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CONTENTS.

MONTGOMERIE PRIZE.

ATTENTION is invited to the conditions under which this prize, in value about £10, is offered for competition each year.

1. The Prize shall be awarded by the R.E. Institute Council in the manner considered best or the encouragement of contributions on professional subjects, by R.E. Officers, to the Corps publications. From the beginning of 1920 it has been decided that the Prize shall be confined to Officers on the Active List not above the rank of Substantive Major.

2. The Prize shall consist of (*a*) a book on Survey, Exploration, Travel, Geography, Topography, or Astronomy; the book to be whole-bound in leather, and to have the Montgomerie book-plate with inscription inside; (*b*) the remainder of the year's income of the Fund in cash.

3. The name of the recipient of the Prize shall be notified in the Corps publications; and copies of the contribution for which the Prize was awarded shall be presented to the representatives of the donors.

The following are suggested as subjects for contributions:—

(*a*). Descriptions of works actually carried out in peace or war.
(*b*). Inventions.
(*c*). Design (excluding works of defence).
(*d*). Labour organization on work.
(*e*). Scientific investigations generally.
(*f*). Accounts of exploration work and surveys.

MILITARY WIDOWS' FUND, BRITISH SERVICE, INDIA.

THE Military Widows' Fund, British Service, was established in India in 1820 to alleviate the distress of families of officers of the British Service *serving in India*, and to enable them to return to England without unnecessary delay. Whenever an officer of the British Service, who is a subscriber to the Fund, dies, his family receives at once the following assistance, namely, six months maintenance allowance ranging from Rs 2,400 to Rs 3,600 according to the rate subscribed, plus Rs 1,500 as a donation for the widow, plus Rs 500 or Rs 300 as a donation for each child according to whether the child is over 12 and under 21 years of age or under 12 years of age. These benefits are secured by a small subscription of Rs 4, 3 or 2 per mensem, which is regulated by the amount of pay an officer draws. An officer, on becoming a subscriber, secures for his wife and children quite irrespective of his length of service in India, the full benefits of the Fund in case of his death after having subscribed for fully three months. In the event of an officer dying within that period, his case is specially considered by the Committee of General Management. Copies of the regulations of the Fund and other particulars relating thereto can be obtained from the Secretary at Simla.

THE WORK OF THE ROYAL ENGINEERS IN THE EUROPEAN WAR, 1914—1919.

CHEMICAL WARFARE.

1. Introduction.

The special *personnel* employed on this work during the late War was formed into Royal Engineer units under the supreme direction of a regular Royal Engineer officer, and an account of the activities of these units therefore properly belongs to the history of the Royal Engineers in the War. In the following notes only a brief outline will be given of the general organization, both offensive and defensive, and of the work done. No attempt will be made to describe chemical developments or technical details.

Chemical warfare in the shape of the discharge of clouds of poisonous gas was instituted without warning by the Germans early in 1915. After full consideration it was decided to undertake a similar offensive in retaliation, and Major C. H. Foulkes, D.S.O., R.E., commanding the 11th Field Company, R.E. (later Brigadier-General C. H. Foulkes, C.M.G., D.S.O.), was summoned to General Headquarters to organize the necessary measures. He at once prepared a report giving an outline of suggested tactics, etc.—a remarkable document almost completely borne out in after years. He then went to England to examine existing resources.

2. First Period.

Owing to the backward state of the chemical industry in the United Kingdom before the War chlorine was the only gas available for offensive purposes. Although easy to extemporise protection against, chlorine was by no means ineffective as a battle gas.

The output in June, 1915, was, however, very limited, and the existing plant had to be expanded and suitable receptacles, discharge pipes, etc., designed and manufactured. In addition suitable gas *personnel* had to be enlisted, organized into units, and trained. Four Special Companies were at first authorized, and civilian chemists were specially enlisted as Corporals, R.E. A similar number of suitable men were drawn from infantry battalions in the line, thus supplying the necessary practical trench experience.

Officers were obtained :—

(*a*).—By transfer in France of infantry officers with knowledge of chemistry, and—

(*b*).—By specially qualified civilians given commissions in England.

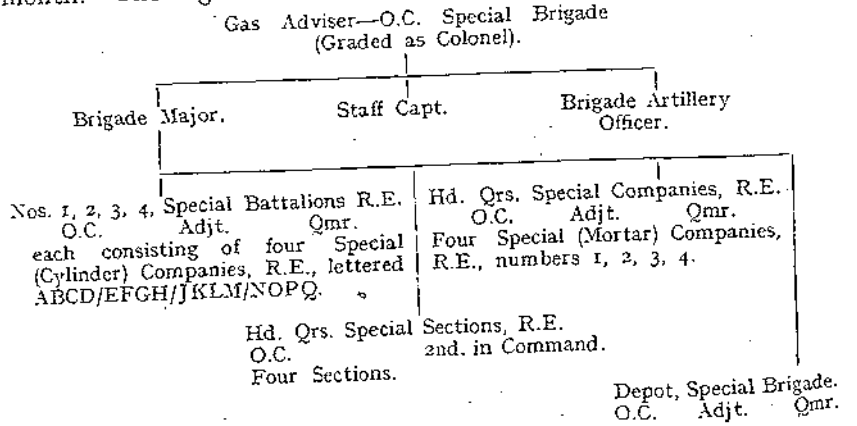
Men came out slowly from England, but one Special Company, R.E. (No. 186) was formed in July, and the other three (Nos. 187, 188, 189) were in being at the opening of the Battle of Loos.

All four Companies were formed and trained at a special depôt at Helfaut under Major Foulkes, whose title at this time was Gas Adviser, and who had direct access to the C.G.S., with whom he chiefly dealt.

Loos—September 25th, 1915.—Only seven weeks were available for training, and the work of organization was not complete before the Battle of Loos, and 12 officers from infantry battalions resting behind the line had to be borrowed to assist in the first gas attack at this battle. There had been no time to organize the systematic collection of information, and in consequence the impression was general throughout the Army that the results of this first gas attack had been comparatively ineffective. That this was by no means the case was acknowledged in the German official communiqué, and was later proved by a quantity of documentary and other evidence. Altogether, considering all the circumstances, it was no mean performance on the part of the Trench Warfare Department that gas was discharged at all on such a large scale only three and a half months after the first decision had been taken by G.H.Q.

Developments during Winter, 1915-16.—Subsequently to the Battle of Loos the method of releasing the gas was considerably improved by the introduction of rubber piping, and a number of smaller attacks were carried out during the Autumn and Winter of 1915, and early months of 1916. During this period phosgene was adopted as the main battle gas; the 4in. Stokes mortar was taken into use, and an apparatus was developed which showed a marked improvement as regards range over the "Flammenwerfer" first employed by the enemy at Hooge on July 30th, 1915.

An expanded organization for a "Special Brigade R.E.," put forward early in October, 1915, was approved by the War Office on the 17th January, 1916, and formation began during the same month. The organization was as follows:—



Special (Cylinder) Company, R.E. (lettered).—Armed with pistols and bandoliers—organized in a headquarters and six sections—total *personnel* eight officers, 250 other ranks.

Special (Mortar) Company, R.E. (numbered).—Each armed with with 48 4in. Stokes mortars—men equipped with rifle and bayonet—organized in a headquarters and four sections, each section divided into three sub-sections, each sub-section forming four mortar crews—total Company, 18 officers, 310 other ranks.

Special Sections, R.E. (for Flame Projector).—Each section consisted of three sub-sections each of which provided crews for two projectors (these sections were never fully equipped or up to strength). The Corporals of the first Special Companies were distributed throughout the Brigade as a nucleus, and the additional *personnel* was obtained for :—

Cylinder Companies—

(*a*).—Men with chemical qualifications transferred from infantry battalions in France.

(*b*).—Men with qualifications or of superior intelligence and good physique from England.

Mortar Companies—

(*a*).—40 young Artillery officers sent from England.

(*b*).—Men transferred from infantry or Trench Mortar Batteries in France.

(*c*).—Men from England.

Drafts from England arrived very slowly, and finally 1,000 R.A. drivers were obtained from the Base in France during June, 1916, which brought the Brigade up to something like strength. Most of the officers were obtained from units already in France, the chief qualification being practical experience in the front line. Temporary officers were transferred to R.E.; S.R. and T.F. were seconded. Practically none were allowed to be drawn from R.E. units. A great many commissions were given to the original chemist Corporals.

The Special Sections, R.E. were formed in England under Captain Livens, R.E. Special Reserve, both officers and men being principally drawn from the Royal Engineers. They arrived in France in July, 1916. The armament was intended to consist of 24 large and 48 portable flame projectors. The former required about 90 men loads each; while the latter weighed 160lbs. and were very bulky and awkward to carry. Very little practical use was actually made of these, but the special sections carried out a series of experiments at Toutencourt throughout the Summer and Autumn of 1916, and the well known Livens projector was first tried there.

3. SECOND PERIOD.

The first Battle of the Somme provided the second distinct phase in the evolution of chemical warfare. This was a period of cloud discharges, mainly of white star gas, of which no fewer than 110 took place. By this time a high standard of efficiency had been attained, and subsequently to July 1st, practically all the discharges were carried out at night, a procedure which, while adding to the technical difficulties of the attacks, greatly increased their effect on the enemy. The large flame-projectors were fired ten times (two came into action just before zero on July 1st), and the semi-portable type four times.

In September the earliest gas projector discharges took place opposite Thiepval and Beaumont Hamel, ordinary oil cans being used as mortars, and others of smaller diameters as bombs.

In October a very successful cloud attack was carried out on the French front at Nieuport.

4. THIRD PERIOD.

Considerable developments took place in the year 1917. During the Winter, 1916-17 there was no general withdrawal of the Special Companies from the line, but the projector was developed and greatly improved—large numbers were manufactured, and the Brigade was trained in its use.

In February, 1917, a reduction of about 15 per cent. of the strength of the special Brigade was effected in order to provide *personnel* for gas defence in various formations.

The first projector operation on a grand scale was carried out on April 4th at the opening of the Battle of Arras when 2,268 drums were fired. Many discharges took place subsequently during 1917, as well as a few cloud attacks, and assistance was also rendered to the Belgian Army by attachments of the Special Brigade.

By April, 1917, sufficient supplies of bombs filled with lethal and lachrymatory gas, as well as with smoke and thermit, had been received in France, and all the mortars of the Brigade were continuously engaged in carrying out gas bombardments or in co-operating in Infantry raids with smoke and thermit. Drums filled with oil, thermit, phosphorus, and "stinks" were fired at times from the Livens projector, in addition to its normal projectile—the gas drum.

Oil drums primarily designed for incendiary purposes were frequently used when projectors had been installed, but when conditions made the use of gas uncertain or undesirable, and later drums filled with thermit were fired on several occasions. Drums filled locally with red phosphorus were designed to form smoke screens at points beyond the range of the 4in. Stokes mortar; and use was made of various chemicals which produced an unpleasant but innocuous smell. Bombs filled with such "stinks" were frequently used i

raids, and led the enemy to put on masks unnecessarily in the belief that they were being gassed.

Revised Organization.—During this year the organization was changed. The four battalion headquarters and the headquarters, Special Companies, each becoming Headquarters, Special Companies, R.E. First-Fifth Armies. Cylinder Companies retained their lettering, and used cylinders or Livens projectors according to circumstances. Mortar Companies retained their numbers and their Stokes mortars, but gradually were instructed in the use of projectors. Special Sections, R.E. became 'Z' Special Company R.E. (Projectors), and were also later instructed in the use of cylinders. Companies were allotted to Armies as required by the tactical situation.

In July, 1917, a new departure was made by the production of a gas warfare monthly summary of information, which was issued by the General Staff and widely distributed up to the end of the War.

5. Fourth Period.

In December, 1917, the Special Companies after many months of continuous activity were withdrawn into G.H.Q. Reserve for rest and training, and the opportunity was taken to develop a new method of cylinder discharge from retired positions. Great efforts were also made to overcome the main difficulty that had been experienced in gas installation, namely, that presented by the shortage of labour; and the use of light trench tramways was developed, and the Leeming principle of aerial ropeway transport adopted.

