops company. He had also the 18th Company of Italian Pontieri, less the portion of it required for ferrying troops at Cosenza, under the command of Captain Odoni of the Italian Engineers. The pontieri were excellent men, many of them specially enlisted watermen, skilled in boat work in rapid waters. The 477th Field Company and pontoons of the 48th Division were in reserve.

On the night of 24th/25th the 54th Field Company with great difficulty got a cable across the stream to Papadopoli. The next night the pontieri put four Italian pontoons into position in bridge, after which they received orders to stop this work and to reinforce the rest of their company engaged in ferrying the last two battalions of the 22nd Brigade across at Cosenza. Their method of getting pontoons into position was to launch one at a time some distance upstream and to let the swift current carry it down while two of the crew steered it into its proper position with paddles, and others at the stern dropped the anchor at the proper place and paid out the cable till the pontoon reached its position in bridge. Needless to say the operation required very skilled men.

On the 26th, the whole of Papadopoli being in British possession, it was possible to work on the bridge by day, and this was facilitated by a mist which obscured the site from distant

view and also from the air. There was still a gap of fifty yards to the nearest shoal and in the morning three Wehlon trestles were placed in position by the R.E. to fill this gap. On the shoal portions of the channel the current ran more slowly, it was possible to lay anchors by hand and the British pontoons rode the water easily. The difficulties of working, however, were such that it became evident that the bridge to the island would not be completed by nightfall. About half of it was therefore made as a footbridge of duckboards on wooden trestles, which were provided by the Chief Engineer from corps stores. This enabled the troops of the 26th and 21st Infantry Brigades to cross during the night of 26th/27th and to reach their positions for the assault on the Austrian main line the next morning.

On the same night, 26th/27th October, the 68th and 69th Brigades of the 23rd Division on the left also crossed to the north-western end of Papadopoli and took up their positions in preparation for the assault. The same methods were employed as on the previous nights; as many as possible were transported by ferry, and the footbridges were reconstructed as soon as it was dark. The Italian searchlight from up-stream again blanketed the Austrian light and the process of crossing proceeded without a hitch. At 10.30 p.m. the British artillery began a systematic bombardment of the enemy's wire and this led to considerable enemy shell-fire in retaliation, but the passage of the troops was not seriously hampered, and all had been successfully landed by 3.30 a.m.

There was still much to be done before the attacking brigades reached the position from which the assault was to be delivered. First there was the broad branch on the opposite side of the Grave di Papadopoli to be crossed. This was from 1,300 to 1,500 yards wide, divided into several streams by islands, sandbanks, etc. On the 7th Division front the infantry had already occupied some of these islands and when they moved towards the farther bank they found no serious obstacle till they began to ford the last stream which was waist deep and running very strongly. The 23rd Division had to cross shoals and sandbanks but encountered two channels which were

fordable only with great difficulty, also being waist deep and very swift. It was only great resolution and courage which enabled the men of both divisions to cross these dangerous obstacles. They linked arms and pressed on in the darkness till they reached the far bank, but many were swept away and drowned. The distance from the farthest bank to the foot of the *bund* which formed the Austrian main line of defence was from 200 yards on the right of the corps front to 400 yards on the left. On this flat space the troops took up their positions preparatory to the assault, which was to take place at 6.45 a.m. when the artillery barrage lifted off the *bund*. Punctually the lines of infantry advanced. The ground was much covered by tamarisk scrub which in some places concealed barbed wire and machine-gun emplacements. Overcoming all resistance the long lines pressed forward, and by 7 a.m. both divisions had stormed the *bund*, putting the defenders to flight, and soon began their advance behind the barrage to their second line of objectives.

By midday (27th October) the engineers under Lieut.-Colonel Kerrich completed with pontoons the other half of the Sallatuol bridge to Papadopoli where the footbridge had been made the day before. The 101st Field Company of the 23rd Division was this day added to those under Lieut.-Colonel Kerrich, and thus reinforced they bridged the channels between the island and the far bank of the river, under some artillery fire and bombs from Austrian aircraft. As soon as bridge communication was through it began to be used for the passage of artillery and the transport of both the 7th and 23rd Divisions. It was, however, decided that on the night of the 27th/28th the 56th Division of the Italian XVII Corps, which had been that day put under the orders of Lord Cavan, was also to cross by the Sallatuol bridge in order to carry out a certain operation on the left flank of the XIV Corps. This necessity arose from the conditions which had come about on the front of the Eighth Italian Army on the left. In the plan of attack there was a gap of no less than 5,000 yards between the left flank of the 23rd Division and the right of the Eighth Italian Army. At this gap the course of the river took a wide bend so that the

direction of advance of the nearest Italian division was oblique to that of the 23rd Division. The plan was that they should gain contact at a point 6,000 yards beyond the river, the triangle of ground between being cleared up later if necessary. It was evident that, should any mishap prevent the Italian division from crossing, this contact would not be made, and the 23rd Division would be left with an entirely open flank several thousand yards deep. In the event of an attack upon this open flank it might be impossible if the river rose again to reinforce the leading brigades from reserves on the near side. In any case this could not be done by daylight as the 23rd Division footbridges were under observation and machine-gun fire from the area still held by the enemy on our left. This dangerous situation did in fact arise, when in the early hours of the 27th news was received that the bridges of the Italian 56th Division had broken down and none of their troops had been able to cross. Fortunately no attack was made by the enemy on our left, but it became obvious that the XIV Corps could not continue its advance until its left flank had been covered. It was to effect this that the Italian 56th Division was sent to cross by the Salletuol bridge in order to move to the left of the 23rd Division and fill the gap between it and the nearest Italian formation. At the same time a brigade of the 33rd Italian Division crossed the river by the Cosenza footbridges to co-operate in the movement.

Great congestion was produced at the approaches to the Salletuol bridge by the necessity for passing a whole Italian division across. One of its brigades crossed early in the night of the 27th/28th and proceeded to the left of the 23rd Division, but before any more could do so a serious disaster occurred at the bridge. The current had scoured under the leg of the nearest Weldon trestle in the main stream and it subsided; when the decking became awash the force of the current carried away all the trestles and two of the Italian pontoons. Attempts to repair the bridge by letting down British pontoons on long cables from Veneto Island were unsuccessful, as they swung about uncontrollably. Finally one capsized, drowning some of the crew.

This mishap came at a very critical time and its immediate result was that no more Italian troops, and no artillery, rations or ammunition for the British troops could be got over to the other side. On the morning of the 28th the two Italian brigades which were already across made a wheeling movement, pivoting on the left flank of the 23rd Division under a barrage from Italian and British artillery, and before midday had attained a position prolonging the British line to the left. At 12.30 p.m. the whole line then continued the advance. The pontoon bridge was repaired by the Italian pontieri by their method of dropping the pontoons down from up stream, and traffic across it was resumed in the evening. The congestion after this delay was worse than ever, and most precise orders were necessary to allot priority to the various infantry and artillery units, British and Italian, who were to use the bridge, and to the transport carrying ammunition and supplies for the three divisions who were dependent upon it. The working out of these orders and the control of the traffic at the bridge, where at times indescribable confusion reigned, taxed the resources of the staff very highly. In view of the possibility of the leading troops being short of ammunition or rations some supplies of both were carried over by aeroplane and dropped.

The pontoon bridge remained till after the Armistice, being used by further Italian troops and for all supplies of the Tenth Army. It was also used for the withdrawal of the Tenth Army after the Armistice. The river continued to fall and when the returning troops crossed the bridge a number of the pontoons were resting on the ground, but, although subjected to heavy loads while in this state, they stood the strain without damage.

The whole of the operation reflects the highest credit on all the troops who took part in it and on the staffs who organized it. It has not been possible to describe the minute care and precision with which all movements connected with the crossing by the ferry and footbridges had to be conducted. The engineers employed on the bridges showed great energy and gallantry in their dangerous duties, battling against difficulties

for which their previous training had not prepared them. Special mention should be made of the Italian pontieri, recruited largely from men with a life-long training in watermanship, without whose skilled help it is difficult to conceive how the bridging operations could have been carried out. They were efficient, highly skilled and gallant. Their commander, Captain Odoni, was a man of great energy and resource and he received the well-deserved honour of the D.S.O. for his services to the British army. The gallantry and endurance of the infantry who were for forty-eight hours unsupported on the island of Papadopoli in heavy rain and under shell-fire, and who then drove off it a superior force of the enemy, and also the dash and resolution of all those who waded the rushing channels of the river in the dark, and, forming up at their assembly line, stormed the enemy position on the bank with faultless punctuality, are all worthy of the highest praise. At any time other than when they occurred these feats would have aroused the pride of the whole nation, but the last scenes of the colossal struggle in France and the imminent collapse of the German armies diverted attention from them. They should, however, rank very high in the annals of the British Army.

From the difficulties experienced by the engineers some lessons may be drawn. The first is the necessity for the staffs, and particularly for the Chief Engineers of higher formations, to consider well in advance the nature of the operations which may fall to the lot of the army, to arrange that there shall be available for the engineers the equipment and stores that they will require for those operations, and, if the duties that are foreseen are outside the experience and training of the engineers, to take steps to have them trained specially. In this case it may not have been possible to foresee that the XIV Corps would be called upon to cross the river Piave, and it is true that it had been stationed in the mountain region of the Asiago plateau for some months previously and had been expecting orders for transfer to the French front. Nevertheless, it is a fact that all the rivers of the North Italian theatre of war, in which the corps had been stationed for twelve months,

are of the mountain torrent type, shallow streams in dry weather, but deep, swift and rushing at times of flood. It is unfortunate, therefore, that it was not remembered that the officers and men of the field companies had had no experience of bridging under such circumstances and that no steps were taken to give them any. Also that it was not recognized that the British pontoons would be found unsuitable for currents such as are found in rivers of that type. The sudden change of plan which took the 7th and 23rd Divisions into the battle caught the engineers unprepared for the job they had to do.

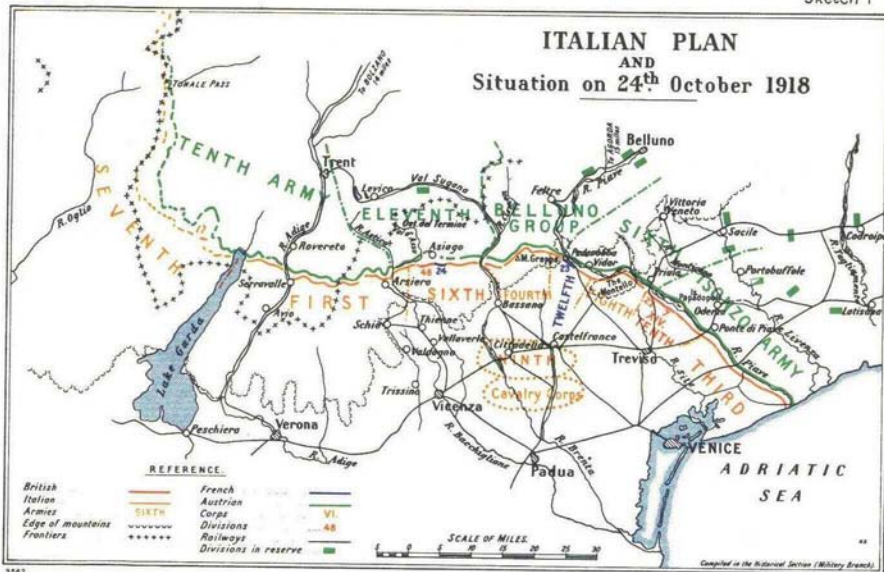
Another lesson is that it is always advisable, when technical operations of exceptional difficulty have to be carried out, to place in definite command of them the most senior and experienced engineer officer available. In this case it was left to the entire charge of the officer who happened at the moment to have succeeded to the post of C.R.E. of the division on whose front the bridge was to be built. Thus a task which would have taxed the capacity of the most experienced and able officer in the Corps, and perhaps the most difficult field engineering problem met with in the whole war, was left to an officer of eight years' service, who, with all his subordinate officers and men, had for the preceding four years been employed exclusively in trench warfare. The fact that Lieut.-Colonel Kerrich rose to the occasion and accomplished more than could possibly be expected under such circumstances does not affect the value of the foregoing comment. He and his officers and men deserve great credit for the gallant efforts they made and for the success they achieved in getting a bridge across at all in the circumstances. The success may be measured by the fact that it was only on the Tenth Army front that a crossing of the river was effected in the first two days. On the fronts of the Eighth and other Italian Armies all bridging attempts were frustrated by the flooded Piave, just as the same river had broken all the Austrian bridges and defeated their attempts to cross and maintain themselves on the right bank in the winter of 1917.

THE PURSUIT AFTER THE CROSSING OF THE PIAVE

During the advance from the Piave to the Tagliamento, various other rivers had to be crossed. The Austrian demolitions were not always completely successful but most of the bridges, many of them large timber structures, were either blown up or burnt. The first bridge to be constructed was, of course, from Papadopoli to the left bank of the Piave. This presented little difficulty as the current in this branch was by then not very swift. On the British front the bridges over the Monticano and its tributaries were prepared for demolition but the charges had not been fired. The Livenza was crossed on 1st November. At Brugnera, a trestle bridge was built by the Italians and at Cavolano, a medium pontoon bridge by the 7th Division. At Sacile the bridge was repaired by the 23rd Division and an Inghis girder bridge constructed by the 285th Army Troops Company. There was great congestion in Sacile because the crossings were also used by three Italian divisions. The Meduna was found to be fordable in the British sector but was subsequently bridged. The Tagliamento was reached on the 3rd November and crossed by a partially damaged bridge at Gradisca. By this time all enemy resistance had ceased as the Armistice had been signed and took effect next day.

Meanwhile on the Asiago plateau, Austrian resistance had weakened and on 1st November a combined attack by the 48th Division and the French on their right captured the plateau and drove the Austrians into the mountains by way of a narrow and precipitous valley called the Val d'Assa. A brigade of the 48th Division with a few guns and two sections of sappers took up the pursuit which continued until the Armistice, very large numbers of prisoners being captured. Except across no-man's-land with its battered villages, the steep mountain road was found to be in fairly good order, with only one serious demolition. The route was made passable for wheels by the 474th and 475th Field Companies assisted by British and Italian working parties.