At the end of January, 1918, the first two American Gas Companies were attached to the Special Brigade for instruction, and to complete their training they took part in several of the actual gas attacks on the British front.

Early in March operations were resumed against the enemy and many of the Companies were involved as infantry during the great German attacks. At one period preparations were complete for organizing them into an infantry brigade in case of need, but the scheme was not actually put into operation.

Ten retired cylinder operations on a large scale were carried out in nine cases from railway trucks which were run up into position d withdrawn immediately after the discharge, and no fewer than 30 projector operations were completed. In fact, so well did the mpanies adapt themselves to the new tactical conditions that, spite of being 20 per cent. under strength, their activity in this eriod was actually greater than at any other time during the War, nd infantry assistance could be largely dispensed with. With the velopment of the cloud method of attack, the provision of a satis-tory design of percussion fuze for gas bombs (the 147), the arrival the Leeming ropeway, etc., offensive operations had reached eir maximum of efficiency at the time the Armistice was signed.

6. SUMMARY OF OPERATIONS.

Altogether during the War 768 gas operations (in addition to many smoke) were carried out as under :—

	Cylinders discharged.	Projector drums fired.	4-in. Stokes Mortar Bombs fired.	Flammenwerfer fired.
1st period	6,045	—	—	—
2nd " "	42,559	290	3,754 gas 15,936 smoke	12
3rd "	12,183	98,102	100,532 gas 14,800 smoke and thermit	2
4th "	27,181	95,476 gas 3,072 dummy oil and smoke	34,874 gas 7,512 smoke and thermit	—
Total ...	87,968	196,940	177,408	14

This represents a total of 5,700 tons gas discharged apart from smoke, oil, and thermit.

The magnitude of these operations varied from the electrical discharge of 5,110 cylinders (148 tons of gas) to the firing of a few score Stokes mortar bombs from the outskirts of a partially captured village. The largest simultaneous discharge of projector drums took place on 21st March, 1918, when 3,728 drums and 920 4in. Stokes mortar bombs were fired into Lens and its outskirts. On another occasion, March 19th, 1918, 2,959 drums were fired into St. Quentin. The largest discharge of oil drums took place on June 4th, 1917, when 1,500 drums were projected into the woods on the slopes of the Messines Ridge.

Nor do the operations tabulated above represent the whole of the work carried out by the Special Brigade; a great many other operations were prepared, but were not completed owing to the changes in the tactical situation, or for other reasons. For instance 286 tons of gas were ready for liberation in front and on the south flank of the Messines Ridge in June, 1917, but conditions were not favourable for discharge until after the successful advance, when the operation was abandoned. Very many smoke operations were also carried out which cannot be included in the table, both by 4in. Stokes Mortar Companies, and also by Cylinder Companies. In one such operation just north of Armentières on September 28th, 1918, 15,000 smoke candles were lighted by a single Special Company.

Surprise was always the essence of success in these operations and this combined with variety was constantly sought after, even to the extent of "violating the laws of gas warfare," of which the enemy actually complained in a captured order! It is an interesting fact

that the surprise tactics of carrying out short concentrated bombardments with lethal gas, which were adopted by all the Allied artilleries, and later still by the enemy, were first practised by the Mortar Companies.

In the intervals of their normal occupation the Special Companies were constantly employed on various engineer duties such as bridging, railway, road and trench construction, etc., etc. Table I. illustrates the total amount of gas discharged on each night during the War. *Photograph* I. shows flame projectors in action; *Photo*. II. shows Livens projectors being loaded, and *Photo*. III. bombs from Livens projectors bursting.

7. Casualties Inflicted on the Enemy.

Gas officers of the various formations worked in close touch with the intelligence branch of their respective staffs, and collected a large amount of information from time to time of the results of the various gas operations. Evidence was obtained from the following sources, which are arranged in order of value :—

(*a*).—Observations and deductions made by our own troops.
(*b*).—Statements of prisoners and deserters.
(*c*).—Letters and diaries found on the battlefield.
(*d*).—Enemy official documents.

The majority of the evidence that was collected related to the losses of small units forming only a portion of the enemy's troops known to have been affected, but casualties amounting to several hundred were frequently reported as the result of single operations. No information could be obtained regarding more than half of these attacks, and the only complete account ever received was volunteered by a deserter with reference to a cloud attack carried out on the French front at Nieuport on October 5th, 1916. On this occasion nearly 1,500 of the enemy were reported to have lost their lives, though this particular operation was not thought at the time to have been very successful owing to the installation having been discovered by a hostile raiding party some days previously. It was frequently reported, more especially in the later stages of the War, that German prisoners appeared to have received definite instructions from their officers to conceal their gas losses, and the existence of the necessity for re-assuring their troops was disclosed in a number of captured documents. For instance the following extract from a statement issued by "Gas Services, Sixth Army," dated 20. 1. 17, was captured in August, 1918 :—

* * * * * * * * * *

"Cylinder attack. In the evening (13. 11. 16) a cylinder attack in two waves took place between 6.45 and 8 p.m. from the

English positions from Blairville to Ficheux on the boundary between the First and Sixth Armies. The very dense wave, principally chlorine, was carried by the northwest wind at a speed of 2-3 metres per second a long way over the country, so that men at a distance of 50 kilometres from the point of discharge smelt chlorine strongly, and were affected with coughing. There were no casualties."

* * * * * * * * * *

Another of our gas clouds had been previously reported by a German officer to have inflicted casualties at a distance of 36 kilometres, but the improbability of the statement in the above report that there were no casualties is obvious, especially as the effects of this particular operation had already been reported from two quite independent sources as follows:—

"Prisoner put the deaths at 20 per cent. of the Regiment due to the men having masks in which the screwing portion was old and defective."

"The Fusilier Regiment's 1st Company had approximately 40 casualties, of which 25 eventually proved fatal."

Both these regiments were in the front line.

It will be long before the influence of these operations on the course of the War can be justly estimated. From the available evidence it was considered by the Director of Gas Services that the enemy lost approximately one man from every cylinder discharged, from every five drums projected, and from every ten Stokes mortar bombs fired, and that the mortality amounted to at least 25 per cent. of the total casualties.

8. Accidental Losses from Gas.

Only on two occasions during the War did our own troops suffer any serious losses from our own gas.

The first was on September 25th, 1915—on this occasion the number of discharge pipes was insufficient, only two being available for each emplacement, so that they had to be connected to one cylinder after another during discharge, a procedure which resulted in a certain amount of leakage. Further escapes of gas were caused by the intense hostile artillery retaliation provoked; while in the northern part of the front of discharge the direction of the wind was unfavourable, and although cylinders were turned off a few seconds after they had been opened, some of the bays were flooded with gas.

The reports, current at the time, of the casualties, were fortunately much exaggerated; in actual fact the bulk of the cases were very mild, and only 10 proved fatal (including three of the gas *personnel*).

The second accident took place on September 1st, 1916, opposite

Messines, when for some unexplained reason the cloud blew back over part of the front of discharge for a few minutes; precautions to prevent crowding of the trenches had been taken, and only 19 of the casualties proved fatal.

The only other accidental casualties that occured were :—

(*a*).—From projector drums falling wide. Only three or four instances of this nature took place, and casualties were very few.

(*b*).—From cylinders being burst while awaiting discharge in the trenches. Careful records show that about thirty accidents of this kind were reported. In about half there were no casualties at all, while in the whole of the remainder 29 fatal cases of gas poisoning occurred, a very small number considering the extent of the front and the length of the period covered; (as many as 20,000 cylinders have been in position in the trenches at one time).

The casualties among *personnel* of the Special Brigade amounted during the whole War to 5,384, but those due to gas poisoning were never high except on the two occasions mentioned above.

9. Defensive Organization and Training.

Immediately after the first German gas attack in April, 1915, defensive measures were organized from the office of the Director General of Medical Services.

During June and July, 1915, officers were appointed at the Headquarters of Armies to direct anti-gas defence and training, a school being established for this purpose in each Army. These officers, known at first as Chemical Officers, then Gas Officers, were finally given the title of Chemical Advisers.

In March, 1916, both the offensive and defensive branches of Gas Services were co-ordinated under the Director of Gas Services at G.H.Q., who at once obtained official recognition of the appointment of Gas Officers at Divisional Headquarters, appointments which had previously been unofficially filled by locally selected officers in the case of certain Divisions only.

Divisional Anti-gas Schools were placed on an established basis, and six trained gas N.C.O.s, many of whom were drawn from the Special Brigade, were included on the establishment of each Divisional Gas Officer. Of these N.C.O.s one was attached to each Infantry Brigade in order to check unit inspections and respirators, to supervise the general state of gas defence in the brigade, and to report on gas attacks or gas bombardments of any magnitude. Of the remaining three, one was attached for duty to the Divisional Artillery, and the other two acted as Instructors at the Divisional Anti-gas School.

In March, 1917, the development of anti-gas work occasioned by the increased use of gas led to the appointment of a Corps Chemical Adviser to every Corps Headquarters.

In November, 1917, Divisional Anti-gas Schools were abolished and Corps Anti-gas Schools substituted, with the idea of increasing the centralization of training. This policy would have been still further extended during the Winter of 1918 if hostilities had not ceased, the intention being to form five Central Gas Schools to take the place of the Army and Corps Schools as Anti-gas Wings of the general Central Schools.

In all cases anti-gas training was carried out in accordance with a definitely laid down scheme which was defined in a pamphlet issued by the General Staff "Defence against Gas" (S.S. 534.).

The average number of respirators inspected monthly by members of the Gas Services as a check on unit inspections in Army areas during the latter months of the War was well over a quarter of a million. In many cases Divisional Commanders found it advisable to appoint unofficial Brigade Gas Officers, and this was done in about 75 per cent. of the infantry brigades in the line. In some cases also unofficial gas officers were appointed for Divisional Artillery, Corps Heavy Artillery, Corps Troops, etc.

Training at the Bases.—In January, 1916, a Chemical Adviser was appointed to Headquarters L. of C. to co-ordinate respirator issues, fitting, training, and inspections at bases. The work of training reinforcements and casuals was carried out at six Base Anti-gas Schools under the control of the Chemical Adviser L. of C.; during the year 1918 alone no less than 1,557,809 all ranks passed through these Base Schools.

Central Laboratory.—The Central Laboratory was first established in April, 1915, at St. Omer, and subsequently moved to Hesdin. In addition to miscellaneous work undertaken for various departments and not connected with the subject of gas, the laboratory carried out all analyses made in France of enemy gas shell filling, German respirator containers, contaminated earth, water and clothing, as well as periodical examinations of British respirators and containers withdrawn from general service.

The final organization of the whole of the gas services in France as existing at the end of the War is given in the Appendix.

10. Notes on Enemy Gas Services.

Although the enemy had a considerable start in chemical warfare it is certain that he very soon fell behind in both offensive and defensive methods and tactics. His defensive measures always appeared to be inferior to our own, though the thoroughness of collective protection varied greatly with formations. It is, however,

not intended here to outline the history of the evolution of enemy gas warfare: two specific illustrations are given below, as being of interest.

The first known employment by the enemy of projectors similar to our own was on 10th-11th December, 1917, opposite Cambrai and Givenchy. Just before the great offensive of March, 1918, a demonstration was reported to have been given with new German projectors—these consisted of iron tubes specially made resembling open gas cylinders, and were built into the ground close together. As far as the informant knew no base plates were employed and on discharge the projectors sank about three feet into the earth. A thousand H.E. projector drums were reported to have been fired by the enemy at the opening of the offensive on the 21st March.

Photo. IV. shows an enemy projector installation that was captured at Boisleux-St. Marc on August 21st, 1918. 123 projectors were dug in, in three parallel rows, and were practically completed for firing at the moment of capture. *Plate* I. gives details of the ordinary German Flammenwerfer.

In June, 1918, a grenade was found by the French which was similar to the ordinary German stick grenade, was marked with a 'G' and labelled with instructions, of which the following is the translation:—"Gas hand grenade, time fuze—only to be thrown in the direction of the wind or in a current of air. Cloud formed on explosion."

In addition to the explosive effect the grenade produced a gas effect similar to that of blue cross shell.

Origin of Flammenwerfer.—The following translation of an extract from the *Hamburger Nachrichten* is interesting:—

* * * * * * * * *

"Our Flemmenwerfer troops owe their origin to a mere incident. Their present commander, Major R., when an officer of the Reserve, received the order, during peace manœuvres, to hold a certain fort at all costs. During the sham fight, having employed all means at his disposal, he finally alarmed the fire brigade unit, which was under his orders as commander of the fort, and directed the water jets on the attacking force. Afterwards, during the criticism of operations in the presence of the Kaiser, he claimed that he had subjected the attackers to streams of burning oil. The Kaiser thereupon enquired whether such a thing would be possible and he received an answer in the affirmative.

"Long series of experiments were necessary before Engineer L. succeeded in producing a combination of various oils, which mixture is projected as a flame on the enemy by means of our present-day Flammenwerfer.

"Major R. occupied himself in peace time with fighting fire as commander of the Munich Fire Brigade. The 'Prince of Hades,' as he is called by his 'fire spouters,' enjoys great popularity among his men as well as among the troops to whose assistance he may be called.

He can look back on an important development of his units. Whereas in January, 1915, Flammenwerfer troops consisted of a group of 36 men, to-day they constitute a formation with special assault and bombing detachments, and are furnished with all requisities for independent action.

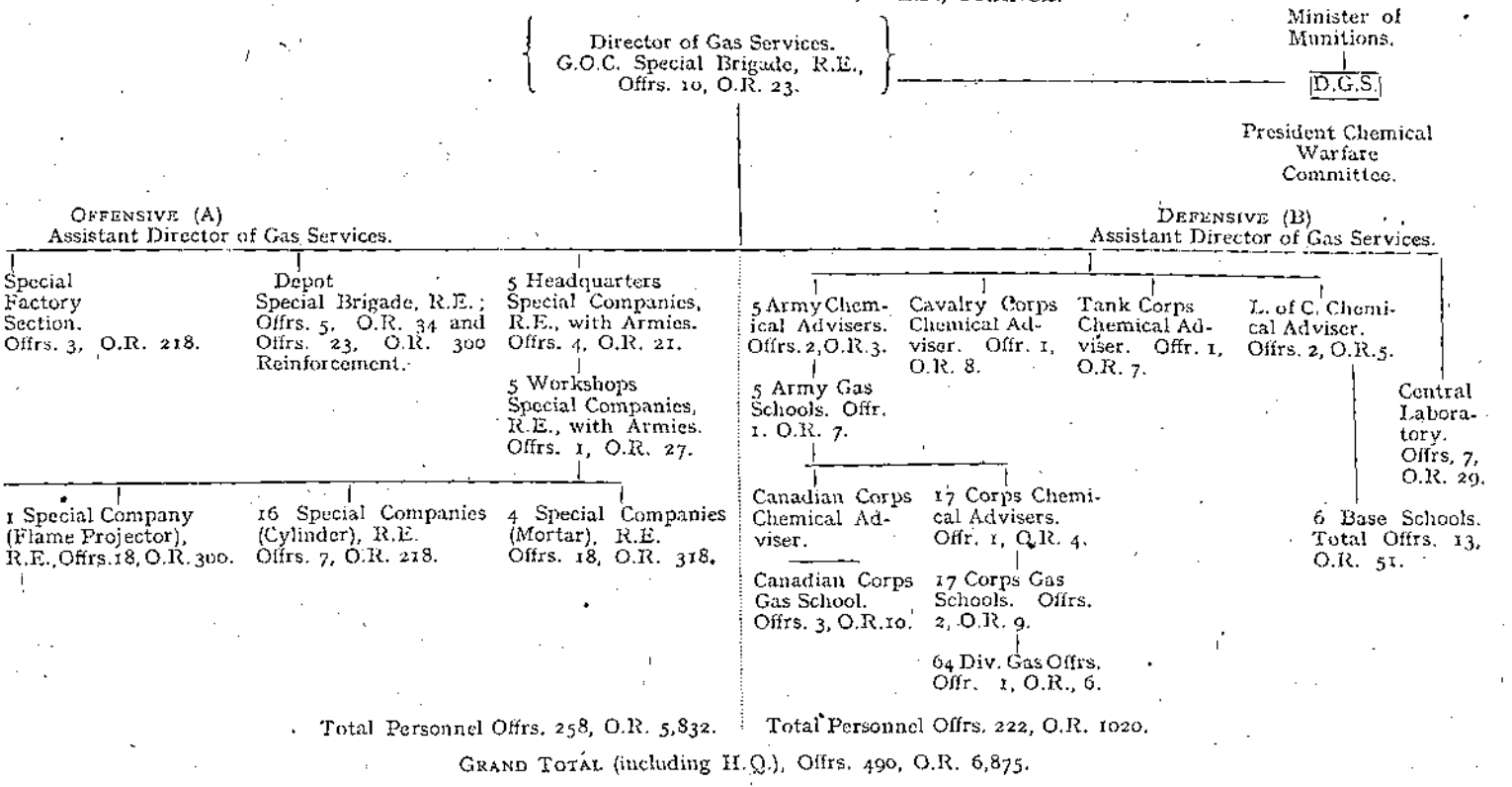
In reading Army communiqués, we often find mention of these troops. If difficulty is experienced in clearing up an English or French infantry nest, the 'Prince of Hades' appears with his hosts and smokes the enemy out.

That conditions of membership of this unit hardly constitute a life insurance policy is obvious; nor is every man suitable. Special men who are physically adapted and who have given proof of keenness in assault are necessary for such work."

* * * * * * * * *

APPENDIX.

ORGANIZATION OF GAS SERVICES, B.E.F., FRANCE.



Total Personnel Offrs. 258, O.R. 5,832.

Total Personnel Offrs. 222, O.R. 1020.

GRAND TOTAL (including H.Q.), Offrs. 490, O.R. 6,875.

TABLE I.*

Date.	Tons of Gas.	Cylinders.	Projector Drums.	4" S.M. Gas Bombs.	4" S.M. Smoke Bombs.	4" S.M. Thermit Bombs.	Operation.
1915.							
Sept. 25	68	2480	—	—	—	—	Battle of Loos.
27	9	325	—	—	—	—	
Oct. 12	35	1225	—	—	—	—	Hohenzollern Redoubt.
Dec. 20	7	245	—	—	—	—	
21	20	700	—	—	—	—	
22	6	225	—	—	—	—	
1916.							
Jan. 8	9	325	—	—	—	—	
19	10	375	—	—	—	—	
Feb. to May			Expansion from 4 Special Companies to 22 and formation of the Special Brigade.				
June 12	5½	200	—	—	—	—	
24	4½	150	—	—	—	—	
25	45¼	1600	—	—	—	—	
26	53	1900	—	—	—	—	
27	145½	5100	—	—	—	—	
28	75¼	2650	—	—	—	—	
29	14	460	—	—	—	—	
30	57	1400	—	—	4400	—	Battle of the Somme, July 1st.
July 2	1½	—	—	—	400	—	
5	30	1040	—	—	—	—	
6	3	—	—	—	780	—	
8	14	400	—	—	400	—	
9	4	—	—	—	800	—	
10	11	400	—	—	—	—	
12	3½	—	—	—	800	—	
13	57	2010	—	—	—	—	
15	15	510	—	—	—	—	
16	½	—	—	—	250	—	
17	16	575	—	—	—	—	
22	1	—	—	—	380	—	
30	1	—	—	—	370	—	
Aug. 3	1¼	—	—	—	400	—	
7	1	—	—	—	350	—	
12	¼	—	—	—	200	—	
13	5	160	—	—	—	—	
14	½	—	—	—	200	—	
16	½	—	—	—	150	—	
17	½	—	—	—	200	—	
20	66	1875	—	—	—	—	
21	2½	—	—	—	600	—	
23	½	—	—	—	150	—	
24	1½	—	—	—	400	—	
27	¼	—	—	—	100	—	
28	¾	—	—	—	200	—	
29	¾	—	—	—	300	—	
30	66	2375	—	—	—	—	
31	19	650	—	—	—	—	
Sept. 2	½	—	—	—	200	—	
4	39	1325	—	—	200	—	
5	39½	1725	—	—	—	—	
9	½	—	—	—	100	—	
14	½	—	—	—	100	—	
15	18	620	—	—	—	—	
16	½	—	—	—	100	—	
24	2½	—	—	700	—	—	
26	½	—	—	—	200	—	
Oct. 5	141	4925	—	—	—	—	
6	4½	150	—	—	—	—	
8	96	3400	—	—	—	—	
12	7	220	—	—	200	—	
14	1	—	—	—	300	—	
17	2	—	—	300	200	—	
28	4½	—	—	1200	—	—	
Nov. 3	½	—	—	—	100	—	
6	½	—	—	100	—	—	

Date.	Tons of Gas.	Cylinders.	Projector Drums.	4" S.M. Gas Bombs.	4" S.M. Smoke Bombs.	4" S.M. Thermit Bombs.	Operation.
1916.							
Nov. 8	20	675	—	—	—	—	
11	6	225	—	—	—	—	
12	33½	975	—	—	1400	—	
13	45	1575	—	—	—	—	
17	½	—	—	—	200	—	
21	½	—	—	200	—	—	
25	28	975	—	—	—	—	
Dec. 4	12	425	—	—	—	—	
14	½	—	—	200	—	—	
20	½	—	—	—	200	—	
23	15	580	—	—	—	—	
1917.							
Jan. 9	1	—	—	100	250	—	
11	1½	—	—	150	250	—	
17	4½	—	—	300	900	—	
21	3	—	—	100	700	—	
26	1	—	—	100	300	—	
Feb. 5	½	—	—	—	200	—	
9	½	—	—	—	300	—	
11	½	—	—	—	200	—	
12	½	—	—	—	250	—	
27	1	—	—	300	100	—	
28	40	1420	—	—	—	—	
Mar. 5	1½	—	—	250	250	—	
15	1	—	—	100	300	—	
16	1½	—	—	550	—	—	
17	4½	140	—	—	—	—	
19	14	460	—	—	—	—	
April 4	37	—	2290	1200	—	—	
5	6½	—	170	1200	—	—	
8	9½	—	—	2400	—	200	
9	9¼	—	—	1800	—	600	Battle of Arras April 9th
10	6½	—	300	600	—	—	
11	1½	—	110	—	—	—	
12	½	—	40	—	—	—	
13	1½	—	110	—	—	—	
15	2	—	150	—	—	—	
16	½	—	50	—	—	—	
17	14½	460	—	—	—	—	
21	3	—	200	—	—	—	
22	2½	—	180	—	—	—	
23	½	—	—	—	—	300	
26	3	—	200	—	—	—	
27	20	220	320	2400	—	—	
28	25	350	780	600	300	—	
29	55½	1320	650	1000	—	—	
30	1½	—	100	—	—	—	
May 1	2	—	150	—	—	—	
2	2½	—	200	—	—	—	
3	1	—	—	—	—	300	
8	18	—	1000	1000	—	—	
9	1	—	50	—	—	50	
12	2	—	75	—	300	—	
14	1	—	—	—	—	300	
15	24	500	450	800	—	—	
16	1	—	—	300	—	—	
19	1	—	—	—	300	—	
20	¼	—	—	—	200	—	
22	5	—	225	—	600	—	
24	20	—	1300	—	200	—	
25	21	—	850	2400	—	200	
28	3	—	—	—	800	—	
29	24½	—	1450	800	—	150	
30	13	—	750	400	—	—	
31	22½	—	1450	400	—	—	
June 1	14	—	1050	200	—	100	
2	1½	—	100	—	—	—	
3	5½	—	500	700	—	—	
4	23½	—	1500	300	—	100	

* The numbers given in this table are approximate only. The information is given in a chart which it has been found impossible to reproduce, but which has been deposited in the R.E. Library at the Horse Guards, where it will be available for inspection on application to the Librarian.—ED., *R.E.J.*