ITALIAN PLAN AND Situation on 24th October 1918



SURVEY IN ITALY

British surveys on this front began in November, 1917, as for some time British artillery units had been attached to the Italian army and were in position on the Carso. These units had obtained their maps from the Italian Command, but artillery surveys, and also sound and visual observation, were far behind the standard of the Western front. On the other hand, Italian cartography was superior to French. Italy was covered with property surveys in the same communal way as France, but had a second and excellent topographical survey at 1/25,000, and its sheets were an admirable base for further development.

In November, 1917, when the British and French divisions were sent to the Italian front, Lieut.-Colonel Winterbotham was ordered to go with three men to make geographical arrangements. The first step of importance was to visit the *Service Géographique* in Paris to ensure close collaboration. It was found that the French had determined to maintain their more usual scale of 1/20,000 and had enlarged record copies of the Italian 1/100,000 to serve the purpose. The maps thus produced were coarse and much inferior to the Italian 1/25,000, but had, overprinted upon them, a co-ordinate system on a suitable projection. This system of reference was adopted for the British use.

On reaching Italy trigonometrical records were obtained from the *Istituto Geografico Militare* at Florence, which carried out map printing for the Italian armies. With great promptitude it provided a full supply of maps of the Piave front for which British troops were destined, and also untrimmed copies, in bulk, on which the new reference grid could be overprinted. Lieut.-Colonel Winterbotham who had one good computer with him, converted the trigonometrical data of the British area into terms of the reference grid. Thus before the heads of columns arrived at Mantua full arrangements had been made. British Corps Headquarters were in Padua and there a barrack was handed over for geographical work, an Italian military surveyor was attached for liaison, and work began.

Fortunately there existed good lithographic printing establishments in the town, and the overprinting of the new grid caused little difficulty.

From this time map printing and supply continued normally. The 6th Field Survey Company (a new unit) was soon formed, mainly by transfers from the 2nd Company, at that time in reserve. By the middle of December both sound and flash observations were working normally. Early in January, 1918, Major C. S. Reid arrived (with G.H.Q. Italy) to relieve Lieut.-Colonel Winterbotham who returned to the Western front.

It is interesting to note that on this front British and French units were able to exchange locations on the same system of reference, as they were never able to do in France.

THE WORKS DIRECTORATE IN ITALY

The R.E. Works Directorate in Italy was an offshoot of that organization in France, and depended for its supply of stores and material on the Director Engineer Stores in France, supplemented of course by local purchase in Italy. At first the Works Branch was established under an Assistant Director of Works, Colonel B. A. G. Shelley to serve only the Mediterranean L. of C. which was opened through France and Italy to Taranto early in 1917 on account of the serious submarine attacks on shipping in the Mediterranean. After the disaster at Caporetto, however, when the British and French force was sent to help our Italian allies, a Works Directorate was formed in Italy, with Brigadier-General G. E. Smith as Director and Colonel G. K. Wait as Assistant Director.

WORKS FOR THE MEDITERRANEAN L. OF C.

Colonel B. A. G. Shelley was appointed Assistant Director of Works for the whole L. of C. through France and Italy, and on 15th May, 1917, Colonel Morgan arrived in Rome to make preliminary arrangements for the stations to be utilized. Taranto became the base for embarkation and disembarkation, Faenza a rest camp where troops were detained for twelve hours or more, and Turin, Voghera, Castellamare, Foggia, and

Brindisi *halte repas* stations (6-hour) with sanitary, washing and refreshment facilities. With at first, only four officers, Colonel Shelley's difficulties were great. Military and civilian labour and contractors had to be obtained and used according to the possibilities of the situation. Soon the numbers to be catered for were doubled but Colonel Shelley had already catered for this and having obtained estimates of the new requirements at Faenza and Taranto, he again doubled them. Events proved that all his redoubled work was required. At Faenza a rest camp was established with Nissen huts and tents, and with water and electric light from the town mains. An existing building was converted into a hospital. At Taranto a much larger camp was required, again built of Nissen huts and tents, but supplemented largely, including the hospital, by huts, built with local soft sandstone which soon hardened. Italian and Egyptian labour was employed and supervised by sappers temporarily promoted to acting staff sergeant. Four battalions of West Indians arrived in the winter to augment the labour force. Two sections of the 158th Company, R.E., and two more officers were a welcome reinforcement.

As early as 20th June, 1917, troops began to use the new L. of C. before it was ready to serve them, and before it had been possible to take sufficient measures to cope with the virulent malaria at Taranto. At the request of Colonel Shelley, Colonel Ross the celebrated anti-malarial expert, reported on the measures required, and by very good fortune Major Kenworthy, R.E., who in civil life was a distinguished land drainage consulting engineer, happened to be in Italy controlling engineer stores at the base at Arquata Scrivia. Brigadier-General Smith who had by now replaced Shelley in Italy, ordered Kenworthy to Taranto and gave him a free hand for anti-malarial work. His expert eye soon saw what was required, and during the three winter months before the next mosquito season he completed the work at a cost of about £4,000. Lieut.-Colonel Robertson, I.M.S., was Principal Medical Officer at Taranto and with his Italian experience he continued Kenworthy's work. The value of this anti-malarial work may be gauged from the facts that in 1917, before it had

been completed, 75,000 individuals passed through Taranto among whom 700 cases of virulent malaria occurred, whereas in 1918, 266,000 persons passed through, among whom only eight contracted malaria, and of these six had been "out of bounds." At Taranto a water-borne system of drainage was installed to replace the camp latrines and incinerators.

At Faenza Colonel Shelley had placed a civilian architect, Captain Parkes, R.E., in charge. His staff was one batman and he knew no Italian, but he rapidly converted an improvised camp into a well sited and well equipped halting place of the most pleasing appearance, making the utmost use of local materials and completing the important plumbing of the hospital with his own hands. The Head of the Italian Medical Service asked that he might be allowed to send parties of his officers to study Parkes's sanitary arrangements.

WORKS FOR THE BRITISH EXPEDITIONARY FORCE IN ITALY

The Anglo-French force, which eventually totalled six French and five British divisions, arrived in Italy during October, November and December, 1917, under the command of General Sir Herbert Plumer. The advanced party of H.Q., L. of C. began assembling on 31st October at Arquata Scrivia. Lieut.-General Sir Henry M. Lawson (late R.E.) reached Arquata on 23rd November to take up the appointment of I.G.C., and Brigadier-General G. E. Smith was appointed Director of Works, Italy, including the Italian portion of the Mediterranean L. of C., which he took over from Colonel Shelley.

Genoa was the Port used for stores coming by sea, but very few engineer stores came that way, because supply was mainly from the Director Engineer Stores, France, and from local purchase in Italy. The base was Arquata Scrivia, through which troops and stores had to pass, whether they came from Genoa or from the Riviera. Tartona was selected for the H.Q., L. of C. since it was the intersection of the L. of C. to the front and to Taranto respectively. Brigadier-General Smith estab-

lished his office in the same building which housed the office of the I.G.C., a very sound principle, ensuring early information and close co-operation. The R.E. Stores Depot was established at Arquata, and by the end of the year a sufficient establishment of R.E. officers and N.C.O.s. for Works had arrived in Italy.

Existing buildings of all kinds were taken over and adapted for the varied requirements of a base, including, of course, hospitals. At first reinforcements lived in tents, but these were replaced as soon as possible by huts constructed by an Italian Territorial unit to an Italian design for erection in panels. A considerable number of such huts were later sent to the front.

Hospitals were established as under :

Cremona	2 Stationary.
Genoa	1 General and 2 Stationary.
Bordighera	2 General.
Arquata	1 Stationary.
Taranto	1 General and 1 Native.
Turin and Faenza	Section Hospitals.

The I. of C. was divided into four areas with H.Q. at Taranto, Faenza, Arquata and Cremona. It contained seventy-six units of various kinds all requiring accommodation. From these units a great variety of demands for works services were received, scattered up and down a long line of communications. The work was delegated to Cx.R.E. of districts. One of these Lieut.-Colonel Pitcairn, R.E., a contracting engineer in civil life, whose energy and valuable work in Macedonia is referred to later, had been transferred to work under Brigadier-General C. E. Smith in Italy, where he was also very useful.

Space does not permit a description of the numerous and varied works carried out, but mention should be made of the ammunition depot at Rivalta Scrivia, comprising fourteen sheds and twelve dumps all a hundred yards apart and served by several railway sidings. The sheds were roofed with large but cheap Italian tiles, an elaborate system of fire mains and pumps was installed to protect them.

Labour was always a difficulty. It was supplied by Italians, but was apt to be taken away suddenly as is always the case in war. The Italians carried out all the road work we required. They are famous for their road-making capacity, but they took the wise precaution of forbidding the use of the British 3-ton lorry. With their gross weight of 7 tons (5 tons on the back axle) and their solid tyres, these lorries were breaking up the roads in other theatres and the Italians preferred to supply us with their own rubber tyred Fiat 1-ton lorries, with a gross weight of under three tons. They allowed us to make a contract to cut down several acres of timber in a forest near Cortona, and also allotted us a share of the timber arriving from Switzerland. The Italian liaison officer with the Director of Works, Colonel di Bunezzo, was most helpful although he spoke no English.

The following R.E. units were at the disposal of the Director of Works, in addition to his own officers, foremen of works, etc. :—

- 158th Army Troops Company (A and C sections).
- Detachment, 8th (Monmouth) Army Troops Company (S.R.).
- Detachment, No. 32 Base Park Depot.
- Detachment, 13th Reinforcement Company, R.E.

TRANSPORTATION IN ITALY

The Directorate of Transportation in Italy had to carry out simultaneously two separate and practically independent tasks—the transportation work required by the British troops in Italy, and also the maintenance of the Mediterranean L. of C., by which, as we have seen, the forces in the Near and Middle East were largely maintained with both stores and personnel during the last two years of the war.

When the Mediterranean L. of C. was first started in the middle of 1917 its overland portion was organized and controlled by a separate directorate working directly under the War Office with headquarters at Paris. This directorate was not only responsible for the port work at Cherbourg and Taranto

and for arranging with the French and Italian authorities for the rail transport between these ports, but was also responsible for erecting and running the transit camps for personnel at Cherbourg and Taranto and for the two rest camps—one in France, near Lyons, and one at Faenza in Italy—at which the personnel broke their journeys during the overland transit. In other words this directorate was not only responsible for transportation work but was also responsible, so far as concerned personnel in transit, for the duties ordinarily allotted to the G.O.C., Lines of Communication.

When, at the end of 1917, it was decided to send British troops to Italy, the War Office decided that, as the directorate of the Mediterranean L. of C. had already some knowledge of transportation work in Italy and were in liaison with the Italian General Staff and transportation authorities, it would be advisable to entrust to it the transportation work required for the new expeditionary force.

For this purpose, therefore, the existing directorate was at once moved to Italy, handing over control of the part of the Mediterranean L. of C. that was in France to the C.-in-C. B.E.F., but retaining in its control the transportation duties for the portion that lay within Italy, making over to the newly appointed I.G.C., Italy* all the remaining responsibilities for the L. of C. From this point, therefore, the directorate had purely transportation duties, and was known as the Directorate of Transportation, Italy.

TRANSPORTATION WORK IN ITALY FOR THE EXPEDITIONARY FORCE

When it was suddenly decided to send a British Expeditionary Force to Italy an entirely new British transportation organization had hurriedly to be built up prior to the arrival of the British forces. This was done partly by the transfer from France of those officers and men that could be spared from the transportation organization there, and partly by the immediate

* Lieut.-General Sir Henry M. Lawson, late R.E.

and direct recruitment of British subjects in Italy, as it was essential to have a number of Italian-speaking officers. In this connexion valuable help was received from many of the British banks, touring agencies and mercantile houses.

In its main lines, though of course on a much smaller scale, the transportation organization in Italy followed the lines of the organization for the R.E.F. France. A headquarters under the D.D.G.T. there were Assistant Directors for Roads, Railway Construction and for Light Railways (the latter posts were subsequently amalgamated), but the actual working of ports and railway transportation generally was dealt with direct by the D.D.G.T. and his assistants. In Italy, however, unlike France, no attempt was made to do operating or construction work by means of British units. Railway operating and road and railway construction was arranged through the Italian Army Transportation Directorate and was carried out by Italian military or civilian agencies.

Stores and equipment were received either from England by rail via France, or direct by sea via the port of Genoa. Except in the case of ammunition, all stores that came by rail were in the first place collected in depots at Arquata, under the service concerned. Those coming by sea were normally stored in sheds at the Genoa docks, and sent by rail to Arquata where the wagons were attached to the daily supply trains going to the front, each of which ordinarily carried the supplies for two divisions. Ammunition came by rail via France, and was taken direct to the main ammunition depot at Rivalta, whence it was sent up by train either to railheads or to advanced ammunition depots.

In addition to the headquarters staff of the Transportation Directorate, which was situated at or near the headquarters of the C.-in-C. (these headquarters moved several times), there was an A.D.G.T. in the forward area and an A.D.G.T. responsible for work on the L. of C. The latter was located at Headquarters, I.G.C., while the former moved from time to time according to the situation. The A.D.G.T. (Forward Area) had under him a number of R.T.Os. located at the various railheads, and similarly the A.D.G.T. (L. of C.), had R.T.Os.

at the Port of Genoa and at the more important railway stations on the L. of C.

The evacuation of sick and wounded from the front was carried out by a few hospital trains composed of British-built rolling stock, maintained by a technically trained British officer with a small technically trained detachment of British R.E. troops.

When the British forces were occupying a section of the front on the Asiago plateau a somewhat unusual method of transport was employed. Supplies were sent up by wire ropeways, the haulage being carried out by petrol engines. The ropeways were erected and operated by the Italian army.

Although the Transportation Directorate did not themselves do any standard-gauge railway operating or construction work, they did lay and operate a certain amount of 60-cm. track at certain advanced ammunition depots, and they maintained at Castel Maggiore under the charge of a platoon of a British light railway operating company, a reserve of 60-cm. locomotives, tractors and wagons and about thirty-five miles of 60-cm. and ten miles of standard-gauge track for use in case of emergency.