TABLE I.—*Continued.*

Date.	Tons of Gas.	Cylinders.	Projector Drums.	4" S.M. Gas Bombs.	4" S.M. Smoke Bombs.	4" S.M. Thermit Bombs.	Operation.
1917.							
June 5	¼	—	—	—	100	—	Attack at Messines, June 6th.
7	6	—	—	900	300	400	
8	15	—	950	—	400	—	
9	9¾	—	660	—	—	—	
10	4	—	200	—	200	—	
11	1	—	—	300	—	—	
13	1	—	—	—	200	100	
14	57½	1725	500	200	—	—	
15	½	—	—	—	200	—	
19	9¾	—	660	—	—	—	
21	27	—	1500	1600	—	—	
22	2	—	—	500	—	—	
24	½	—	—	—	200	—	
26	12	—	850	—	—	—	
28	4¼	—	100	400	300	—	
July 1	¾	—	—	—	—	300	
5	¾	—	—	—	—	300	
8	6	—	—	1700	—	—	
9	51	1000	1450	400	300	—	
10	24½	550	500	400	—	—	
11	½	—	—	—	—	200	
13	1¼	—	—	—	—	500	
15	51½	—	2700	3600	—	—	
16	27	—	1475	1110	400	—	
17	5½	—	150	1000	—	—	
18	4	—	200	—	—	200	
19	9¼	—	250	1600	—	—	
20	18	—	1075	400	—	100	
21	34	—	1700	2700	—	—	
24	14	—	625	1300	—	—	
26	24	—	1300	1400	—	—	
27	17½	—	1225	—	—	—	
28	2	—	150	—	—	—	
29	30½	—	950	800	—	—	
30	19½	—	1000	—	400	1100	Attack from Ypres, July 31st.
Aug. 1	9	—	600	—	—	—	
2	5	—	—	1400	—	—	
9	14½	—	600	1600	—	—	
10	3½	—	250	—	—	—	
12	5½	—	400	—	—	—	
13	2	—	125	—	—	—	
15	22	200	750	600	1000	—	
16	32	—	1600	2400	—	200	
17	4	—	150	600	—	—	
18	7	—	500	—	—	—	
19	5	—	—	400	600	600	
20	27	—	1850	400	—	—	
21	4½	—	150	400	200	—	
22	3	—	—	800	—	—	
23	17	150	750	700	—	—	
24	9½	—	400	1000	—	—	
25	8	—	425	500	—	—	
26	16	—	1000	—	—	600	
28	13	—	200	2800	—	—	
29	12½	—	650	700	200	—	
30	½	—	50	—	—	—	
Sept. 2	10	—	700	—	—	—	
4	¼	—	—	—	200	—	
7	4	—	250	—	—	—	
8	40	—	2300	2000	—	—	
9	13	—	—	3600	—	200	
10	½	—	—	—	200	—	
12	48	—	3360	—	—	—	
13	38	—	1650	2800	—	—	
14	15	—	1100	—	—	—	
15	21½	—	800	600	800	1400	
17	3	—	200	—	—	—	
18	14	—	725	800	—	—	
19	40	500	850	1000	—	—	
22	3	—	—	—	400	400	
24	3	—	—	—	300	300	
25	12	—	750	400	—	—	
26	4	—	—	1000	—	—	
1917.							
Oct. 3	18	—	1250	—	—	—	
4	102	2425	1875	1700	—	—	
5	19	—	1100	600	200	—	
6	9	—	600	—	—	—	
7	4	—	—	1100	—	—	
10	10½	—	725	—	—	—	
11	14	—	975	—	—	—	
12	4½	—	100	600	200	—	
14	13½	—	575	—	500	900	
15	9	—	600	—	—	—	
19	8	—	100	1700	—	—	
22	6	—	450	—	—	—	
25	29	—	1850	600	—	—	
26	22	—	900	1800	500	200	
28	12	—	150	2800	—	—	
29	22	—	1425	—	200	—	
31	4¼	—	200	300	100	—	
Nov. 1	9½	—	650	—	—	—	
2	37	—	2450	600	—	—	
4	½	—	—	—	200	—	
5	14½	—	1000	—	—	—	
6	20	700	—	—	—	—	
7	31	—	2850	1200	200	—	
8	9½	—	150	2000	—	—	
9	26	—	1150	2700	—	—	
10	5½	—	275	200	200	—	
11	5	—	250	—	300	—	
14	10	—	650	—	200	—	
19	70½	—	4225	—	2200	900	Battle of Cambrai.
20	9	—	525	—	200	—	
21	1¾	—	—	300	200	—	
22	8½	—	500	—	—	—	
24	8¾	—	525	—	—	—	
25	4½	—	300	—	—	—	
26	29	—	2000	—	—	—	
28	25½	—	1500	1200	—	—	
Dec. 1	9	—	—	2100	—	300	
2	9	—	600	—	—	—	
3	18	—	1000	700	200	—	
7	10	—	725	—	—	—	
11	3	—	—	—	700	—	
12	24½	—	1350	1400	—	—	
14	7	—	400	500	—	—	
15	6½	—	500	—	—	—	
1918.							
Jan.							
Feb.		Brigade in G.H.Q. Reserve.					
Mar. 11	25	—	1750	—	—	—	
17	15	—	1050	—	—	—	
19	83	—	5750	500	—	—	
20	1¾	—	100	—	—	—	
21	57	—	3728	1200	—	—	German offensive St. Quentin, Mar. 21st.
22	1¼	—	100	—	—	—	
24	¼	—	—	—	200	—	
27	37	—	2100	2000	—	—	
29	1	—	75	—	—	—	
30	22	—	1200	1400	—	—	
31	25½	—	1300	2000	—	—	
April 1	35½	—	2425	300	—	—	
5	25	—	1475	1000	—	—	
6	9¾	—	550	400	—	—	
7	10	—	700	—	—	—	German offensive Lys, April 9th.
16	5½	—	400	—	—	—	
19	17½	—	1200	—	—	—	
21	1	—	75	—	—	—	
23	1	—	75	—	—	—	
24	3	—	300	—	—	—	
25	2¼	—	150	—	—	—	
26	33	—	2200	800	—	—	
29	5	—	325	—	—	—	
May 4	8½	—	550	—	—	—	

TABLE I.—*Continued.*

Date.	Tons of Gas.	Cylinders.	Projector Drums.	4" S.M. Gas Bombs.	4" S.M. Smoke Bombs.	4" S.M. Thermit Bombs.	Operation.
1918.							
May 5	½	—	50	—	—	—	
6	10½	—	750	—	—	—	
7	13½	—	100	—	—	—	
8	24	—	1625	—	—	—	
9	27	—	1900	—	—	—	
12	114½	3000	2000	—	—	—	
13	1½	—	100	—	—	—	
14	1	—	75	—	—	—	
21	1	—	75	—	—	—	
23	138	3825	2000	—	—	—	
24	29	—	1800	800	—	—	
25	14	—	200	3000	—	—	
27	13½	—	900	—	—	—	
28	5	—	350	—	—	—	
31	1½	—	100	—	—	—	
June 2	9	—	600	—	—	—	
4	2	—	20	—	400	—	
7	39½	—	2325	1600	—	—	
8	½	—	—	—	200	—	
9	142	4175	1650	—	—	—	
10	7½	—	—	500	—	—	
12	9	—	600	—	—	—	
13	7½	—	100	1600	—	—	
14	9	—	600	—	—	—	
16	90	3150	—	—	—	—	
17	41	—	1750	500	—	—	
18	10½	—	750	—	—	—	
19	13½	—	775	500	—	—	
21	3	—	300	—	—	—	
22	68½	1500	1350	1600	—	—	
24	13½	—	900	—	—	—	
25	9	—	75	2100	—	—	
26	5½	—	250	—	400	—	
27	14	—	750	—	700	200	
28	35	—	2450	—	—	—	
29	2	—	75	—	200	—	
30	1½	—	50	—	200	—	
July 1	1	—	75	—	—	—	
2	3	—	200	—	—	—	
3	20	—	850	400	1800	—	Capture of Hamel, July 4th.
5	30½	—	1975	800	—	—	
6	8	—	550	—	—	—	
9	5½	—	325	—	—	—	
10	10	—	700	—	—	—	
11	½	—	—	—	200	—	
12	165	5100	1300	1400	—	—	
18	24	—	1300	900	200	—	
20	20½	—	1375	—	200	—	
21	37	825	675	600	300	—	
22	9	—	580	—	—	—	
23	85	1750	3320	—	400	—	
24	11	—	800	—	—	—	
25	11	—	525	900	200	—	
26	4½	—	300	—	—	—	
27	14	—	625	900	—	—	
29	5½	—	400	—	—	—	

Date.	Tons of Gas.	Cylinders.	Projector Drums.	4" S.M. Gas Bombs.	4" S.M. Smoke Bombs.	4" S.M. Thermit Bombs.	Operation.
1918.							
Aug. 2	9½	—	625	—	—	—	
4	34½	—	2225	700	—	—	
6	29½	—	1600	1900	—	—	
8	8½	—	425	400	200	—	Fourth Army Somme offensive, Aug. 8th.
9	5	—	375	—	—	—	
12	29½	—	2075	—	—	—	
14	4½	—	100	800	—	—	
16	36½	—	2550	—	—	—	
17	1½	—	100	—	—	—	
18	½	—	50	—	—	—	
19	43	1200	600	—	—	—	
20	9	—	400	1600	—	—	
21	4½	—	300	—	—	—	3rd Army offensive, Aug. 21st.
26	57	2000	—	—	—	—	
27	9	—	600	—	—	—	
28	½	—	50	—	—	—	
31	9	—	600	—	—	—	
Sept. 1	½	—	50	—	—	—	
3	14½	—	1000	—	—	—	
6	8	—	450	—	500	—	
7	2	—	125	—	—	—	
8	1½	—	100	—	—	—	
9	¼	—	—	—	100	—	
10	18	—	1250	—	—	—	
11	7	—	350	600	—	—	
12	10	—	700	—	—	—	
13	12	—	675	800	—	—	
17	17	—	1125	—	300	—	
19	17½	—	1250	—	—	—	
20	5	—	350	—	—	—	
21	5½	—	375	—	—	—	
22	7½	—	375	500	—	—	
23	39	—	2550	500	100	—	
24	18	—	1350	—	—	—	
25	6½	—	200	1000	—	—	
26	10	—	700	—	—	—	
27	4	—	150	—	400	—	
28	6	—	450	—	—	—	
29	2	—	150	—	—	—	
30	1½	—	100	—	—	—	
Oct. 1	16½	—	1175	—	—	—	
4	3	—	200	—	—	—	
5	15	—	1050	—	—	—	
6	½	—	50	—	—	—	
12	10	—	700	—	—	—	
13	2	—	—	—	500	—	
16	5	—	225	—	600	—	
Nov. 1	½	—	50	—	—	—	
2	1	—	100	—	—	—	
3	11	—	600	400	300	100	
7	½	—	—	—	—	200	

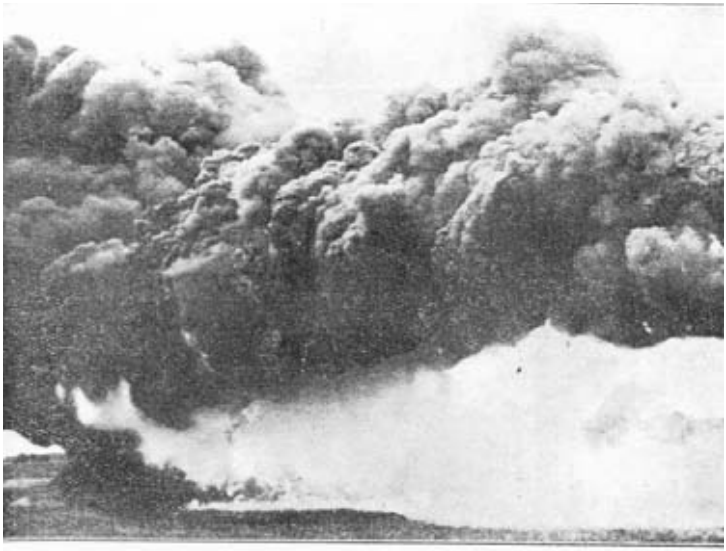


Photo I.—Flame Projectors in Action.