TRANSPORTATION WORK FOR THE MEDITERRANEAN L. OF C.

Large numbers of British troops were transported in both directions over this line of communication in special troop trains, whilst supplies, stores etc. for the British Forces in the Near or Middle East arrived in sealed wagons at Taranto either in complete trainloads or by ordinary Italian goods trains. In addition to arranging for such rail movements over the Italian railways, through the Italian Army Transportation Directorate, the British Transportation Directorate itself undertook at Taranto the unloading of the stores from wagons, checking, storage and the reloading on to lighters.

For the sole use of the Mediterranean L. of C. a special port installation had been constructed at Taranto in the *Mare*

Piccolo harbour, complete with railway lines, transit sheds, decauville tracks, cranes and lighter jetties (there was insufficient depth of water for ocean-going vessels to come alongside). The construction was carried out by Italian agency on plans drawn by the British Transportation Directorate, but the latter provided the cranes, decauville track, lighters and motor boats. The British for the purpose of maintaining and operating this port posted at Taranto a large number of officers and men (the majority were R.E. specialists) under the command of an A.D.G.T., working directly under the D.G.T. The labour needed at the port was supplied from British labour battalions stationed at Taranto.

An interesting feature of the Mediterranean L. of C. lay in the fact that stores throughout their transit remained solely in charge of the transportation authorities, even when they were stored in the transit sheds at Cherbourg and Taranto. Their loading, unloading, checking and reloading had, therefore, to be done throughout by the transportation staff and not, as would ordinarily be the case, by the services concerned. This, of course, meant that a very large number of checkers had to be stationed at Taranto, and that complete records of all stores and supplies passing through had to be maintained by the transportation staff.

On the whole the work at Taranto proceeded very smoothly, though from time to time owing to shortage of shipping to the Near or Middle East, congestion occurred in the transit sheds and on the quays. The transit of personnel presented no difficulty, though on some days as many as 8,000 troops had to be moved by lighters between ship and shore. Not only were the relations between the British Transportation Directorate and the staff of the C.-in-C., Italy always particularly pleasant and cordial, but friendly help was invariably given by the Transportation Directorate of the Italian Army (*Direzione Trasporte*), through whom all demands for transportation facilities from the Italian Railways or from the Italian Army had to be made. No efforts were ever spared by the *Direzione Trasporte* to ensure their fulfilment as promptly and as completely as possible.

OFFICERS OF THE TRANSPORTATION DIRECTORATE IN
ITALY

<i>Appointment</i>	<i>Former experience</i>
D.G.T.—Major-General W. H. Grey	
D.D.G.T. (in charge after March, 1918) —Brigadier-General G. L. Colvin	Traffic Dept., East Indian Railway.
A.D.G.T., Forward Area—Lieut.- Colonel H. G. Verey	Solicitor in London.
A.D.G.T., L. of C.—Lieut.-Colonel P. C. Sheridan	Traffic Dept., East Indian Railway.
A.D.G.T., Taranto—Lieut.-Colonel Betts	Manager of electrical firm, South America.
A.D., Railway Construction—Lieut.- Colonel C. Walton	Regular R.E. Officer, Indian State Railways.
A.D., Light Railways—Lieut.- Colonel Middleton	Civil Engineer.
A.D., Roads—Lieut.-Colonel Longden	British roads engineer.
A.D.R.T., Forward Area—Lieut.- Colonel O'Connor	Indian State Railways.
A.D.R.T., Arquata—Lieut.-Colonel M. Brown	Traffic Dept. of a British railway.
A.D.R.T., Genoa—Major Pearson	British engineering contractor.
A.D.R.T., Rome—Major le Mesurier	British banking firm at Genoa.
A.D.R.T. at Headquarters—Major R. W. Brooker	Thomas Cook & Sons.

APPENDIX

PORTRAITS OF SOME SENIOR OFFICERS MENTIONED IN THIS VOLUME

Portraits of some of the distinguished officers mentioned in this Volume are reproduced on the following pages.

These portraits are taken from the 1914-18 War Portrait Gallery now hung in the Officers' Mess at Gordon Barracks, Gillingham.

Details of some of the more important posts held by these officers are given in an Appendix to Volume VII, which also includes details of certain other officers who held important positions before and during the 1914-18 War.



Lt Gen Sir Edwin H de V Atkinson, KCB, KBE, CMG, CIE



Maj Gen Sir Hugh Bruce-Williams, KCB, DSO



Maj Gen Sir Reginald U H Buckland KCMG, CB



Maj Gen Sir John E Capper, KCB, KCVO,



Lt Gen Sir J Ronald E Charles, KCB, CMG, DSO



Maj Gen Clifford Coffin, VE, CB, DSO



Brig Gen E W Cox DSO



**Maj Gen Sir Sidney D A Crookshank, KC
MG, CB, CIE, DSO, MVO**



Gen Sir Hugh J Elles, KCB, KCMG, KCVO, DSO



Maj Gen C H Foulkes, CB, CMG, DSO



Lt Gen Sir George H Fowke, KCB, KCMG



Lt Gen Sir John Fowler, KCB, KCMG, DSO



**Maj Gen Sir Henry F E Freeland
, KCIE, CB, DSO, MVO**



Maj Gen C G Fuller, CB, CMG, DSO



Maj Gen Sir Frederick M Glubb, KCMG, CB, DSO



Maj Gen Sir Phillip G Grant, KCB, CMG



Maj Gen Sir Charles W Gwynn, KCB, CMG DSO



Lt Gen Sir George M Harper, KCB, DSO



Maj Gen R N Harvey, CB, CMG DSO



**Maj Gen Sir Gerard M Heath,
KCMG, CB, DSO**



Maj Gen E R Kenyon, CB, CMG



Lt Gen Sir Henry M Lawson, KCB



Maj Gen Sir Richard P Lee, KCB, CMG



Maj Gen Sir William A Liddell, KCMG, CB



**Lt Gen Sir George M W Macdonogh,
GCB, KCB, KCMG**



Lt Gen Sir Ronald C Maxwell, KCB, KCMG



**Maj Gen Sir Spring R Rice,
KCMG, CB**



**Maj Gen Sir George K Scott- Moncrieff,
KCB, KCMG, CIE**



**Maj Gen Sir Andrew M Stuart,
KCMG, CB**



**Maj Gen Sir Ernest D Swinton
KBE, CB, DSO**

Henry Thuillier.



**Maj Gen Sir Henry F Thuillier,
KCB, CMG**

Geoffrey
Twining.



**Maj Gen Sir Philip G Twining
KCMG, CB, MVO**

INDEX TO VOLUME V.

Note. It is regretted that, owing to considerations of space, it has been impossible to index the references to each of the more than a thousand R.E. units. The index headings refer to all or a number of units, e.g., that for "held companies" refers to matters of organization, etc., affecting all or a number of such companies.

The rank mentioned against a person's name usually indicates the highest rank mentioned in connexion with him in *this book*. This is not necessarily the highest rank attained.

- Accommodation for troops, etc.,
 at Home, 68-75
 in France, 232, 254, 255, 256, 260,
 295, 296, 362, 366
 in Italy, 686-90
- Adams, Lieut. E.S.R., 100, 137
- Adams, Capt. T. H., 513
- Addison, Maj. Gen. G. H., viii, x, 68,
 322, 347, 505
- Admiralty, the, 50, 60, 81, 88, 113, 122
- Advanced Park Coys., 38-44
- Aerodromes, 72, 346, 549
- Aeroplane location, 400
- Aeroplane Sqns., Searchlight Sectns.,
 40, 60, 63, 480-48
- Agar, Maj. H. E. T., 234
- Air Attack, defence against, 55-68, 82, 83
- Air Ministry, the, 75, 81
- Air raids, 36-67, 105
- Aisne,
 first battle of, 194-201, 426
 second battle, 373-80
- Albert, battle of, 408, 409
- Albert, King of the Belgians, 420, 653,
 658
- Aldershot, R.E. Training Depot, 136,
 139
- Allbright and Wilson, Messrs., 88
- Allenby, Gen., 100
- Allmand, Maj., A. J., 512
- American Army, the, 75, 79, 80, 65,
 384, 387, 485, 651
- Anderson, Lieut. Col. R. E., 607
- Anti-aircraft defences, 82, 101, 107
- Anti-aircraft Searchlight and Sound
 Location School, 64
- Anti-aircraft Searchlight units, 35,
 38-42, 56, 58, 63-66, 136
- Anti-gas services, 41, 61, 63, 507-14,
 524, 525
- Arbuthnot, 2nd Lieut., 381
- Archibald, Sapper A., 309
- Arden Close, Col. Sir Charles E., see Close
- Armstrong, Lieut. A. L., 204
- Armstrong, Lieut.-Col. B. H. O., 41,
 69-72, 80
- Armstrong, Brig.-Gen. C. J., 170, 225
- Army Mines, School of, 41
- Army Ordnance Corps, 46, 78, 81, 139
- Army Reserve, Regular, 3
- Army Troops Coys., R.E.,
 general, 28, 38-42, 101, 231, 253, 280
 the Somme, 253, 272
- Asas, battle of, 297-303, 423, 522, 631
 preparations for battle, 292-297
- Arthur, Lieut. Col. J. M., 348, 419
- Artisan Works Coys., 38-42, 106
- Ashmore, Maj.-Gen. E. B., 65, 68
- Asquith, Mr., 6, 11, 12, 18, 21, 72
- Asst. Adjt. Gen., R.E. and A.G.,
 29-31, 36
- Aston Lieut. C. J., 104
- Atkinson, Lieut.-Gen. Sir Edwin H.
 de V., viii, 168, 169, 697
- Aubers Ridge, battle of, 221-5, 250
- Auld, Lieut.-Col. S. J. M., 510, 512,
 513
- Australian armed forces, 14
- Aylmer, Lieut. Gen. Sir Penton J., 25
- Babington, Maj.-Gen. Sir James, 672, 673
- Bagnold, Col. A. H., 105
- Baker, Maj. H. A., 348, 353, 354
- Baker, Prof. H. B., 86, 88, 92
- Baker Brown, Brig.-Gen. W., iii, viii,
 x, 58, 59, 68, 172, 542, 560
- Baldwin, Maj. W. F., 354, 378, 379
- Balloon sqns., 65
- Bangalore torpedoes, 149, 151, 125,
 247, 454

- Bannister, Corpl., 237
 Barker, Lieut., 309
 Barley, Maj. L. J., 512
 Barnardiston, Lieut.-Col. E., 671, 673
 Barron, 2nd Lieut. S. N., 144, 150
 Barstow, Maj. J. B., 188
 Base park coys., 38-42
 Bassett, Col. T. P., viii
 Bateman, Lieut.-Col. H. H., 450
 Bates, 2nd Lieut. H. C., 144, 149, 150
 Batho, 2nd Lieut., 228
 Battye, Col. B. C., 456
 Baxter, Lieut. G. H., 344
 Baylay, Lieut.-Col. A. C., 328, 359
 Bayley, Col. F., 51
 Beach, Brig.-Gen. W. H., 25
 Behrens, Lieut.-Col. T. T., 304, 316
 Beilby, Sir George, 88
 Belgian coast, projected landing,
 305-10
 Bell, Lieut.-Col. A. H., viii
 Bell, Lieut.-Col. R. M., 439
 Bennett, Lieut. S. G., 439
 Bernard, Mr. O. P., 483
 Berthelot, Gen., 381
 Betts, Lieut.-Col., 695
 Betty, Lieut.-Col. P. K., 207, 325,
 334, 497
 Biddulph, Brig.-Gen. H. A., viii, 134,
 167, 168, 170, 172, 264, 270, 280,
 317, 328
 Bigge, Brig.-Gen. T. A. H., 30, 133,
 229
 Bilham, 2nd Lieut., 341
 Binney, Col. E. V., viii
 Bird, Lieut.-Gen. Sir Clarence A., viii
 Birdwood, Lieut.-Gen. Sir William R.,
 418
 Birney, Col. C. F., 667
 Bisset, Lieut., 239
 Black, Capt. A. D., 377, 378
 Blakeney, Maj. R. B. D., 119
 Bland, Brig.-Gen. E. H., 170, 253
 Blandy, Lieut.-Col. L. F., 105
 Bliss, Capt. T. S., x
 Blount, Col., 543
 Boileau, Brig.-Gen. G. H., 169, 171,
 243, 264, 321, 421
 Bombs, manufacture, 206, 207, 455, 456
 Bond, Brig.-Gen. F. G., 69, 74
 Bond, Lieut.-Gen. Sir Lionel V., x
 Bond, Capt. R. L., 140, 398
 Bonham, Lieut.-Col. C. B., 264
 Bost, Lieut., 283
 Botha, Gen. Louis, 13
 Boulnois, Col. P. K., x, 178, 179, 185
 Bourdillon, Lieut., 205, 227
 Bourgeois, Gen., 537
 Bovet, Lieut.-Col. W., 328
 Boys, Lieut.-Col. R. H. H., 182, 205
 Brady, Col. D., 46, 47, 77, 483, 557
 Bragg, Maj. (Prof.) W. L., 531, 534
 Brand, 2nd Lieut. R., 369, 370
 Brandon, Lieut.-Col. O. G., 316, 320,
 327, 359, 419
 Brandon, Lieut., 61, 62
 Brazier, Lce.-Corpl., 381
 Bremner, Lieut.-Col. A. G., 172, 205,
 316, 324, 427, 436
 Bridging,
 France and Flanders, 167, 194-200,
 220, 227, 393-422, 603
 general, 79, 80, 98, 99, 100, 101, 160
 Italy, 674-84
 tank, 449
 Bridging experimental coys., 100, 102
 Bridging Park, Cav. Corps, 38-42
 Bridging Schools,
 England, 42
 France, 164, 300
 Bridging trains, 38-42, 193, 200, 210,
 220
 Briggs, Lieut.-Col. F., 671
 Bright, Lieut. and Qr. Mr., 140
 British Expeditionary Force,
 general and miscellaneous, 39-42,
 58, 76, 121, 122, 175-211, 426, 579
 R.E. units with, 38-42, 210, 211, 426,
 488
 survey arrangements, 112
 Broad-gauge Operating coys., 29, 130
 Broadway, 2nd Lieut. H. A., 215
 Broodseinde, battle of, 321, 322
 Brooker, Brig.-Gen. F. P., 168, 171,
 264, 298
 Brooker, Maj. R. W., 695
 Brough, Maj.-Gen. A., viii, x, 280, 667
 Brown, Lieut.-Col. M., 695
 Brown, Lieut.-Col. W. G. C., 30, 31
 Browne, Lieut.-Col. C. M., 28, 316,
 351, 415
 Browne, Maj. F. M., 200
 Bruce-Williams, Maj.-Gen. Sir Hugh
 B., 25, 319, 697
 Brummel, 2nd Lieut., 375
 Brunyate, Lieut. W. M., 342
 Buchanan, Maj.-Gen. A. G. B. 9
 Buchanan, Maj. E. J. B., 441,