Photo II.—Livens Projectors being Loaded.

PROJECTORS

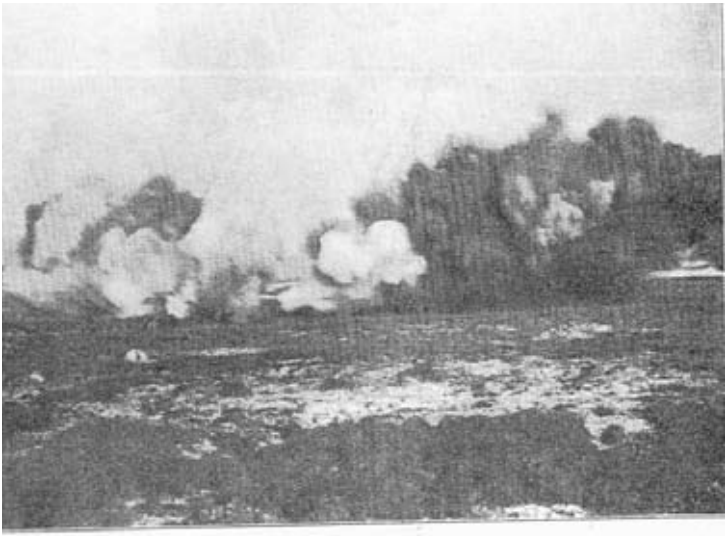


Photo III.—Bombs from Livens Projector Bursting.

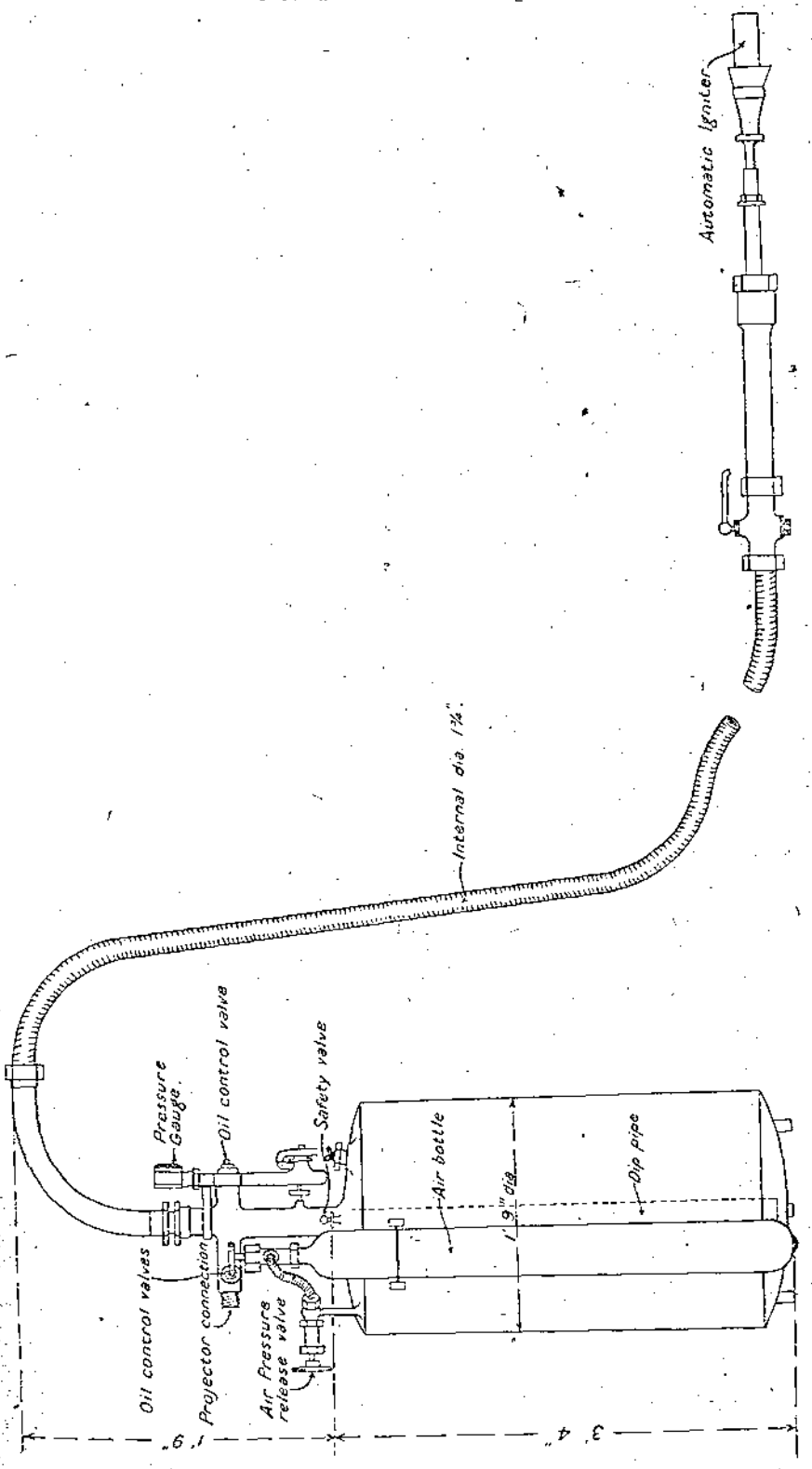
Photo IV.—Enemy's Projector Installation at Boisleux-St. Marc.

PROJECTOR

PLATE I.

SKETCH OF GERMAN FLAMMENWERFER.

Not drawn to scale.



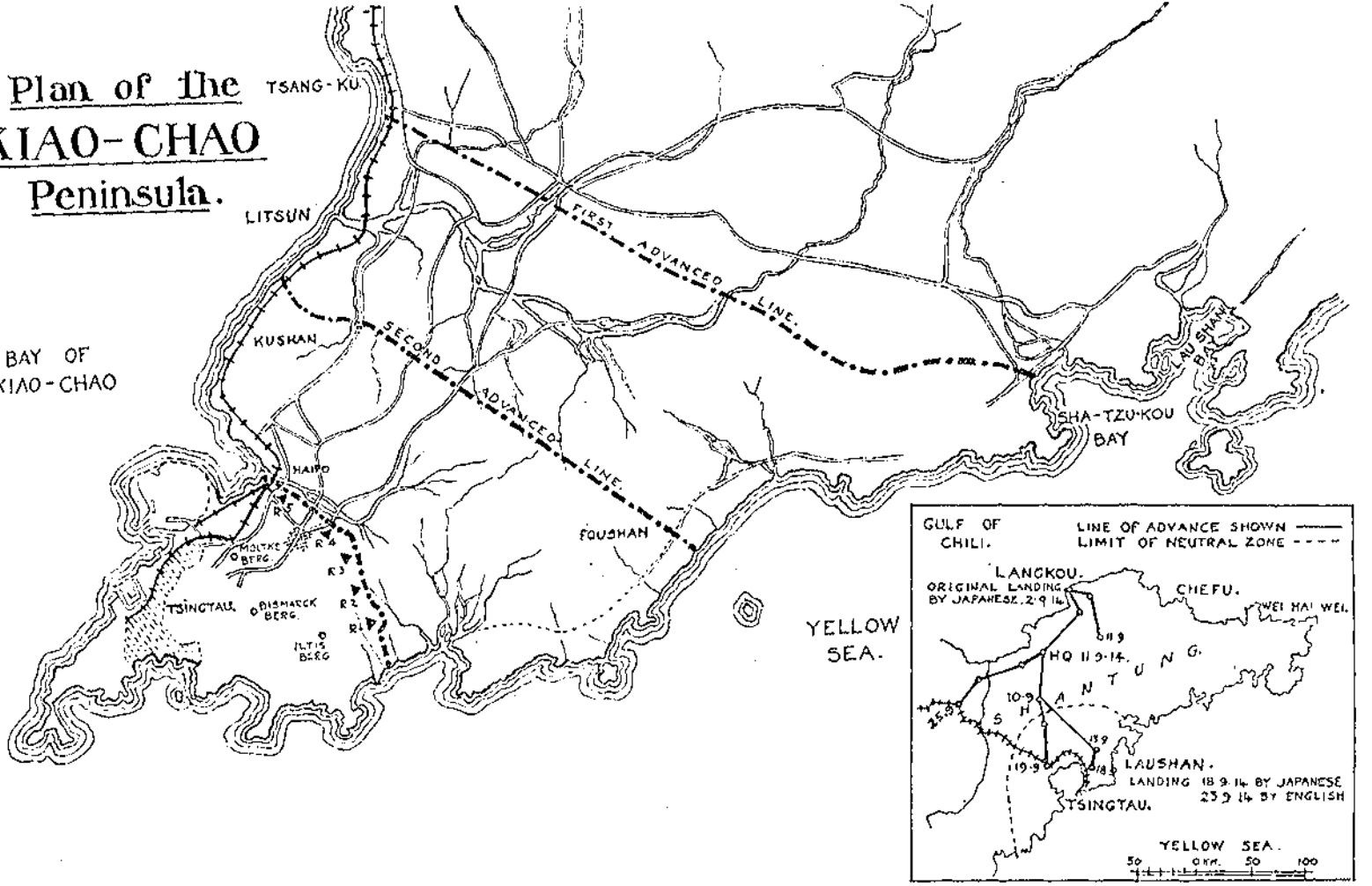
THE DEFENCE OF TSING-TAU, 1914.

By BRIG.-GENERAL J. E. EDMONDS, C.B., C.M.G.

THE despatches of the late Brig.-General N. W. Barnardiston, who commanded the small British force which took part with the Japanese in the operations against the late German Colony of Kiao-Chao, are very brief. Including the mentions, they cover less than seven columns of the *London Gazette* of 25th May, 1916, and they tell us practically nothing about the siege. A Japanese General Staff account, in four volumes it is said, is not yet available in England. Though as a rule the Germans write about nothing except "victories," no success no story, as has been said, an account of the defence of the naval fortress of Tsing-tau has just been published.* Its author is Konteradmiral Waldemar Vollerthun, who took part as Chief Intelligence Officer. In August, 1914, he was a Captain, and as head of the Colonial Section of the Admiralty, under which Kiao-Chao and certain other German oversea possessions were administered, was on a visit of information in China. His book is based on his diary and the official records which have been placed at his disposal, and has all the features (orders of battle, lists of batteries, maps, diagrams, etc.) of the usual German official accounts of operations; though as far as can be judged it contains fewer of the half truths which make these accounts the greatest works of military fiction in the world.

The German secret service seems to have been entirely mistaken as to the feeling in Japan in the early days of August, 1914:—"The "attitude of the Japanese people and particularly the army was "described as distinctly full of enthusiasm for Germany . . . the "people of *Bushido* had not only the wish, but the hope that the "unsurpassable German Army, the never-to-be-forgotten instructress "of Japan, would finally triumph over all its foes." The disillusion was particularly unpleasant, and the Admiral can hardly find words to express his disgust of a people who could deceive poor Germany so: "Germany to whom Japan owes practically all it possesses of "progress in *Kultur* in the European sense." He can never forgive her "brutality" for using the same words in the ultimatum as Germany used to her over Port Arthur in 1895. But he has a strong

* *Der Kampf um Tsing-tau*, Leipzig, Hirzel, 30 marks.


Plan of the
KIAO-CHAO
Peninsula.
TSANG-KU
LITSUN
FIRST ADVANCED LINE.
KUSHAN
SECOND ADVANCED LINE.
BAY OF KIAO-CHAO
HAIPO
MOLTKE BERG
BISMARCK BERG
ILTIS BERG
TSINGTAU
FOUSHAN
SHA-TZU-KOU BAY
AU SHAN BAY
YELLOW SEA.
GULF OF CHILI.
LINE OF ADVANCE SHOWN
LIMIT OF NEUTRAL ZONE
LANGKOU.
ORIGINAL LANDING BY JAPANESE. 2·9·14.
CHEFU.
WEI HAI WEI.
HQ 11·9·14.
ANTUNG.
LAUSHAN.
LANDING 18·9·14 BY JAPANESE
23·9·14 BY ENGLISH
TSINGTAU.
YELLOW SEA.
50 0 KM. 50 100

suspicion that "London was the originator of the form of this "wonderful document."

As regards the fortifications of Tsing-tau, he says, "they were "never intended to withstand the formal attack of a large besieging "army for a long period. Their design was based on the supposi- "tion of a defence against European powers and Chinese rebels." It will be seen however that in most matters the defences were up-to-date and superior to any fortification that the Germans had to tackle in Belgium, France, or Russia.

The town of Tsing-tau is built on a promontory at the south-west corner of an area, roughly a square of some 15 miles side, which projects southward from the south-west end of the Shan-Tung peninsula, "Our Shan-tung," as the Germans used fondly to call it. On the east side of the square is the Yellow Sea, and on the west the land-locked Bay of Kiao-chao, with a three-mile wide entrance opposite the town of Tsing-tau.

The coast defences covered the outside anchorage between two headlands, south of the town, and the entrance to the Bay of Kiao-chao. They consisted of (1) one battery of four 8-inch (21 cm.) long guns, (2) one of four 5.9 inch (15 cm.) guns of most modern construction, (3) one of two 9.2 inch (24 cm.) and three 5.9 inch long guns, (4) one of four 11 inch (28 cm.) howitzers on the Bismarck-berg, a hill a little over a mile from the sea, (5) minefield batteries.

Batteries (1) (3) and (4) were concrete-built closed works, with shell-proof magazines and living casemates. The others had only shell-proof magazines. Batteries (1) and (4) could fire towards the landside as well as seawards. All the guns were in open battery.

On the land side of the town, cutting off the S.W. corner of the square and the projection on which the town stands, are four groups of hills running N.W. and S.E., separated by deep valleys; the hills forming each group are similarly divided. The groups are narrower in width the nearer they are to the town. On the nearest group consisting of the Iltis-berg, Bismarck-berg, Moltke-berg, were most of the land batteries, with a line of Twydall redoubts from sea to sea on a subsidiary ridge below them. The upper and lower Iltis batteries had two 4-inch (10.5 cm.) QF guns, and six old 4.5 inch; the 4-inch guns had splinter proof shields; close by, cut in the rock, were shell-proofs, and there were also spacious shell-proof concrete magazines and living rooms.

The 11-inch howitzers on the Bismarck-berg have already been mentioned. Left of them lay a new battery with two 8-inch guns. Next came a shell-proof casemated battery for eight 5.9 inch howitzers, but with only three available. All the above batteries had been built at great expense in concrete, and were shell-proof, which was not the case with one 4.5 inch, four 3.5 inch and six 1.5 inch batteries,

and three improvised batteries of naval guns, including two 5.9 inch. "In all, omitting the light pieces, 1.5 inch and 1.8 inch, there were "not less than 94 guns available for the defence . . . The most "efficient protection which most of the batteries had was their "concealed positions. Shell-proof armour was altogether lacking; "and no batteries were in closed works defensible against infantry "attacks." The total number of batteries of all calibres was 41. Ammunition for the small calibres was plentiful; for the heavier natures there was "no superfluity"; the figures given are: For 11 inch howitzers, 260 rounds; 9.2 inch, 230; 8-inch 320; 5.9 inch guns, 450; 5.9 howitzers, 300. There were 71 machine guns and four million rounds of S.A. ammunition.

The five Twydall redoubts in front of the batteries, closed, as has been said, the isthmus, where it was 3.4 miles (5.5 km.) across. They had been completed before war and were so well sited as to be practically invisible. They were of various sizes according to tactical requirements. The flank ones, I. and V., were the largest, and II. and III. the smallest. The plan which is given in the book has no dimensions on it except the width of the sunken wire entanglement which is 32.8 feet (10 m.); taking this as the scale, the face is 131 feet (40 m.) and the flanks are 82 feet (25 m.). There were a double storied casemate under the central parados, and shelters under the parapet, designed to resist 8-inch, but which without exception kept out all calibres even 11-inch, the roof being 4.9 inch (1.5 m.) ferro concrete, the same thickness used for "pill-boxes" in France. The garrison available for each redoubt was 260—290 men, but "the larger ones could have sheltered 1,000." The armament was 4—10 machine guns, a number of trench-mortars, and about six electric light projectors. A continuous wire entanglement ran in front of the works from sea to sea.

The author comments that the design was found unsatisfactory:— The O.P. were not sufficiently protected, and the machine guns fired over the parapet without any cover, there were no covered ways from the casemates to the parapet, and the open passage ways were soon blocked. "But the greatest weakness was the lack of a good "deep ditch with strong concrete escarp and counterscarp, well "flanked from galleries."

The total garrison of the fortress, in round figures, counting the reservists, etc., who arrived from up-country, was 144 officers and 3,600 men. The warships in harbour, which assisted in the defence from the bay were the gunboat *Jaguar*, with four 3-inch guns, torpedo boat N 90, and the Austrian cruiser *Kaiserin Elizabeth*, with six 5.9 inch.

There being abundance of Chinese labour, the improvement of the defences was carried on without pause. Between the infantry

redoubts several lines of strong points connected by traffic trenches were dug; and to give the position depth a system of splinter proof blockhouses was built behind the intervals of the redoubts. Six batteries of two 3.5 inch guns were also constructed to cover these intervals with fire, and another pair of these guns was mounted on a truck on the railway which passed through the left of the line; and machine gun nests and short lengths of trench were scattered over the ground in well-concealed positions.

Further, two advanced positions were prepared on the nearest two lines of hills in front of the main position:—The first from Shatzu-kou Bay to Tsang-ku, 12 miles from the town, where the peninsula is about 11 miles wide; and the second from Fu-shan to Ku-shan, six miles from the town, where the peninsula is about 7½ miles wide. "Originally hasty fire-trenches, they had become strong field positions "with wire entanglements, minefields, dummy positions, emplace-"ments for field batteries. The Tsang-ku heights were specially "well defended," as they covered the approach roads on the left. "The right of the second line was particularly strongly provided with "artillery," and an important observatory with an all-round view was constructed on Fu-shan.

On the evening on the 25th August there was a terrific typhoon rainstorm which did an immense amount of damage to the defences, made a breach in the dam of the waterworks at Litsun outside the main defences, and flooded the machinery room of the bombproof waterworks, for war use, at Hai-po. But the effect on roads and communications placed such obstacles and difficulties in the way of the advance of the attackers that the destruction done by the storm was, taking it all round, greatly in favour of the Germans.

The Japanese commenced landing on the 2nd September at Lung-kou on the northern side of the Shan-tung peninsula, 112 miles north of Tsing-tau. The force was believed to be a division, under General Kamio.

By the 17th they had reached the frontier of the Protectorate, 16 miles from the town. Admiral Vollerthun complains of "the slow march of the Japanese and their careful, from-all-surprise-and-ruse-enterprises-free, pedantic methodical ways," and abuses them as "yellow dwarfs" (*gelbe Zwerge*). On the 18th however the Admiral should have been satisfied with their enterprise, for they made a surprise landing at Lau-shan Bay on the eastern side of the Protectorate, and not far outside the right flank of the outer defences. "Our weak patrols in the plain before Lau-shan had soon to clear "out in order not to run the danger of being cut off by superior "force." Lau-shan now became the main Japanese base, and the British contingent, the 2nd South Wales Borderers from Tientsin,

landed there on the 25th September, followed on the 22nd October by a half-battalion of the 36th Sikhs.

The Germans put up a poor fight in their advanced positions. The Japanese commenced their forward movement on the 26th September, with apparently two columns from the north and one from the east, against the first position, and the Germans immediately retreated to the second. In this they made a short stand, with the assistance of the guns of the war ships on the left flank. But the ships were driven off by Japanese aeroplanes, and as the Japanese commander was making preparations for assault, in which the British contingent was to have taken part, the German governor gave the order for retreat into the fortress. Admiral Vollerthun now complains that the enemy was guided by Chinese, who pointed out where the minefields were, in fact marked each mine with a white stone. In these preliminary moves the Germans lost less than 100 men, including 2 officers and 50 men captured in the forward lookout station. The author considers the shooting of the Japanese infantry was of small account (*minderwertig*); he admits later on however that they were superior to the Germans in night operations.

The Governor now appears to have lost heart, although he had received a wireless message:—"His Majesty has ordered that "Tsing-tau is to be defended to the last." He had "three great "yawning pits dug, one in the cemetery, and the others right and "left of it. They were mass-graves for the expected casualties"; and he began to think of the irreparable loss it would be to *Kultur*, if all the Germans who had intimate knowledge of China trading were killed. The torpedo boat was ordered to escape and ran itself ashore, the other ships were sunk at various dates, the *Kaiserin Elizabeth* on the 1st September. Meanwhile under constant fire of the guns of the defence the Japanese prepared batteries for their 28 cm. howitzers; the Germans had only one aeroplane at their disposal, but this at any rate was more than General Leman of Liége possessed.

The bombardment began at daybreak on the 21st; the infantry redoubts were "knocked out of recognition and usefulness . . . great breeches were made in the wire . . . the blockhouses were nearly all destroyed." Only one open but well concealed 5.3 inch battery remained undamaged and undiscovered. On the night of the 30th September-1st October a first parallel with approaches to a second was made by the Japanese. On the night of the 1st-2nd the second parallel was dug. An attempt to storm infantry redoubt IV. is said to have been repulsed. Meantime the bombardment continued and on the 4th it was extended to the town, warships assisting from the south west, under protection of Cape Jäschke. On the same day the advanced works on the right and left of the line and the

waterworks defences were captured (the garrison was then reduced to well water) and sounds of mining in the rock under the infantry redoubts were heard. On the night of the 5th-6th attempts of the Japanese to break through on the left of infantry redoubt IV. and over the mudflats of the inner bay on the extreme left are said to have failed. On the night of the 6th-7th the Japanese made a general assault :—Redoubt III. was captured at 2 a.m., II. and IV. by 5.30 a.m. ; at 6 a.m. the storm of I. was commenced, and artillery fire concentrated on V. At 6.20 a.m. the white flag was seen to be hoisted on the Observatory and Signal Station, but it was 7.30 a.m. before the last shot was fired.

The author claims that the Japanese losses were over 5,000, and declines to believe the official figures of 1,800 killed and wounded. The total German losses were, he says, 199 killed and 500 wounded, 16 per cent. of the garrison. There is the usual curious whine of the defeated German that his opponents were drunk ; in this case *heftig unter Alkohol stehend* when they entered the town, and that they plundered and stole. The final piece of spitefulness that this German officer indulges in to relieve his feelings is that " the Japanese officers spoke of their English allies in a contemptuous way. For the attack they always sought the safest places."

From various sources it is stated that the besieging army consisted of 50,000 men and the artillery of six 11-inch howitzers, six 9.1 inch howitzers, 36 field guns, 18 mountain guns, four 4.7 inch and four 5.9 naval guns, and that during the seven days bombarding 43,500 shells were fired at the fortress.

The defence of Tsing-tau as regards both its conception and execution is not a creditable episode to German arms, and in no wise comparable with the resistance of Liége, Maubeuge, or Antwerp. Tsing-tau was a modern fortress, its 4.9 feet thick concrete shelters were, as the author boasts, shell proof against the Japanese 11-inch howitzers, and even against 12-inch. " A 12-inch shell struck the " concrete of a magazine at the extremely steep angle of about 60°. " The cover was only 4.9 feet thick and yet the force of the explosion " could not destroy it. There were only radiating cracks made, " and a crater shaped hole outside about 20 inches deep." At Liége, Maubeuge, and Antwerp there was not a single shelter that was shell-proof available even for headquarters that would resist the German 16-inch (42 cm.) shells. At these three old fortresses the attackers' batteries outranged the defenders' and could not be touched, whilst at Tsing-tau the German guns, the author again boasts, not only engaged but knocked out the Japanese.