- Buckingham, Capt. W. E., 235
 Buckland, Maj.-Gen. Sir Reginald
 T. H., 169, 170, 207, 253, 264,
 280, 341, 508
 Buckle, Maj., 187
 Bulfin, Maj.-Gen., 266
 Burford, Maj., viii
 Butler, Capt. Hon. R. T. R. P., 448
 Butterworth, Col. R. F. A., viii, 314,
 316, 346
 Burr, Lieut. P., 378
 Byng, Gen. Sir Julian, 326
 Bywater, Maj. F. G., 340

 Cadman, Lord, 32, 89, 106
 Callwell, Gen., 21
 Calthrop, Lieut. F. E., 192
 Calthrop, Sir Guy, 124, 631
 Cambrai, battle of, 325-35, 439, 522,
 536, 631
 Camouflage, 100, 163, 167, 483-87
 Camouflage (Special Works Park), 38
 42, 100, 484
 Campbell, Lieut.-Col. A., 229, 303,
 318, 328
 Campbell, Maj.-Gen. A. D., 9
 Campbell, Lieut.-Col. H. G. T., 324,
 410, 411, 419
 Campbell, Col. J. D., viii
 Canadian troops, 75, 78
 Canal du Nord, crossing of, 409 16,
 481, 653
 Capper, Lieut. Gen. Sir John E., x, 25,
 133, 160, 231, 304, 316, 447, 451,
 698
 Carden, Capt. E. D., 104, 236
 Carey, Brig.-Gen. A. B., 170, 324, 479
 Carey, Maj.-Gen. G. C. S., 336
 "Carey's Force," 335-38
 Cargill, Bt. Lieut.-Col. S. T., 89
 Carnduff, Lieut. K. M., 434
 Carpenter, Brig.-Gen. C. M., 170, 197,
 200, 220, 323, 497
 Carrier Pigeon services, 38-42
 Cartwright, Brig. Gen. G. S., 170, 230,
 235, 264, 318, 386, 587
 Cator, Capt. E. P. D., 308
 Cavan, Gen. the Earl of, 671, 672, 679
 Cave-Browne, Maj.-Gen. W., x, 9
 Chappell, 2nd Lieut., 434
 Charles, Col. F. M. S., x
 Charles, Lieut. Gen. Sir J. Ronald E.,
 x, 699
 Chatham, 33, 34, 133-37, 152
 Chemical Advisory Committee, 70
 Chemical Warfare Dept., 91, 3
 Chenevix-Trench, Capt. L., 185, 426, 428
 Chenevix-Trench, Lieut. R., 104, 105
 Cherbourg-Toronto route, 128, 129, 672,
 686-8, 693, 694
 Chesney, Capt. C. R., 484, 485
 Chief Electrical Engineer, 45, 82
 Chief Engineers,
 France and Flanders, 168-72, 207,
 225, 231, 253, 264, 278, 280, 292,
 298, 303, 309, 315-17, 327, 328,
 359, 384, 391, 407, 410, 419, 421,
 422
 Kings and Parliament, 8
 Chief Inspector, R.E. stores, 83, 84
 Chief Mechanical Engineer, 45, 78-82
 Chief Surveyor, 45
 Chippindall, Brig. J. E., viii
 Chivers, Maj., 353, 354
 Christie, Brig.-Gen. H. R. S., 171, 304,
 316, 334
 Churchill, Winston, 21, 24, 91, 92, 145
 Cinema Coy., 42
 Clarke, Capt. H. G. C., 495
 Clarke, Lieut.-Gen. Sir Travers, 569
 Clarke, 2nd Lieut., 375
 Cleave, Col. S. D., 47
 Close, Col. Sir Charles F., x, 114
 Close, Maj. F. M., 527
 Cloutman, Maj. B. M., 414
 Coast Battalion, 50
 Coast Defence, 50, 53-5, 82
 Coast Works Coys., 38-42
 Cobb, Capt., 435
 Cochran, Lieut.-Col. T. H., 134
 Coffin, Lieut.-Col. Campbell, 225
 Coffin, Brig.-Gen. Clifford, 25, 230, 247,
 264, 316, 317, 609
 Coldstream, Col. W. M., 115
 Colbard, Brig. Gen. A. S., 127
 Collins, Lieut. A. E., 203, 204
 Collins, Lieut.-Gen. Sir Dudley S., x,
 9, 317, 422
 Collins, Sapper, 142
 Colman, Sergt., 381
 Colonial R.E., 29, 39-43
 Colvin, Brig. Gen. Sir George L., viii, 695
 Command Quartering Committee, 74
 Committee of Imperial Defence, 42, 55
 Conscription, 17, 18, 33, 34
 Contracts, 72
 Controller of Mines, 41
 Cook, Sergt. E., 398

- Cooper, Brig.-Gen. A. S., 127
 Cooper, Lieut.-Col. W. C., 362, 368
 Cooper, Lieut., 367, 368
 Coussinaker, Lieut.-Col. L. J., 408, 420
 Couchman, Lieut.-Col. H. J., 316
 Cowan, Col. J. H., 45, 69, 70
 Cowan, Lieut.-Col. S. H., 323
 Cowie, Lieut.-Col. H. E. C., 667
 Cowley, Lieut., 283
 Cox, Brig.-Gen. F. W., 25, 339, 700
 Craster, Lieut.-Col. J. E. E., 265, 342
 Craster, Col. S. L., 47, 79
 Craven, Brig.-Gen. A. J., 170, 230, 247, 318, 320, 328
 Creswell, Col., 115
 Crompton, Col., 445
 Crookshank, Maj.-Gen. Sir Sydney D'A., 171, 427, 436, 651, 666, 700
 Crossley, Lieut.-Col. (Prof.) A. W., 88, 89, 92
 Crossley, Sergt., 350
 Cummins, Lieut.-Col. S. L., 506, 508, 509, 510, 512
 Cunningham, Lieut.-Col. R. H., 127
 Curtis, Maj.-Gen. R. S., 30, 31, 55
 Cusins, Lieut.-Col. A. G. T., 342
- Dabell, Sapper, 179
 Dale Logan, Lieut.-Col. D., 472
 Darbyshire, Lieut., 351
 Darlington, Capt. A. J., 205
 Davenport, Lieut., 237, 9
 David, Maj. Sir T. W. Edgeworth, 163, 172, 501
 Davidson, Maj.-Gen. A. E., viii, x
 Davies, Lieut.-Col. O. S., 391, 420
 Davey, Capt. B. C., 350
 Davy, Lieut.-Col. C. W., 230, 248, 557, 566
 Dawson, Corpl. J. L., 248, 249
 Dawson-Scott, Capt. J. K., 203
 Day, Lieut. A. F., 178, 179
 Daycock, Sapper G. F., 308
 de Candolle, Brig.-Gen. R., 125
 Defence,
 against air attack, 55-68
 against invasion, 49-55
 Deganwy training depot, 139, 140
 de Meric, Lieut., 441
 de Mole, Mr., 443, 444
 Demolition equipment, 98
 Demolition sections, 49
 Demolitions, bridge and general, 154, 177-94, 339, 340, 400, 639, 641
- Denning, 2nd Lieut. B. C., 141
 Denis de Vitre, Maj. P. T., 184, 205, 264
 Denison, Lieut.-Col. G. W., 316, 349
 Dent, Sir Francis, 124
 des Vocux, Lieut.-Col. H. B., 230, 265
 Deyermund, Lieut., 142
 D'Eyncourt, Sir Eustace T., 445
 di Bunezzo, Col., 690
 Dickson, Brig.-Gen. W. E. R., viii
 Director of Fortifications and Works,
 office and establishment, 4-7, 9, 33, 44-9, 52, 55, 57, 69, 72, 73, 78, 85, 99, 100
 Directorate of Railways, 33, 155, 607, 613, 625
 Director of Works, France, 46, 8, 77, 78, 80, 81, 539-52, 555
 Director-General of Transportation, 79, 155, 166, 569
 Dobbie, Lieut.-Gen. Sir William G. S., viii, 189, 193, 308
 Dobbs, Lieut.-Col. C. R., 230, 265
 Dobson, Brig. A. C., viii, x, 264, 323, 359, 421
 Docks, directorate, 540, 616, 620, 621
 Docks, general, 131, 616, 620, 621
 Dominion R.E., 29
 Done, Lieut.-Col. R. J., 303, 316, 366, 379, 391, 419
 Doucet, Lieut.-Col. L. C. A. de B., 447
 Douglas, Gen. Sir Charles, 20
 Douglas, Col. G., 510, 512
 Downs, Maj. W., 242, 285, 286
 Drew, Col. F. G., viii
 Dreyer, Col., 531
 Duchêne, Gen., 374
 Duff, Gen. Sir Beauchamp, 14
 Dug-outs, 250, 260, 262, 265
 Duke, Mr. H. (afterwards Lord Merivale), 74
 Dumaresq, Col. A. H., 47, 82, 99
 Dumble, Col. W. C., 445
 Durnford, Lieut.-Col. G. E. J., 280, 281, 318, 346, 370, 419
 Dutton, Lieut.-Col. R. B., x
- East Africa, operations, 1914-15, 15, 39-42, 132
 Edmonds, Brig.-Gen. Sir James E., viii, x, 2, 154, 167, 168
 Edwards Ker, Lieut.-Col. D. R., 512
 Edwards, Lieut. B. B., 243

- Edwards, Col. R. F., 51
 Egerton, Lieut. R. R., 426
 Egypt,
 engineer troops, 15, 39-42, 121
 operations, 77
 Electrical and Mechanical Coys., 38-42,
 165, 253, 501, 543, 552, 566
 Electric Light Coys., 40, 54
 Electric lights and power, 83, 167
 Elles, Gen. Sir Hugh J., x, 25, 313,
 325, 446, 701
 Elliott, Brig.-Gen. C. A., 145, 171,
 265, 320, 391
 Elphick, Mr. W. B. and Mrs. C. M., xi
 Engineer and Railway Staff Corps,
 124-8
 Engineer-in-Chief, France, 49, 77, 78,
 85, 100, 102, 156-68, 257, 279, 555
 Engineer-in-Chief, Home Forces, 49
 Engineer-in-Chief, Italy, 169
 Engineer-in-Chief, War Office, 4, 5, 6,
 48, 155
 Engineer services, 38-42
 Enthoven, Mr. R., 89
 Entrenching battalions, 338
 Esher Committee, 4-6, 118
 Evans, Capt. C. E., 104, 105
 Evans, Lieut.-Col. G. F., 280, 309, 320,
 372
 Evans, Lieut.-Col. W. H., 172, 298,
 427, 435
 Eveleigh, Col. E. N., viii
 Ewart, Gen., 109
 Experimental Coys. and Sections, 42,
 100, 156, 157
 Explosives, 106-7, 167, 467
 Faber, Major S. G., 186, 197
 Fair, Brig.-Gen. F. K., 171
 Fairbourn, Lieut. A. N., 343
 Fairtlough, Capt., 441
 Fanshawe, Maj.-Gen. R., 290
 Fay, Sir Sam, 127
 Fayolle, Gen., 634
 Feary, Lieut. S., 372
 Ferguson, Lieut.-Col. F. A., 407
 Fergus Wood, Maj. G., 495
 Festubert, battle of, 225-8, 250
 French-Mullen, Col. D. K., viii, 490, 495
 Field Coys. R.E.,
 general, 28, 38-42, 57, 140-51, 261,
 273, 274, 459
 Field Defences, 453-62
 Field Searchlight Coys., 40-2, 57, 488-98
 Field Squadrans, 38-42, 102, 272,
 426-42
 Field Troops, 38-42
 Findlay, Maj. G. de C. E., 396-8
 Findon, Lieut. R., 369
 Firmin, Maj. N. H., 60
 Fishbourne, Lieut. C. E., 188
 Fisher, Lord, 23
 Fitzpatrick, Brig. N. T., viii, x, 366
 Flame projectors, 88, 228
 Fleming, Lieut.-Col. J. G., 317, 328,
 344, 359, 362
 Flint, Lieut. R. B., 181, 183, 198
 Poch, Marshal, 219, 373, 381, 580, 634,
 640, 647, 649, 651, 653, 654
 Foot, Capt. S. H., 447
 Fordham, Col. H. M., viii, 389
 Forestry Directorate and Coys., 38-42,
 78, 166, 249, 302, 540, 543, 559, 565
 Forster, Capt. C. M., 60
 Fortescue, Hon. Sir John W., 1
 Fortress Coys., *general*, 38-42, 51, 54,
 210, 232, 540
 Fortress Works Coys., 41
 Foster, Lieut. T. H., 426
 Foulkes, Maj.-Gen. C. H., viii, 89, 96,
 159, 173, 205, 233, 508, 511, 515,
 701
 Fowke, Lieut.-Gen. Sir George, 25,
 154-61, 168, 175-7, 189, 190,
 541, 702
 Fowle, Col. F. E., viii
 Fowler, Maj.-Gen. Sir John S., 173, 702
 France and Flanders,
 see also Aisne, Arras, Aubers,
 Cambrai, Festubert, Loos, Marne,
 Mons, Neuve Chapelle, Somme,
 Passchendaele, Ypres, battles of,
 autumn, 1914, 175-206
 defensive work, 1915, 249-52
 final phase, 384-425
 general, 15, 130, 131
 German offensive, 1918, 336-83,
 440-3, 479, 549, 634, 643-51
 German withdrawal, 1917, 277-92,
 548, 564, 619, 629
 R.E. units, 211, 212, 273, 274
 spring and summer, 1917, 277-335
 summer, 1915, 228-49
 summer, 1916, 265-76
 winter, 1914-15, 206-9
 Francis, Lieut.-Col. H. S., viii
 Fraser, Maj.-Gen. Sir Theodore, viii,
 x, 25