At Liége a Zeppelin commenced the bombardment on the night of the 4th-5th August (see German General Staff account) and the heavy artillery on the 6th-7th ; the last fort did not surrender until

the 17th ; there was at least 10 days' bombardment. At Maubeuge the bombardment with 16-inch and 12-inch howitzers was opened on the 29th August, and the fortress capitulated on the 7th September (von Zwehl) ; there was at least nine days' bombardment ; Antwerp held out 12 days (28th September—9th October). Tsing-tau with its superior protection and armament held out only seven days against howitzers of only 11-inch calibre, just as long as the entirely obsolete fortress of Longwy (22nd-28th August, *vide* Stegemann).

Until the exact number of heavy howitzers employed and the amount of ammunition fired is known, a final opinion of the defence made by the Germans cannot with fairness be given.

It would be of interest to know what reception the Governor received from his superiors when he returned to Germany.

PROFESSIONAL NOTES.

QUALIFYING EXAMINATION FOR THE MECHANICAL SCIENCES TRIPOS, CAMBRIDGE UNIVERSITY.

THE following synopsis of the examination and two specimen papers are published by permission.

SYNOPSIS.

MATHEMATICS.—3 HOURS.

Use of slide rule and graphs; elementary algebra, including the use of the binominal theorem, the exponential theorem, and logarithms. Elementary trigonometry, including the solution of plane triangles. Representation of directed quantities by vectors. The rudiments of plane analytical geometry, including the simpler properties of conic sections referred to rectangular axes, but excluding the general equation of the second degree. Use of the elements of the differential and integral calculus, elementary applications to plane curves, *maxima* and *minima* of simple functions of one variable, easy areas and volumes, expansions of simple functions.

MECHANICS.—3 HOURS.

(*It is necessary to satisfy the examiner in both Statics and Dynamics separately*).

Units: composition and resolution of forces, treated analytically and graphically: conditions of equilibrium: force diagrams: friction. Graphic methods of representing motion, including varying acceleration. Force, momentum, work energy, power: conservation of momentum, conservation of energy; efficiency of machines: uniform circular motion: simple harmonic motion: moment of inertia: rotation and oscillation of solid bodies about a fixed axis.

NOTE.—In both papers it is usual to set from 12 to 15 questions of which answers are only required to 10.

Papers set at a recent Examination.

MATHEMATICS.

Answers are not expected to more than ten *questions.*

1. For use in solving certain problems, a slide rule is constructed with an extra top scale, the numbers on which give the values of the numbers immediately under them on the bottom scale raised to the

power of 1·4. If the bottom scale reads from 1 to 10 and is 10 inches long, calculate the distance between the divisions marked 4 and 6 on the extra top scale. Also explain how you would obtain the value of $0{\cdot}2^{1{\cdot}4}$ by means of such a slide rule.

2. Express $\dfrac{x^2(x^2+1)}{(x+1)(x^3+1)}$ in Partial Fractions.

3. Find graphically the positive value of x which satisfies the equation

$$3 \sin x + \cos x = x.$$

4. The motion of a car is assumed to follow the law $xy = a - bx^2$ where y is the rate of increase of velocity with distance and x is the velocity, a and b being constants. Observed values of x and y are given in the following table :

x	6·3	10·5	14·1	17·6	19·7
y	2·94	1·33	0·71	0·23	0·04

Allowing for errors of observation, find by a graphical method the most probable values of the constants a and b .

5. Write down the expansion of $(1+x)^n$ in ascending powers of x and show that when x and y are small,

$$\frac{(1+x)^n}{(1+y)^m} = 1 + nx - my \text{ approximately.}$$

The profits of a mill are found to be proportional to $\dfrac{N^{\frac{1}{2}}}{P^{\frac{1}{3}}}$ where N is the number of machines and P the number of workmen employed. Find approximately the percentage increase in profits when the number of machines is increased by 1 % and at the same time the number of workmen is decreased by 3 %.

6. In a $\triangle ABC$, $AB = 12''$, $AC = 10''$ and the $\angle BAC = 15° 14'$. Find the length of BC and the remaining two angles. Find also the magnitude and nature of the error in the calculated value of BC which would arise from an error of 1 % in the measurement of AC.

7. Prove that $\tan(\theta - \theta') = \dfrac{\tan\theta - \tan\theta'}{1 + \tan\theta \tan\theta'}$.

Hence find the angle between the straight lines whose equations are $3x + 4y + 5 = 0$ and $2x - 3y + 6 = 0$.

8. Differentiate with respect to x:

(1) $\tan^{-1}(e^x \cos ax)$,

(2) $\log_e \sqrt{\dfrac{1-\cos x}{1+\cos x}}$,

(3) $\left(\dfrac{1+\sqrt{x}}{1-\sqrt{x}}\right)^{3/2}$.

9. Prove that for the parabola $y^2 = 4ax$, the subnormal is of constant length.

10. In a submarine telegraph cable, the speed of signalling is found to vary as $x^2 \log \frac{1}{x}$ where x is the ratio of the radius of the core to that of the covering. If the radius of the core is $\frac{1}{2}$ inch, find the radius of the covering in order that the greatest speed of signalling possible may be attained.

11. Prove that if $y = Ae^{-kt} \cos(pt + B)$ where A, B, p and k are constants, then

$$\frac{d^2y}{dt^2} + 2k\frac{dy}{dt} + n^2y = 0,$$

where $$n^2 = p^2 + k^2.$$

12. Integrate with respect to x:

(1) $\dfrac{x}{x^2+6x+8}$; (2) $\dfrac{1}{\sqrt{x-1}}$; (3) $x \tan^{-1} x$.

13. The generating curve of the inside of a barrel consists of a parabola whose equation referred to the centre of the barrel as origin and a maximum radius as axis of x, is given by $y^2 = k(a - x)$, where k is constant. Prove that if the internal length of the barrel and the radius at either end be h and b respectively, the volume of the inside is given by

$$\frac{\pi}{15}\{8a^2 + 4ab + 3b^2\}h.$$

MECHANICS.

Candidates are not expected to show up solutions to more than **ten** *questions, but must satisfy the examiners in* **both** *parts of the paper.*

PART I. STATICS.

1. A uniform plate in the form of an equilateral triangle of side 3 ft and mass 6 lbs. is free to swing in a vertical plane about a fixed axis through the mid-point of AB. To A and C are attached strings of lengths 2 ft. and $2\frac{1}{2}$ ft. respectively whose other ends are attached to a mass of 4 lbs.

Find grapically or otherwise the angle which AB makes with the vertical in the position of equilibrium.

2. Fig. (1) shows the end view of a roof.

On the planes AC and DE wind pressures of 10,000 lbs. wt. and 3000 lbs. wt. respectively are acting, whose lines of action may be taken as normal to the planes and passing through their mid-points.

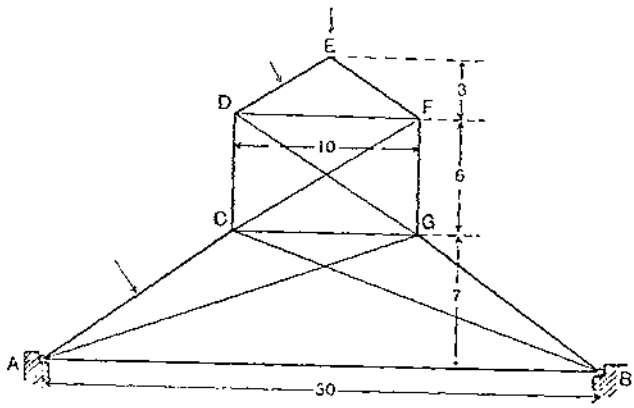


FIG. 1.

The roof is symmetrical and weighs 20,000 lbs., the dimensions in feet being as shown.

If the reaction at A is known to be vertical, find the magnitude and direction of the reaction at B.

(A graphical method of solution is preferred).

3. Draw a diagram to show the stresses in the bars of the loaded framework in Fig. (2), consisting of light rods pin jointed at their extremities and hanging from A and B.

The reactions at A and B are vertical.

Mark the rods which are in compression.

[Transfer the figure by pricking through.]

4. A uniform bar of length 15 ft. and mass 60 lbs. rests on a rough peg with one end against a rough vertical wall. The angle of friction

between the surfaces in contact is 10°. Find graphically or otherwise the two distances which the peg may be from the wall, if the bar is just in equilibrium when making an angle of 50° with the vertical.

5. A heavy cubical box of side 3 ft. is dragged at a uniform rate along a level passage with vertical walls just over 3ft. apart. The box weighs 100 lbs. and its centre of gravity is 9 inches from a wall of the passage.

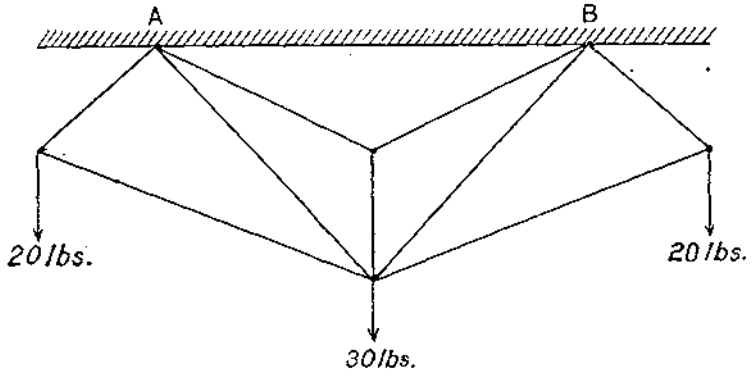


FIG. 2.

Find the pull required if it is applied horizontally in the central vertical plane of the passage. The coefficient of friction between the box and the floor or walls of the passage is 0·3.

6. Distinguish between the "instantaneous efficiency" and "average efficiency" of a mechanism.

The crank AB in Fig. (3) is driven counter clockwise forcing the cross-head C, which slides on the guide DE, against a thrust F of 5000 lbs. wt. acting in the direction CA. The coefficient of friction between cross-head and guide is 0·3.

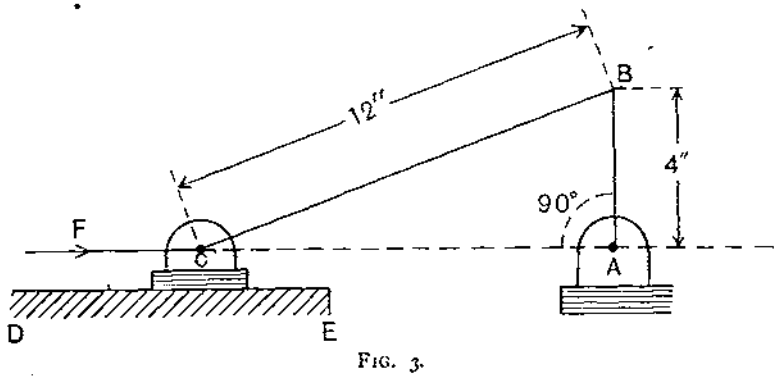


FIG. 3.

Find the efficiency of the mechanism in the position shown in Fig. (3), neglecting friction in the bearings at A and B.

7. Find the position of the centre of gravity of the sheet of metal

in Fig. (4). The diameter of the circular hole is 2ft., and its centre is $1\frac{1}{4}$ ft. from the nearest sides.

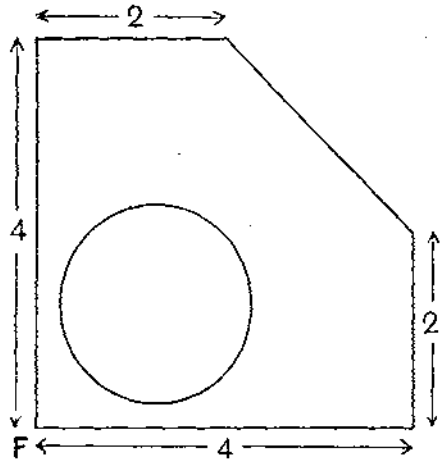


FIG. 4.

PART II. DYNAMICS.