- Frecheville, 2nd Lieut., 229
 Freeland, Maj.-Gen. Sir Henry P. E.,
 x, 123, 125, 173, 388, 612, 688,
 703
 French army, v r
 French, P. M. Sir John, 49, 54, 55, 89,
 154, 221, 308, 315, 518
 French General Staff, talks with, 6
 Friend, Maj.-Gen. T. B., 545
 Fuller, Maj.-Gen. A. C., 104, 106
 Fuller, Maj.-Gen. C. G., 703
 Fuller, Brig.-Gen. F. G., x
 Fuller, Col. J. F. C., 457
 Fullerphone, the, 106

 Gaine, Capt., 520, 532
 Gale, Brig.-Gen. H. K., 115, 171, 230,
 253
 Gallipoli operations, 13, 54, 77, 468
 Gamage, Lieut., 229
 Garbutt, 2nd Lieut. H. C., 376
 Gardner, 2nd Lieut., 375
 Garforth, Lieut. Col. W., 387
 Gaskell, Maj.-Gen. H. S., viii
 Gas directorate and special coys.,
 38 42, 233, 246
 Gas warfare, 38, 156, 217-19, 233, 241,
 243-9, 360, 363, 506-25
 Gaddes, Maj.-Gen. Sir Eric, 6, 125, 126,
 173, 547, 560, 611-13, 621, 629,
 631, 632, 634, 637
 General Staff, 3, 6, 21
 Geographical section, G.S., 111-13
 George V, H.M. King, xii, 151, 484,
 524
 German Offensive, 1918, 336-58, 359-
 83, 449-51, 479, 549, 634, 643-57
 German S.W. Africa, campaign in, 15,
 75
 German withdrawal, 1917, 277-92,
 518, 561, 619, 629
 Gibb, Col. Sir Alexander, 173, 610
 Gibbon, Brig.-Gen. J. A., x, 170
 Gidday-Kitchin, Col. E. C., viii
 Giles, Lieut. Col. F. L. N., 173
 Giles, Lieut.-Col. V., 280, 289, 316,
 670
 Gillam, Brig.-Gen. R. A., 170, 328
 Ginnard, Col. Sir F. Percy C., 117,
 586, 589, 590, 613
 Glubb, Maj.-Gen. V. M., 169, 191,
 197, 200, 207, 311, 670, 704
 Godly, Brig.-Gen. C., 169, 171, 207,
 225, 231, 265, 316, 325, 421
 Godsell, Major K. R., 180, 184, 350
 Goldney, Lieut.-Col. C. F. B., 328,
 344, 387
 Goodwin, Lieut.-Col. J. G. P., 348
 Gordon, Brig.-Gen. H. W., 469, 265,
 270, 318, 419
 Goodwin, Brig.-Gen., 276
 Gordon, Lieut. Col. P. J., 113
 Gorrings, Lieut.-Gen. Sir George F., 25
 Gorrings, Capt., 380
 Gosport Electric Light School, 58, 61
 Gough, Gen. Sir Henry 195, 337, 355, 636
 Goutlay, Lieut. R. L., 185
 Gowelland, Lieut. G. C., 191, 192, 204
 Graeme, Col. J. A., viii, 407, 410
 Graham, Capt. H. W., 463
 Graham, Lieut.-Col. O., 356
 Granet, Sir Guy, 326, 614
 Grant, Maj. J. R., 375
 Grant, Maj.-Gen. Sir Philip G., viii,
 x, 4, 105, 150, 169, 171, 214, 222,
 246, 253, 264, 280, 311, 355, 356, 704
 Grant Grieve, Capt. W., 268
 Greathead, Lieut., 434, 441
 Greenstreet, Col. C. B. L., viii
 Greig, Maj. J. P. S., 668
 Grenades, hand, 87, 99, 159
 Grey, Maj.-Gen. W. H., viii, 128, 632,
 670, 693
 Grieve, Capt. G., 463
 Griffith, Lieut. Col. D. M., viii, 217
 Griffith, Maj. Sir J. Norton, 159, 163,
 465, 466
 Grimshaw, Capt. G. E., 434, 435
 Guggisberg, Maj. F. C., 145, 262, 264
 Guinness, Col. V. E. G., viii
 Gundulph, Bishop, 4
 Gunter, Col. C. P., viii
 Gwynn, Maj.-Gen. Sir Charles W., 705

 Habibullah, King of Afghanistan, 14
 Hackett, Sapper W., 481
 Haggitt, Maj. E. D., viii
 Haig, Gen. Sir Douglas, 91, 212, 221,
 247, 292, 301, 225, 336, 381, 384,
 406, 416, 478, 481, 509, 513, 519,
 612, 549, 653
 Haldane, Brig., 188
 Haldane, Dr. J. B. S., 86
 Haldane, Visct., 1-9, 11, 12, 52
 Halewood, Lce.-Corpl., 179
 Hall, Maj. G. C. M., 119
 Hall, Lieut.-Col. H. A. L., 367
 Hall, Lieut.-Col. P. de H., 391

- Hamilton, Gen. Sir Ian, 53, 54
 Hammond, Brig.-Gen. F. D., viii, x, 120, 667
 Hardman, Maj., 389, 390
 Hards, Brig. P. W., viii
 Harper, Lieut.-Gen. Sir George M., 25, 298, 317, 705
 Harrison, Lieut.-Col. E. F., 93, 96, 510
 Harrison, Brig.-Gen. G. H., 115, 173, 542, 544, 550
 Harrison, Mr., 616
 Hartley, Brig.-Gen. Sir Harold, 512
 Harvey, Brig.-Gen. R. N., 157, 159, 170, 173, 302, 407, 470, 706
 Haw, 2nd Lieut. J., 147
 Hawksley, Brig.-Gen. R. P. T., 172
 Hay, Lieut. F. S., 435
 Hay, Sergt., 237, 240
 Hearn, Lieut.-Col. G. R., 245, 309, 320, 386
 Heath, Maj.-Gen. C. E., 69
 Heath, Maj.-Gen. G. M., 161, 169, 170, 207, 298, 339, 706
 Heath-Caldwell, Brig.-Gen. F. C., 51
 Hedley, Col. Sir W. Coote, 109, 113, 114, 531
 Hemming, Col. E. H., 47, 539, 542
 Hemming, Maj. G. H., 534
 Henderson, Col. G. P. R., 2
 Henderson, Capt. H. M., 187
 Henniker, Col. A. M., viii, x, 121, 573, 574, 586, 588, 655, 667
 Henniker, Lieut.-Col. G., viii
 Hewett, 2nd Lieut. A. F., 145
 Heyes, T. H. E., viii
 Heywood, Lieut.-Col. R. B., 216
 Hicking, Lieut. Col. H. C. B., 421
 Higgs, 2nd Lieut. H. J., 215, 224
 Hill, Maj. A. F. S., 439
 Hill, Brig.-Gen. C., 51, 170, 231, 265, 292, 298
 Hill, Prof. Leonard, 92
 Hill, Lieut.-Col. R. C. R., 447
 Hill, Col., 115
 Hillman, Maj. E. C., 376, 377, 378
 Hills, Col. E. H., 74
 Hindenburg Line, the, 277, 292, 325, 329, 385-93, 409, 416, 653
 Hobbs, Lieut.-Col. R. F. A., 265
 Hodgkin, Maj. A. E., 512
 Hodgson, Lieut.-Col. P. E., 304, 315, 368, 373, 380, 419
 Hogg, Lieut.-Col. C. C. H., 157, 565
 Holland, Brig.-Gen. G. E., 173, 601
 Holmes, Mr., 483
 Holt, Lieut. H. W., 178
 Home Forces, 49, 53, 54
 Homer, Lieut.-Col. E. E. F., 407, 419
 Hopkins, Capt., 165
 Hopkins, Lieut.-Col. L. E., 667
 Hopkins, Maj. N. J., 177
 Hopkins bridges, 165
 Hopkinson, Prof., 89
 Horne, Lieut.-Col. R., 356
 Horrocks, Col. Sir William, 506, 510
 Hosegood, Maj. C. B., 283
 Hospitals,
 at Home, 71
 in France, 545
 in Italy, 689
 Howard, Lieut.-Col. A. C., 348, 422
 Howard, Maj. F. G., 178, 192
 Hoysted, Maj. D. M. F., 195, 197
 Hughes, Maj.-Gen. H. B. W., 9
 Hunter, Brig.-Gen. C. G. W., 171, 230
 Hunter-Weston, Lt.-Gen. Sir Aylmer, 25, 195, 264, 269, 317, 373
 Husey, Brig.-Gen. R. H., 376
 Huskisson, Maj.-Gen. W., 169, 170, 265, 542
 Hutting,
 at Home, 69-75, 80
 France, 80, 164, 254, 255
 Hyland, Maj.-Gen. F. G., viii
 Imperial General Staff, 176
 Independent Air Force, 548, 549
 Indian Army, 13, 76
 Indian Corps, 207, 427, 435-7, 541, 585, 589
 Inglis, Maj. (Prof.) C. E., 80, 102, 160, 164, 450, 558
 Inglis, Lieut., 235
 Inglis bridges, 80, 102, 103, 164, 406, 450
 Inland Water Transport,
 directorate, 127, 625, 640
 general, 116, 125-7, 576, 601, 610, 627, 638
 Inland Water Transport and Docks
 coys., units and depots, 29, 38-42, 123, 126, 129
 Inspector General of Fortifications and
 R.E., 4, 9, 97
 Inspector of Iron Structures, 45, 78, 99, 100, 627
 Inspector of Lights, 44
 Inspector of Mines, 470, 558, 561

- Inspector of R.E. stores, 100, 104
 Inspector of Searchlights, 41
 Institution of Royal Engineers, 539
 Intelligence, engineer, 161, 167
 Inundations, 167, 549, 640, 647
 Irwin, Lieut.-Col. N. M. S., 356
 Italy, operations in, 95, 96, 129, 325, 359, 548, 631, 632, 636, 669-95
 engineer troops in, 132, 485, 670-73
 Izat, Lieut.-Col. W. R., 371, 385, 420
 Jack, Brig. E. M., x, 173, 526-9
 Jackson, Sir John, 73
 Jackson, Maj.-Gen. Sir Louis, viii, 26, 45, 47, 48, 57, 84-91, 99, 233, 515
 Jackson, Lieut.-Col. R. D., 407
 Jacobs-Larkcom, Lieut. E. H., 378
 Jarvis, Lee.-Corpl. C. A., 179, 180
 Jellicoe, Admiral, 55
 Jerome, Lieut.-Col. H. W., 216
 Jerome, Lieut.-Col. T. S., 47, 140
 Jessep, Col., 115
 Joffre, Marshal, 22, 221, 254, 292, 616, 619
 Johnson, Lieut.-Col. C. R., 321, 368, 415, 419, 434
 Johnson, Lieut.-Col. D., 397
 Johnson, Maj. F. H., 236, 334
 Johnson, Col. W. J., 115
 Johnson, Lieut., 141
 Johnston, Capt. W. H., 181, 182, 198
 Joly de Lotbinière, Brig.-Gen. A. C., viii, 172, 253, 264, 318, 320
 Joly de Lotbinière, Brig.-Gen. H. G., 170, 171, 298, 316, 320, 415
 Jones, Lieut.-Col. H. B., 186, 193
 Jones, Brig.-Gen. L., 171, 231
 Jordan, Lieut.-Col. P. O. L., 420, 426
 Joseph, Maj. S. H., 229
 Keeling, Maj. B. E. F., 536
 Keen, Lieut.-Col. S., 216
 Kellner, Lieut.-Col. T. S., 591, 602, 628
 Kelly, Lieut.-Col. W. H., viii, 320
 Kelsail, Lieut.-Col. T. F., 201, 264, 407
 Kemp, Lieut.-Col. G. C., 200, 229
 Kenney, Col. A. H., 140, 216, 225
 Kensington, Lieut.-Col. G. B., 667
 Kent, Col. E., 45, 47
 Kent, Col. H. V., 52
 Kenworthy, Maj., 561, 687
 Kenyon, Maj.-Gen. E. R., 169, 170, 230, 292, 294, 297, 300, 707
 Kermack, Lieut., 488
 Kerrich, Brig.-Gen. W. A. F., 671, 673, 677, 679, 683
 Kezar, Lieut., 440
 Kiggell, Maj., 352
 King, Maj.-Gen. C. J. S., 9
 King, Lieut.-Col. L. N. F. L., 537
 King, 2nd Lieut. M. H., 379
 King, Capt. W. B. R., 160, 501
 King George V's Own Sappers and Miners, 41
 Kirkness, Lieut.-Col. L. H., viii, x
 Kirkpatrick, Gen. Sir George, 26
 Kitchener, F.-M. Earl, *Frontispiece*, 11-21, 25, 52, 53, 69, 76, 86, 117, 134, 148, 589, 612
 Knox, Capt., 423
 Knox, Lieut. C. L., 432
 Knox, Lieut.-Col. G. S., 265, 343
 Labour battalions, R.E., 163, 258, 272
 Laffan, Col., 115
 Lambert, Maj. B., 510, 512
 Lambert, 2nd Lieut. H. R., 291
 Land Drainage Coys., 38, 41, 249
 Land mines, 343
 Lands, directorate of, 540
 Langemarch, battle of, 317, 318
 Lawson, Maj.-Gen. Sir Henry M., 26, 118, 123, 670, 688, 691, 707
 Lee, Maj.-Gen. Sir Richard P., x, 25, 169, 214, 225, 316, 708
 Leeming, Capt., 89
 Lees, Lieut.-Col. E. F. W., 317, 328, 407
 Lefroy, Capt. H. P. T., 104, 531
 Legh, Maj. F. B., 536
 Le Mesurier, Maj., 695
 Leslie, Maj.-Gen. G. A. J., 20, 225
 Leslie-Carter, Lieut. W. C., 378
 Lethbridge, Sergt., 203
 Lewis, Capt. C. G., 147
 Lewis, Maj. H. L., 242
 Lewis, Maj. R. A., 99
 Lewis, Lieut.-Col. R. H., 560
 Ley, Maj., 90
 Liddell, Maj.-Gen. Sir William A., viii, 9, 157, 162, 168, 169, 355, 499, 505, 708
 Lightfoot, Capt. K., viii
 Light railways, 130, 166, 256, 257, 303, 313, 327, 547, 577, 600, 608, 616, 637, 638, 659, 665
 Lindsay, Maj.-Gen., 155, 156

- Lines of Communication
 France, b. 7, 76; 82, 157
 general, 153
 Lister, Capt., 89
 Livens, Capt. W. H., 88, 89, 521
 Livingstone, Lieut.-Col. H. A. A., 217,
 244, 245
 Lloyd, Maj. J. W., 307
 Lloyd-George, D., 13, 22, 80, 290, 607,
 612-14, 639
 London Electrical Engineers, 35, 40-2,
 59-64, 101
 Longden, Lieut.-Col., 695
 Longe, Col., 115
 Loos, battle of, 20, 200, 229-49, 250,
 433, 434, 456, 508, 517-21, 532
 Lovat, Brig.-Gen. Lord, 174, 565
 Lowbridge, Maj., 389
 Lubbock, Brig.-Gen. G., viii, 667
 Luck, Maj. S., ix, x
 Ludendorff, Gen., 475
 Lyell, Col. D., ix, 573-5, 617, 655
 Lynam, Maj. C. G., 402, 405
 Lyon, Capt., 345
 Lyons, Col. Sir Henry, 134, 536
 Lyons, Lieut. and Qr.-Mr. J., 558

 MacAdam, Col. W., 47, 72
 Macaulay, Lieut.-Col. R. K. A., 355,
 377, 421
 Macauley, Lieut.-Col. Sir George, 119
 McClellan, Maj., 379
 McClintock, Capt., 99, 151
 McCombie, Maj. H., 512
 McCourt, Lieut., 239
 McCrone, Capt., 348, 351
 Macdonald, Maj.-Gen. Sir James, 119
 Macdonald, Col. R. H., 134
 Macdonnell, Col., 115
 Macdonough, Gen. Sir George M. W.,
 25, 709
 Macdougall, Maj. D. A., 386
 McEnery, Capt. J. A., 301
 McInnes, Brig.-Gen. D. S., 168, 310,
 319
 Mackenzie, Lieut.-Col. R. H., 421
 Mackesy, Lieut.-Col. J. P., 229, 264,
 270
 McLaren, Sergt., 396
 MacLeod, Maj.-Gen., M. N., x, 534
 McKay, 2nd Lieut. D. F., 369
 MacMunn, Gen. Sir George F., ix
 MacNaught, Lieut., 236
 Maconochie, Lieut. H. D., 439

 McQueen, Lieut.-Col. J. A., 347, 353,
 359, 364
 McPherson, Lieut.-Col. J. E., 216
 McPhie, Corpl. J., 417
 Macready, Lieut. G. N., 186
 MacWhirter, Capt., 239
 Macedonia, operations in, 620, 621
 Madge, Maj. R. G., 495
 Magniac, Brig.-Gen. Sir Charles E., ix,
 x, 667
 Mainguy, Capt. R. F., 436
 Mair, Lieut.-Col. R. J. B., 280
 Malan, Col. L. N., ix, x
 Mallins, Lieut. J. W. D., 243
 Mallinson, Lieut., 166
 Mance, Brig.-Gen. Sir H. Osborne, ix,
 x, 120-2, 126, 127, 612
 Mansel, Maj. A. S., 421
 Manton, Brig. L., ix, x, 573-5, 667
 Maps,
 France and Belgium, 109, 526-32,
 538
 Italy, 685
 Marconi, Signor, 83
 Marne, battle of, 193, 194, 429, 488
 Marr-Johnson, Maj., 586, 587
 Marsden, Corpl., 180
 Marshall, Brig.-Gen. H. J. M., 171,
 264, 359, 420, 670
 Martel, Lieut.-Gen. Sir Giffard le Q.,
 ix, x, 100, 199, 445, 447, 451
 Martelli, Capt. H. de C., 587
 Martin, Lieut. K. J., 205, 209
 Master, Lieut.-Col. G., x, 407
 Master General of the Ordnance, 5
 Matheson, Col. J. C., 89
 Matthewson, Lieut., 441
 Mathy (German Air Force), 57, 62
 Maud, Brig. P., ix, 66
 Mawby, Maj. A. W. M., 495
 Maxwell, Col. G. A. P., ix, 119, 667
 Maxwell, Lieut.-Gen. Sir Ronald, 25,
 51, 133, 569, 587, 709
 Maybury, Brig.-Gen. Sir Henry, 73,
 173, 616
 Mechanical transport, 251, 570, 659
 Melvin, Lce.-Corpl. 236
 Menin Road, 318-20
 Merivale, Lord (formerly Mr. Duke), 74
 Mesopotamia,
 engineer troops, 132
 operations, 1914-18, 15, 39-42, 77,
 80
 river transport, 128, 132

- Messenger Dog service, 42
 Messines, battle of, 292, 301-5, 312, 474, 631
 Meteorological sections, 38-42
 Michel, Mr. J. D., 69
 Micklem, Col. H. A., 127
 Middle East, 620, 631
 Middleton, Lieut.-Col., 695
 Midwinter, Lieut.-Col. E., 119
 Mildred, Maj. S., 235, 264, 270
 Miller, Lieut., 375
 Mills, Mr., 87, 456
 Mills, Wallis, 485
 Mills bombs, 87, 456
 Mining and Mines, 107, 159, 163, 217, 247, 261, 267, 269, 302, 431, 454, 460, 462-82, 657
 Mining Coys., 41, 460
 Mining Stores Depot, 41
 Mobilization, R.E., 120, 134
 Molesworth, Col. F. C., ix
 Monier-Williams, Maj. G. W., 512
 Monkhouse, Capt., 64
 Monro, Gen. Sir Charles, 231
 Mons, battle of and retreat from, 53, 154, 177-93, 417, 428, 429
 Montgomery, Maj.-Gen. Sir Archibald, 390, 398
 Moore, Lieut.-Col. A. T., 201
 Moore, Lieut. L. T., 345
 Moreland, Capt., 89
 Morgan, Col., 686
 Morgan, Lieut.-Col. Sir Charles, 128
 Morris, Capt. J., 68
 Morshead, Lieut. Col. H. T., 387
 Mouat-Jones, Lieut.-Col. B., 507
 Mount, Lieut.-Col. Sir Alan H. L., ix, x, 667
 Movement control, 581, 616
 Mozley, Lieut.-Col. E. N., 328, 407, 418
 Mullaly, Maj.-Gen. H., 51, 133
 Munitions,
 general, 18-20, 125, 607, 611, 612, 639
 Ministry of, 48, 84, 90-2, 94, 99, 108, 125, 578, 607, 612
 Murray, Gen. Sir Archibald, 21
 Murray, Brig.-Gen. Sir Valentine, 173, 589, 590, 666
 Nanton, Brig.-Gen. H. C., 171, 172, 207, 253, 265, 292, 298
 Napier-Clavering, Lieut. Col. N. W., 415
 Narracott, Capt. R. W., 225
 Nash, Maj.-Gen. Sir Philip, 651
 Nash, Mr., 612
 Neame, Capt. P., 209, 223
 Neary, Sapper, 180
 Neuve Chapelle, battle of, 212-18, 250
 Newark, Reserve Training Centre, 34, 37, 139
 New Army,
 general, 17, 37, 134, 138
 training of a unit, 140-51
 Newcombe, Capt. S. F., 189, 190
 Newell, Lieut.-Col. E. M., 298, 328, 346, 418
 Newman, Capt., 463
 New Zealand military forces, 14
 "Nine brave men," 275
 Nissen, Maj., 80, 164, 562
 Nissen huts, 80, 164, 254, 296, 562, 566
 Nivelles, Gen., 301, 619, 630
 Noble, Col. N. D., ix, x
 Nolan, 2nd Lieut., 236
 Norman, 2nd Lieut. T. V., 342
 North, Maj. C. N., 185, 186, 192, 203
 Oakes, Lieut.-Col. R., 47, 78, 81, 99, 100, 125, 558
 Oakes, Lieut., 399
 O'Connor, Lieut.-Col., 695
 Odoni, Capt., 677, 682
 Officers, R.E., provision of, 32-6
 Officer i/c R.E. records, 30
 Ogilvie, Col. Sir Francis, 89
 Ogilvy, Lieut.-Col. D., 310, 322, 418
 O'Meara, Maj. W. J., 141
 Ommauey, Capt. R., 205
 Ordnance depots, 72
 Ordnance Survey, 109-15, 529
 Osborne, Brig.-Gen. Delano, 127
 Otway, Lieut., 378
 Paget, Lieut.-Col. Sir Cecil, 595
 Painter, Col. A. C., x, 170
 Pakenham-Walsh, Lieut.-Col. R. P., 407, 419
 Palestine, operations in, 80
 Palmer, Lieut.-Col., 559
 Panet, Brig.-Gen. A. E., 172, 253, 264, 303, 321, 415
 Pank, Lieut. R. D., 433, 434
 Parker, Lieut. J. A., 237, 238, 240
 Parkes, Capt., 688
 Parks, R.E., 501
 Parrish, Corpl., 237

- Passchendaele, battle of, 305, 311-25,
 477, 631
 Paul, Brig.-Gen. E. M., ix
 Payne, Corpl. A., 178
 Peacock, Lieut., 269
 Pears, Col. G. B., x
 Pearson, Col. H. L., ix
 Pearson, Maj., 695
 Pennycuik, Brig. J. A. C., ix, 181,
 183, 187, 188
 Penrose, Brig.-Gen., 115
 Perceval, Maj., E. M., 120
 Perkins, Lieut. A. F. Q., 192, 203
 Perowne, Brig. L. E. C., ix, 68
 Pétain, Gen., 381, 649, 652, 653
 Peters, Mr., 84
 Petrie, Brig.-Gen. R. D., 170, 221,
 327
 Petty, 2nd Lieut. J. M., 404, 405
 Philpotts, Lieut.-Col. B. S., 317
 Phipps, Brig. C. C., ix, x
 Piggott, Maj.-Gen. F. S. G., ix
 Piave, crossing of, 672-83
 Pilckem Ridge, battle of, 315-17
 Pill-boxes, 312
 Pioneers, 231, 460-2
 Pitcairn, Lieut.-Col., 689
 Pitt, Lieut.-Col. R. B., x
 Playfair, Maj.-Gen. I. S. O., ix
 Plumer, Gen. Sir Herbert, 220, 318,
 421, 670, 688
 Pocock, Lieut. J. C., 398
 Pollard, Lieut.-Col. G. C., 306, 309,
 325, 387
 Pollard-Lowsley, Maj. H. de L., 236,
 319, 321
 Pontoon Park Coys., 38-42, 280
 Pope, Prof. W. J., 92
 Port Construction Coys., 131
 Porter, Maj.-Gen. W., iii
 Ports, work at
 British, 82
 French, 579, 610
 Portuguese Army, 359-63
 Postal services, 38-42, 210
 Pottinger, Lieut. C. E. R., 180
 Pottle, Lieut. H. C., 379
 Powell, Brig.-Gen. S. H., 47, 55, 171,
 253, 264
 Powell, Lieut., 346
 Pratt, Capt. J. Davidson, 93
 Preedy, Col. C., ix
 Prendergast, Col. T. J. W., 47
 Prentice, Lieut.-Col. H., 217
 Prichard, Col. W. C. H., ix, 58, 159, 174,
 489, 491
 Printing Coys. and Sectns., 38-42, 111,
 112, 210
 Pritchard, Maj.-Gen. H. L., iii, iv, ix,
 171, 192, 206
 Quarries, 547, 626
 Quarrying Coys., 29, 38-42, 129, 130
 Raban, Col. Sir Edward, 47, 55, 60, 61
 Radcliffe, Lieut.-Col. P. J. J., 230
 Railway Depots and Coys., 29, 118,
 120, 121, 123, 129-32, 210, 272,
 591-92, 596, 624
 Railway Executive Committee, 121-8
 Railway Operating Units, 38-42, 594,
 608
 Railway Staff Corps, 124-8
 Railway Transport Establishment,
 585-9
 Railway Transport Section, 120
 Railway units, 38-42, 117, 119, 129,
 608, 624, 646, 659, 661, 665
 Railways,
 British, assistance by, 124
 Engineer and Staff Corps, 124-8
 historical, 116
 in France, 6, 79, 123, 166, 256-7,
 302, 547, 569, 573-668
 mobilization arrangements, 120
 rolling stock, 598-9, 620-3, 664
 South Africa, 117
 stores, 120, 121, 125, 602, 607, 662
 Sudan, 117
 war regulations, 153
 Railway, light, 130, 166, 256, 257,
 303, 313, 527, 547, 577, 600, 608,
 616, 637, 638, 659, 665
 Rainsford-Hannay, Maj. A. G., 379
 Rainsford-Hannay, Brig.-Gen. F., 9, 133
 Ranging Sectns., 38-42, 527-9
 Ramsay, Sir William, 86
 Rathbone, Lieut.-Col. H. E. F., 324
 Rawlinson, Gen. Sir Henry., 253
 Rawlinson, 68
 Rayfield, Lieut.-Col. F. A., ix, x
 Rebbeck, Lieut. W. H., 379
 Reconnaissance, R.E., 281
 Redman, Col. A. S., 121, 127
 Redwood, Sir Boverton, 89
 Rees, Brig.-Gen. H. C., 356
 Reid, Lieut.-Col. A. W., 670

- Reid, Maj. C. S., 532, 534, 686
 Rendel, Palmer and Tritton, 125
 Rendell, Capt. E. F., 496
 Renny Tailyour, Lieut. H. F., 204
 Respirators, anti-gas, 307-14
 Rhind, Capt., 396
 Rhodes, Brig. Sir Godfrey O., x, 119, 667
 Rhodes, Capt. J. P., 484, 485
 Rice, Maj.-Gen. Sir Spring, 51, 161, 168, 169, 175, 207, 279, 456, 710
 Rice, Lieut., 367
 Richard, Lieut. and Qr.-Mr. A. W., 561
 Richards, Maj. F. W., 401
 Richborough, cross-Channel services, 123, 127, 9
 Richmond, Capt., 89
 Riddick, Lieut.-Col. J. G., 407
 Roads,
 directorate, 540, 637
 France and Flanders, 256, 258, 293, 299, 302, 312, 592, 599-601, 608, 626, 627, 637, 638
 Italy, 690
 United Kingdom, 73
 Road Construction Coys., 29, 38-42, 129, 130
 Roberts, Lieut.-Col. G. B., 280, 320, 328, 334
 Roberts, Brig. W. H., ix
 Roberts, Lieut., 370
 Robertson, Col. F. W., ix, 101
 Robertson, F.-M. Sir William, 14, 21, 49, 55, 515
 Robertson, Lieut.-Col., 687
 Robinson (later Wakely), Maj. A. V. T., 100, 300, 558
 Robinson, Col. E., 64
 Robinson, Lieut., 62
 Rogers, Mr. A., 87
 Rogers, Maj. H. S., 271
 Rolland, Brig.-Gen. A., 169, 280, 384, 419
 Rooke, Lieut.-Col. E. H., 304, 670, 671
 Ropeways, wire, 81, 693
 Rose, Capt. L. St. V., 201
 Ross, Col., 687
 Rotherham, Lieut.-Col. W. H., 140, 207
 Royal Air Force,
 general, 46, 72, 550
 works directorate, 540, 550
 Royal Anglesey Royal Engineers, 35, 118, 130, 135, 207
 Royal Corps of Signals, vii
 Royal Engineers,
 board, 98, 106, 108
 Royal Engineers,
 committee, 44, 48, 83, 85, 96-108
 expansion, 1914-18, 27, 37-42
 officers, 24-31, 263
 organization, 154, 155, 301
 training, 4, 7, 10, 27
 Royal Engineers, Coys.,
 Army Troops, 161, 162
 Field, 175, 208, 210, 211
 Fortress, 161, 175
 Telegraph, 83
 Royal Flying Corps, 17, 46, 47, 72, 79, 84, 232, 546, 548, 550
 Royal Geographical Society, 113
 Royal Military Academy, Woolwich, 33, 42, 136
 Royal Military College, Sandhurst, 42
 Royal Monmouthshire Royal Engineers, 35, 118, 130, 135, 207, 211, 220
 Royal Naval Air Service, 56
 Royal Navy, 49, 50
 Royal Tank Corps, 443-52
 Ruck, Brig.-Gen. R. M., 9, 53, 55
 Rudd, Thomas, 4
 Rundall, Lieut.-Col. C. F., 265, 328, 385
 Rundle, Gen. Sir Leslie, 54
 Russell, Col. W. K., 667
 Rushton, Brig.-Gen. H. W., 170, 265, 280
 Russell, Sir Walter, 483
 Russell-Brown, Lieut.-Col. C., 184, 242, 280, 283, 306, 309, 325
 Russia, engineer troops in, 132
 Ryan, 2nd Lieut., 235
 St. John, Col. C. W. R., 539
 Salmon, Lieut.-Col. F. J., 530
 Salonika operations near,
 general, 39-42, 77, 231
 engineer troops, 39-42, 131
 Sambre-Oise canal, 393
 Sandbach, Maj.-Gen. A. E., 169, 175, 207
 Sandbags, 79
 Sanders, Maj.-Gen. G. A. F., 26
 Sandes, Lieut.-Col. E. W. C., vi, ix
 Sandys, Lieut.-Col. E. S., x, 426, 427, 433
 Sankey, Lieut.-Col. C. E. P., 102, 152, 387, 398, 426
 Sankey, Capt. M. P. H., 47
 Sappers and Miners,
 First K.C.V's. Own, 207, 211, 213
 Third, 207, 211

- Sargeaunt, Lieut.-Col. A. F., 200, 228
 Savage, Lieut.-Col. A. J., 385, 418
 Sayer, Brig. A. P., ix, 236, 237, 240, 241
 Scarpe, battle of, 414-16
 Scevola, G. de, 483
 Scheme Z., 648
 Scholes, Corpl., 144
 Scholfield, Brig.-Gen. G. P., 170, 200, 205, 245, 303, 315, 319
 School of Electric Lighting, later A.A. Searchlight School, 41, 58, 59, 64
 School of Military Engineering, 33, 44, 133-7
 Schreiber, Brig.-Gen. A. L., 140, 169, 195, 225, 264, 278, 280, 286, 328
 Scientific Advisory Committee, 89, 90, 106
 Scott, Dr. Sir Alexander, 89
 Scott, Admiral Sir Percy, 56
 Scott-Moncrieff, Maj.-Gen. Sir George K., ix, 9, 44, 45, 69, 84, 710
 Scudamore, Brig.-Gen. E. W. V., ix
 Seaman, Lieut.-Col. E. C., 47, 82
 Searchlight Coys., field, 40-2, 57, 488-98
 Searchlights, 50, 56-68, 82, 83, 167, 488-98, 672, 675, 676
 Searle, Col. P., 448
 Seely, Col. John, 11
 Sewell, Brig.-Gen. J. S., 172, 545, 556, 558, 560, 561, 568, 569
 Shakespear, Brig. A. T., ix, 205, 384
 Shanks, Maj. W., 285, 286, 396
 Sharpe, Lieut. H. F., 379
 Shelley, Col. B. A. G., ix, 545, 686-8
 Shephard, Capt. G. J. V., 160
 Sheppard, Maj.-Gen. S. H., ix, 26
 Sheridan, Lieut.-Col. P. C., 695
 Shingleton, Maj. L., ix
 Shipping, 81, 126-8, 638
 Short, Maj. C. M., 64
 Shortt, Col. A. C., ix
 Sibbeth, 2nd Lieut., 229
 Siege Coys., Special Reserve, R.E., 40, 41, 207, 211
 Signal Experimental Establishment, 104-6
 Signalling, 103-6
 Signal Service, B.E.F., 210
 general, vii, 27, 28, 34, 38-42, 48, 83, 101
 organization for war, 155
 training centre, 104-6
 Sim, Col. G. H., 134
 Sim, Lieut. G. E. H., 426
 Simon, Col. M. St. L., 60, 89
 Simon, Maj. V. H., 248, 438
 Sinai, survey, 110
 Sinclair, Col. H. M., 123
 Singer, Brig.-Gen. C. W., 171, 180, 183, 306, 309, 359, 421
 Sinnott, Lieut.-Col. F. S., 216
 Skey, Col. F. E. G., ix, x
 Skinner, Lieut.-Col. T. C., 230
 Skipwith, Lieut.-Col. J. W., 205, 324, 422
 Slaterry, Capt. F. J., 379
 Smith, Lieut. A. G., 192, 206
 Smith, Brig.-Gen. G. E., ix, 545, 670, 686-9
 Smith, Lieut. T., 433
 Smith, Capt. V. P., 197, 198
 Smith, Maj. W. G., 283, 396
 Smith, Sergt., 179, 180
 Smith-Dorrien, Gen. Sir Horace, 182, 183
 Smith-Skelton, Capt., ix
 Smyth, Lieut. G. F. B., 184, 186
 Solomon, Lieut.-Col. S. J., 483-5
 Somme, battle of the, 88, 165, 245, 265-76, 435, 473, 535, 607
 preparations for battle, 253-65, 605
 water-supply, 501
 Somme, bridging, 279
 Sound Location and Ranging, 64, 67, 101, 107, 326, 531-7
 South African War, 111, 117
 Sowrey, Lieut., 62
 Special Brigade, R.E., 82, 88, 89, 159, 163, 508-25
 Special Reserve, 33, 35, 40-3
 Special Works Park (Camouflage), 38-42, 100, 484
 Spencer, Lieut.-Col. C. L., 216, 225, 561
 Squires, Lieut.-Gen. E. K., ix
 Stafford, Lieut. J. H., 191
 Stafford, Brig.-Gen. W. J. H., 51
 Stallard, Maj. G. H., 668
 Stapylton-Smith, Lieut., 342
 Stephens, Lieut., 286, 287
 Stevenson, Maj.-Gen. A. G., ix, 170, 201, 229, 407, 475
 Stewart, Col. W. R., 47
 Stewart, Brig.-Gen., 124, 646
 Stockley, Brig.-Gen. E. N., 172, 304, 309, 316, 422, 670

- Stokes, Sir Frederick, 87
 Stokes, Maj. R. G., 470
 Stokes Mortars, 87, 89
 Stone, Lieut. R. G. W. H., 426
 Stone, 2nd Corpl., 188
 Stone, supply of, 562
 Stores and Equipment, R.E.,
 directorate, 540
 general, 44, 48, 76, 77, 107, 251,
 262, 544, 553
 Story, Lieut.-Col. P. F., 421
 Strachan, 2nd Lieut., 145
 Stranack, Col. F. K., ix
 Stratton, Col. W. H., ix
 Strong, 2nd Lieut., 376
 Stuart, Maj.-Gen. Sir Andrew M., 46,
 47, 172, 538, 550, 711
 Stuart-Wortley, Col. the Hon. H. R.,
 120, 122
 Submarine Mining, 50, 52
 Sudan campaign, 1896-8, 117
 Summers, Lieut.-Col. F., 419
 Survey,
 France and Flanders, 526-8
 Italy, 685-6
 units, 686
 Survey, Artillery, 107, 326, 526-38
 Survey Coys. and Sectns., 38-42,
 110-14
 Survey of India, 112, 113
 Sutton, Capt., 89
 Sutton, Lieut. C., 376
 Swinburne, Maj. T. A. S., 185, 429, 447
 Swinton, Maj.-Gen. Sir Ernest D., ix,
 x, 26, 58, 444, 7, 711
 Symons, Lieut.-Col. C. B. O., 316, 341,
 384, 391
 Szlumper, Mr. C., 121
 Tamlyn, Maj. W. H., 342
 Tandy, Maj. M. O'C., 445
 Tank Corps, 75, 446, 452, 548
 Tanks, 88, 327-9, 443-52, 622
 Tanner, Brig.-Gen. J. A., 170, 230,
 251, 265, 292, 297
 Tardenois, battle of, 380-2
 Taylor, Maj.-Gen. Sir G. Bryan O., x, 9
 Telegraph Construction Coys., 41
 Telegraphy, 103-6
 Tempest, Lieut. W. J., 62
 Territorial Forces,
 field coys., 176, 208
 general, 3, 14-16, 33, 40-3, 50-3,
 55, 58, 59, 176
 Thomas, Lieut.-Col. R. H., 280, 306, 309
 Thompson, Maj.-Gen. R. L. B., ix, x,
 9, 46, 544, 557, 565
 Thornton, Maj.-Gen., 127
 Thorpe, Prof. J. F., 88, 92, 93
 Threlfall, Sir Richard, 87
 Thuillier, Maj.-Gen. Sir Henry F., ix,
 x, 9, 26, 91-3, 96, 173, 242, 316,
 509, 511, 671, 673, 712
 Tickell, Maj.-Gen. Sir Eustace, lii, x, 9
 Timber, supplies of, 166, 561, 562,
 566
 Tomlin, Lieut. J. L., 104
 Topographical Sectns., 38-42
 Townshend, Capt. F. H. T., 484, 485
 Traill, Lieut.-Col., 387
 Train Ferry Coys., 129
 Training Battalion, R.E., 135-7
 Training Depot, Aldershot, 37-42, 138,
 139
 Tramways,
 France, 166, 256, 303, 599-601, 608,
 660
 trench, 209, 212, 247, 251, 263, 296
 Transportation,
 Directorate, 126, 155, 590, 614-18
 Italy, 690
 Phase I (Aug. to Oct., 1914), 576,
 585-92, 624
 Phase II (Nov. 1914 to Sept. 1916),
 576-8, 593-624
 Phase III (Oct. 1916 to end of War),
 578, 579, 595, 611-33
 references, 116-32, 166, 293, 313,
 560, 563, 573-633, 614-18
 stores, 627
 Transportation,
 War Office, 116-32
 Transportation units, R.E., 29, 30,
 42, 43, 75, 123, 129-32
 Travers, Maj. G. A., 30
 Trelawny, Capt., 89
 Trench, Col. A. H. C., ix
 Trench mortars, 149, 156
 Trench warfare,
 dept. of D.F.W., 45, 46, 48, 79, 84,
 85, 89-91, 99, 107, 108
 France, 198, 250, 251, 261, 262
 general, 156, 450, 462
 research dept., 91, 92
 Trewby, Lieut. A., 227
 Trodd, Mr., 139
 Tucker, Capt. and Qr.-Mr. A. N., 48,
 81

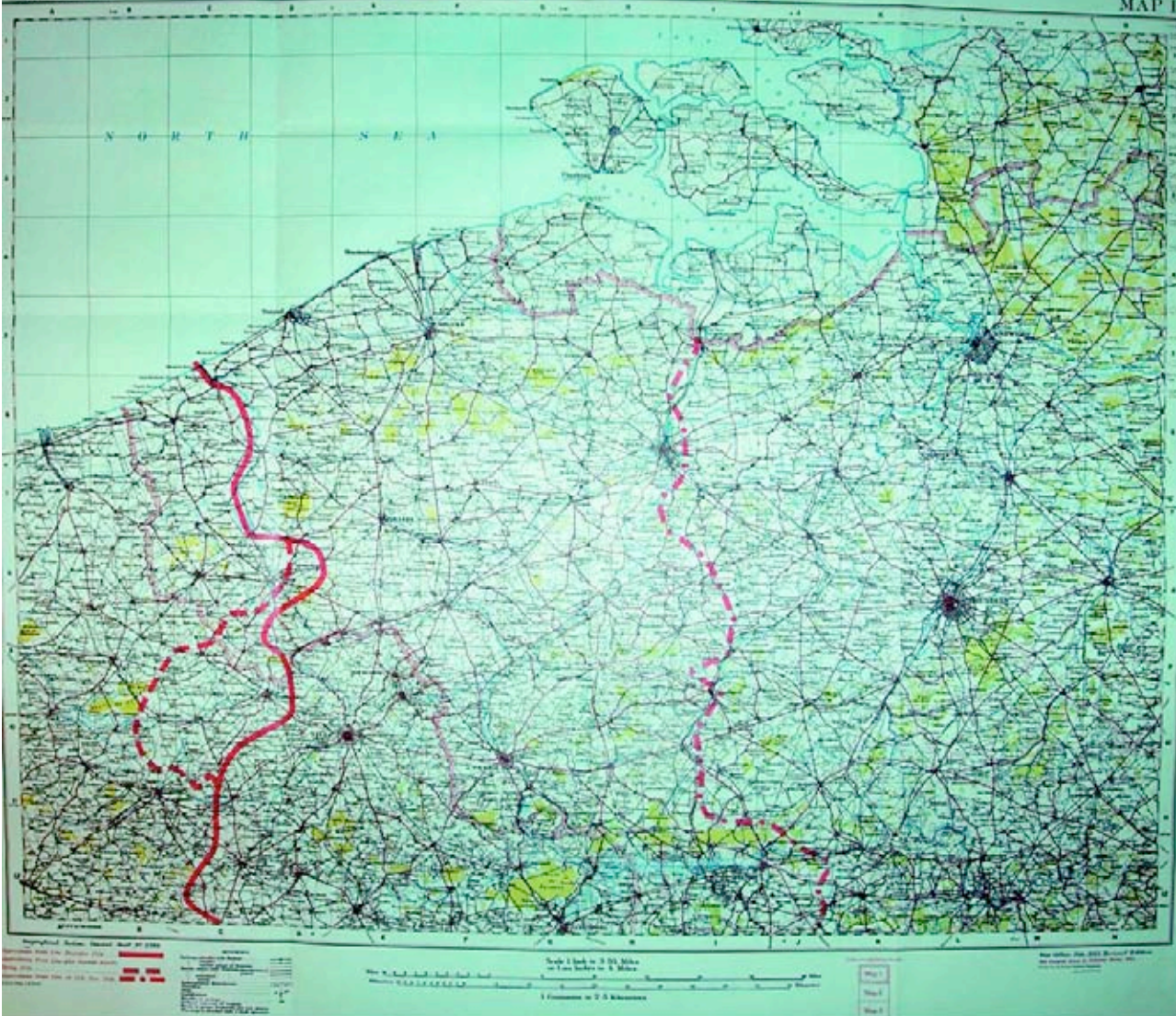
- Tudor, Brig.-Gen. E. A., 170
 Tulloch, Brig.-Gen. J. A. S., 171, 180, 231, 253, 264, 304, 316, 319
 Tunnelling, 167, 223, 267, 298, 463-82
 Tunnelling Coys., R.E., 28, 35, 38-42, 163, 167, 208, 217, 223, 234, 267, 272, 280, 281, 295, 425, 463, 82
 Turner, Capt. A. G., 229
 Turner, Major. R. A., 671
 Twining, Maj.-Gen. Sir Philip G., 9, 46, 712
 Twiss, Brig.-Gen. J. H., 122, 123, 173, 586, 589-91, 604, 617, 622, 624
 Tyler, Lieut. A., 205
 Tyler, Maj. A. H., 203, 204
 Tyne Electrical Engineers, 35, 40-2, 59-64
 Tyrell, Brig.-Gen. W. G., ix

 Vanrenen, Lieut.-Col. J. E., 230, 248
 Vaughan, Capt., 561
 Verey, Lieut.-Col. H. G., 695
 Vesey, Maj. C. E. G., 207, 214
 Vibart, Lieut. N. M., 204
 Victoria Cross, awards,
 Archibald, 399
 Cloutman, 414
 Coffin, Clifford, 317
 Dawson, 248
 Findlay, 397
 Hackett, 482
 Jarvis, 180
 Johnson, D., 397
 Johnson, E. F., 236, 334
 Knox, 342
 McPhie, 417
 Martin, 209
 Neame, 209
 Waters, 399
 Wright, 180
 Vincent, Brig.-Gen., 330
 Vincent, Capt., 88, 89
 Von Donop, Gen., 515
 Von Kluck, Gen., 483
 Vye, Sapper, 204

 Waghorn, Brig.-Gen. Sir William D., 123, 171, 173, 410, 591, 595, 617, 666
 Wagon Erecting Coys., 38-42, 130
 Wait, Col. H. G. K., ix, 82, 558, 686
 Wakely (formerly Robinson), Maj. A. V. T., 100, 300, 558
 Walker, Lieut.-Col. A. D., 327, 343, 346
 Walker, Brig.-Gen. G., 171, 181, 182, 187, 188
 Walker, Sir Herbert, 121
 Walker, Maj. R., 223, 224
 Walker, Lieut.-Col. R. S., 316
 Wall, Lieut., 341
 Waller, Brig.-Gen. R. L., 172
 Walsh, 2nd Lieut. R. E., 345, 346
 Walton, Lieut.-Col. C., 667, 695
 Walton, Lieut.-Col. G., 667
 War Babies, facing 174
 Ward, Col. B. R., 30, 134
 Ward, Capt. Sir T. C., ix
 War Dog School, 42
 Waring, Maj. W. H., ix
 Warneford, Lieut. R. A. J., 57
 War Office, 11-21
 Wars,
 American Civil, 2
 Balkan, 1912-13, 151
 Crimea, 624
 Egypt, 624
 Russo-Japanese, 2, 151, 454, 464
 South Africa, 13, 454, 581, 591
 Sudan, 13, 454, 591, 624
 Water Boring Sectns., 38-42, 501
 Water Supply,
 Committee, 499-501
 Egypt and Palestine, 80, 81
 France and Flanders, 165, 167, 254, 255, 257, 271, 294, 295, 307, 308, 386, 498-505, 563
 general, 79
 stores, 563
 Water Supply Coys., 41, 498-501
 Waters, Maj. A. H. S., 399
 Watson, Col. Sir Charles, iii
 Watson, Lieut.-Col. G. J., 667
 Watson, Lieut.-Col. W., 507, 510
 Watson, Lieut., 349
 Wauhope, Col., 115
 Webb-Bowen, Col. H. E., ix, x
 Webster, Maj. H. W., 371
 Wedgewood, Brig.-Gen. Sir Ralph I, 173, 616
 Weekes, Col. H. W., ix, 133, 141
 Weir, Mr. A., 84
 Wellesley, Lieut. G. J., 215
 Wells, Lieut. C. S., 404
 Wells, Lieut.-Col. L. F., 407, 410
 Wells, Lieut. R. C., 187
 Wemyss, Admiral, 55
 West, Capt. C. A., 187, 344, 347
 Westland, Maj. F. C., 188, 189, 195, 281

- Westropp, Lieut. F. M., 328
 Wheeler, Corpl., 346
 White, Col. F. A. K., ix, x, 293, 304, 318, 425
 White, Lieut.-Col. J. R., 365, 679
 Whitmore's Cosmopolitan Force, 353
 Whittall, Maj. P. F., 344, 351
 Whitwill, Maj. M., 349
 Wickham, Capt. J. C., 436
 Wicks, Capt., 89
 Wilbraham, Col. B. H., 526-8, 537
 Williams, Maj.-Gen. Sir Godfrey, x
 Williams, Gen. Sir Guy C., iv, ix, x, 223, 307, 310, 322, 347, 351, 471
 Williams, Brig. Gen. S. F., 179, 217, 248, 265, 277, 280
 Williams, Lieut., 365
 Williamson, Maj. A. S., 344
 Wilson, Gen. Sir Charles, 110
 Wilson, Brig.-Gen. C. E., 171, 177, 206, 251, 280, 317, 320, 670, 671, 673
 Wilson, Lieut.-Col. F. H., ix
 Wilson, F.-M. Sir Henry, 109
 Wilson, Brig.-Gen. Sir Samuel H., ix
 Wilson, Lieut.-Col. W. R., 243, 287, 421
 Wingate, Maj. M. R., 344
 Wingfield-Stratford, Brig.-Gen. C. V., 216, 248, 265, 270
 Winsloe, Lieut.-Col. A. R., 248
 Winterbottom, Brig. H. St. L., ix, 508, 509, 522, 534, 536, 685, 686
 Wireless Telegraphy, 98, 99, 101, 103
 Wireless Telegraph Exptl. Sectn., 53, 101
 ; Wess, Capt. D. F. S., 434, 436
 Werts, Maj.-Gen. F. V. B., ix
 Wollerson, W. A., ix
 Wood, Maj. H., 534, 537
 Wood, Serge., 404
 Woodhouse, Lieut.-Col. E., 127
 Woodhouse, Brig. F. L., ix
 Works,
 at Home, 68, 75
 in France, 539, 552
 in Italy, 686-90
 Works Coys., 40, 41
 Works Directorate, 539-52
 Workshops in France, 167, 567
 World War II, 574
 Wright, Maj.-Gen. H. D., x
 Wright, Lieut. R. G., 186, 194
 Wright, Capt. T., 179, 180, 198
 Wyatt, Brig.-Gen., 367
 Wyatt, Col. F. J. C., ix, 100, 164, 174, 484, 485
 Wyeth, Maj. F. J. S., 512
 Wynne, Col. O. E., 526
 Young, Maj.-Gen. B. K., x, 189, 190, 194
 Young, Dr. C. R., 93
 Ypres,
 1st battle, 19, 156, 201-6, 217, 430, 455, 153
 2nd battle, 85, 159, 218-22, 452, 413, 506, 514
 3rd battle, 202, 311-15, 403, 631
 Yule, Lieut.-Col. J. S., ix, 391

NORTH WEST EUROPE



Approximate Front Line after German retreat to Hindenburg Line Spring 1917

[illegible]

Miles 0 1 2 3 4 5 6 7 8 9 10

Kilometres 0 5 10 15 20 25 30 35 40 45 50

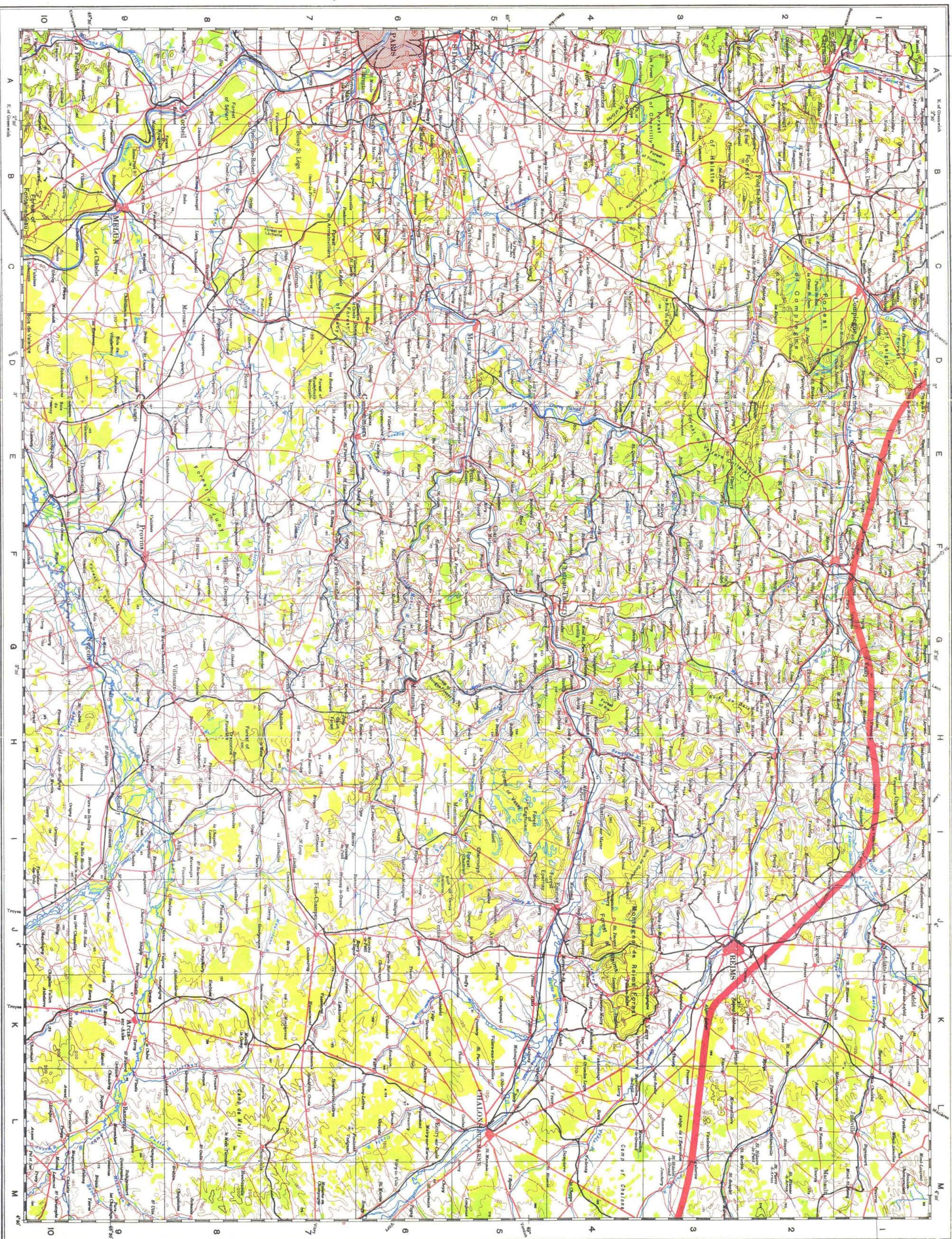
The white specks on the paved roads are 1/2 mile apart.

Prepared and Printed at the Ordnance Survey Office, Southampton, 1920.
Red overprint drawn by the Ordnance Survey, 1951.

Printed by 42 Survey Engineer Regiment.

4000 6/784 / 8409851

Indices to adjoining sheets





MAP 4