8. Show that if V be the speed and S the distance travelled from some fixed point in the path of a moving body, the slope of the graph of $\frac{V^2}{2}$ plotted to a base of S gives the acceleration of the moving body along its path.

Observations of velocity and distance from the starting point of a car are as follows:

V	0	12·6	16·7	19	21·4	23·2	23·6	f. s.
S	0	30	65	100	160	250	300	ft.

Find the initial acceleration, and the H.P. being exerted at 160 ft. from the start if the car weighs 1 ton and resistance to motion is 100 lbs. wt.

9. A balloon weighing 1200 lbs. is found to be descending and in two consecutive minutes the distances fallen are calculated to be 240ft. and 600 ft. respectively. Find the amount of ballast that must be suddenly released in order that it may rise 240 ft. in the next two minutes. The acceleration may be taken as uniform both during descent and ascent.

10. The bar of a goal is 10 ft. above the ground level. A ball is kicked from a distance of 30 yards so as to leave the ground at an angle of 30° to the horizontal. Neglecting air resistance, find the least initial velocity which must be given to the ball in order that it may just clear the bar.

11. A machine gun is fired backwards from the rear of an armoured car at the rate of 600 rounds per minute. The mass of

each bullet is $\frac{1}{2}$ oz. and muzzle velocity 2200 f. s. Find the driving power added to that of the car when the car is travelling at 40 m. h.

12. A football player weighing 10 stone and running at 15 m.h. overtakes and collars another weighing 13 stone, and running at 12 m.h., the angle between their directions of motion being 30° at the moment of collaring. Find the magnitude and direction of their common velocity immediately after the impact, and the impulse which either receives.

13. A bullet, of mass 3 oz., moving with a velocity of 2200 f.s. strikes a ballistic pendulum of mass 15 lbs. and remains embedded in it. Calculate the percentage of kinetic energy converted into heat, and the average resistance to penetration if the bullet comes to rest after penetrating 5 inches.

14. Define Simple Harmonic Motion.

If a point moves with S.H.M., show that the graph connecting its velocity with distance along its path may be represented by a circle, if a particular scale is chosen for the velocity ordinate.

Show also that, during motion from one end of the travel to the other, the mean velocity with respect to the distance is $\frac{\pi}{4}$ × the maximum velocity, and with respect to the time is $\frac{2}{\pi}$ × the maximum velocity.

15. Two cog wheels, having respectively 50 and 100 teeth and moments of inertia 10 and 50 lbs. ft.^{2} units, are in gear. The larger wheel is driven by a light spiral spring which exerts a torque of 0·5 lb. ft. per revolution through which it is twisted.

If the spring be wound up through 10 turns initially, and the system be then let go, find the maximum speeds which the wheels would attain if they ran smoothly and without friction.

TEXT BOOKS RECOMMENDED BY THE STAFF OF THE ENGINEERING LABORATORY.

Qualifying Examination and First Year Tripos Course.

Subject.	*Author.*	*Title.*	*Publisher.*	*Price.*
Mathematics	Perry, J.	Elementary Practical Mathematics	Macmillan	7/-
,,	Thompson, S. P.	Calculus made easy	Macmillan	3/-
,,	Carslaw, H. S.	An introduction to the infinitesimal Calculus	Longmans	6/6
Statics	Fawdry, R. C.	Statics, Parts I. and II.	G. Bell and Sons	5/-
Mechanics and Mechanics of Machines	Landon, J. W.	Elementary Dynamics	Camb. Univ. Press	10/6
	Duncan, J.	Applied Mechanics for Engineers	Macmillan	10/6

Subject.	*Author.*	*Title.*	*Publisher.*	*Price.*
Electricity	Yorke, J. Paley	Applied Electricity	Arnold	8/6
Properties of Materials.	Charnock, G. F.	Mechanical Technology	Constable	10/-
Surveying	Whitelaw, J., jun.	Surveying	Crosby Lockwood	10/6
Drawing	Spooner, H. J.	Machine Design, Constructional Drawing	Longmans	21/-

Second and Third Year Tripos Course.

Subject.	*Author.*	*Title.*	*Publisher.*	*Price.*
Mathematics	Lamb, H.	Infinitesimal Calculus	Camb. Univ. Press	20/-
Mechanics	Duncan, J.	Applied Mechanics for Engineers	Macmillan	10/6
,,	Worthington, A. M.	Dynamics of Rotation	Longmans	6/6
,,	Inglis, C. E.	Examples in Applied Mechanics and Elementary Theory of Structures	Camb. Univ. Press	3/-
Heat	Ewing, J. A.	The Steam Engine and other heat Engines	Camb. Univ. Press	16/-
,,	Wimperis, H. E.	The Internal Combustion Engine	Constable	8/6
,,	Peel, T.	Examples in Heat and Heat Engines	Camb. Univ. Press	5/-
Electricity	Hay, A.	Continuous Current Engineering	Constable	9/6
,,	James, W. H. N.	Alternating Currents in Theory and Practice	Camb. Univ. Press	12/-
,,	Lamb, C. G.	Notes on Magnetism	Camb. Univ. Press	5/-
,,	Lamb, C. G.	Examples in Applied Electricity	Camb. Univ. Press	3/-
,,	Gill and Teago	Examples in Electrical Engineering	Arnold	
Theory of Structures	Ewing, J. A.	Strength of Materials	Camb. Univ. Press	12/6
Properties of Steel	Edwards, C. A.	The Physico-Chemical Properties of Steel	Griffen	21/-
Hydraulics	Lea, F. C.	Hydraulics	Arnold	18/-

Brig General Sir Francis Anderson

MEMOIR.

BRIGADIER-GENERAL SIR FRANCIS JAMES ANDERSON, K.B.E., C.B.

SIR FRANCIS JAMES ANDERSON, K.B.E., C.B., of Ballydavid House, Rossduff, Waterford, whose loss the Corps has to deplore, at the comparatively early age of 60, was born in Edinburgh on the 17th February, 1860. He was the fourth son of Deputy Inspector General of Hospitals Robert Carew Anderson, of Suir View, Kilkenny, of the family of the Andersons of Gracedieu, Co. Waterford, descended from the Andersons of Wester Eyrederbeck, in Aberdeenshire; and of his wife, Jane Wallis, daughter of the Rev. Henry Bolton, vicar of Dysart Enos, Queen's County.

Anderson was educated abroad and passed into the Royal Military Academy at the age of 16½ in September, 1876. He passed out tenth on the list in July, 1878, his commission in the Royal Engineers, as was then the custom, being antedated to the 31st January, 1878.

While at Chatham he was an enthusiastic member of the R.E. Yacht Club and made many cruises in the old *Buccaneer* and *Violet*, crossing occasionally to France and coasting round the south of England. He was keenly interested in navigation and wrote a pamphlet on Elementary Lessons in Nautical Astronomy. The fortification tour on which his batch was taken while under instruction necessitated visits to the Portsmouth and Isle of Wight defences and the batch hired a yacht for the visits to Yarmouth, Hurst Castle, Southampton and Ryde, the navigation being undertaken by Capt. Bogle and Anderson.

On quitting the S.M.E., Anderson, after the usual leave, was posted to the 18th Company, R.E., and, amongst other duties, served with the Cork flying column from January to April, 1881, in the suppression of the Mitchelstown disturbances.

In 1881 he volunteered for service on the Indian Establishment and embarked at Queenstown in the *Malabar* on the 10th December. The monotony of the voyage out was relieved by detention for two days in the Suez Canal, a liner ahead having gone aground. There was a pack of hounds on board going out to the Peshawar Hunt and these were taken ashore on the sandy banks of the Canal on Christmas Day for a jackal hunt. There was no sport,

but the exercise was refreshing to both hounds and men. On reaching India Anderson was attached to the 1st (K.G.O.) Sappers and Miners first at Roorkee and afterwards on detachment at Rawal Pindi, until posted to the Military Works Department, which he joined in June, 1882, at Peshawar. In November, 1884, he was transferred to the 2nd Queen's Own Sappers and Miners at Bangalore, being posted to B Company. On the outbreak of the war against Theebaw in 1885 he was sent with C Company, which he was then commanding, to Rangoon in October, and proceeded with the river column and was at the taking of Fort Minhla and of Mandalay in November, 1885. The company was employed thereafter in various flying columns sent out to pacify the country. For this campaign he received the Frontier medal with clasp.

In December, 1885, he was appointed Adjutant of the 2nd (Queen's Own) Sappers and Miners, but was prevented from taking up the appointment immediately by a dangerous attack of Peshawar fever which confined him to hospital for three months and necessitated nine months' sick leave to England. During his leave he married Frances Alice, daughter of Major O'Gorman, of the 90th Light Infantry, sometime M.P. for Waterford. On the termination of his leave Anderson and his wife sailed for India in December, 1886, and he took up his duties as Adjutant, Colonel A. F. Hamilton being at that time Commandant.

In 1888 Anderson, having completed his seven years on the Indian Establishment, reverted to home duty and was posted to Portland as Division Officer in December, 1888. He was promoted to Captain on the 18th of that month. His work there brought him into touch with convict labour, which was employed on the defences and barrack building under his charge and caused his large heart to take a kindly interest in the troubles and history of some of these unfortunate men, especially in the case of young fellows who had been tempted and bitterly regretted what they had done. Anderson spent much of his leisure time while at Weymouth in his favourite pastime of yachting. He owned and sailed the *Gazania*, and made many voyages round the coast east and west, occasionally running over to Havre and Cherbourg. The crew on these occasions consisted of himself and one deck hand.

Anderson's mathematical and analytical brain drew him early in life to a deep study of cryptography in which he became an expert and an authority. In 1887 he published a pamphlet, "Remarks on a method of deciphering Cryptograms," and also contributed articles on the subject to *The Pioneer*, and had besides written many notes and collected much information on this interesting subject. He was the means, while at Weymouth, of discovering and preventing an outbreak in the convict prison at Portland, by reading a cypher which had been intercepted. He used to amuse himself by answering

cypher communications in the agony columns of the papers to the extreme annoyance of the people who put them in. His work was known to the military authorities and led to his being asked to serve from time to time, while at Weymouth, on committees of the Intelligence Division engaged on examining systems of cryptography and compiling code and handbooks for military use. His knowledge was later to prove of immense value to the country in time of war.

In 1892 Anderson was offered and accepted the post of Deputy Colonial Engineer at Penang, and, in 1894, President of the Municipal Commission at Georgetown, the late Sir Henry MacCallum being at that time Colonial Engineer of the Straits Settlements. While at Penang it fell to Anderson's lot to ascertain the cause of, and to remedy a serious leak in the great reservoir at Waterfall. This he accomplished with success. During his tenure of office a scheme for the harbour improvements at Penang was in course of preparation and he was responsible for the improved design for the new pier which was adopted on his advice and recommendation. Under his direction the detailed survey of the territory was advanced and improved and complete new revenue sheets were prepared and issued. He designed and built a bungalow for himself on Penang Hill. Later in his service in the Straits he acted as Colonial Engineer during the absence of Sir Henry MacCallum and was sworn a member of the Executive Council on the 18th March, 1896. He was also a member of the Legislative Council.

His promotion to Major came on October 10th, 1896, and in August, 1897, he returned to duty in England and was posted to Aldershot, when he was employed on barrack reconstruction and on the electric lighting of the barracks. Colonel Pitt, his C.R.E. at that time, writes:—

"He was an extraordinarily capable man all round and an unusually good mathematician. Whilst he was at Aldershot we were getting out a large scheme for the electric lighting of the whole place, including the design for the generating station and laying all the cables, as well as wiring all the buildings. This involved a great deal of highly complicated calculation which Anderson entered into *con amore* and carried out most successfully. The 'three wire' system was adopted and, as no adequate text-book was forthcoming, he had to work out his own formulæ."

In 1899 Anderson was transferred to Clonmel and served there and at Waterford as reconstruction officer of the Cork district. His stay in Waterford with his family was a happy and uneventful time. His service there covered the period of the war in South Africa. In the course of these operations cypher messages from the Boer Government were intercepted and Anderson's special knowledge was requisitioned with a result that the Boer code was discovered and the messages de-coded. For his success on this and other occasions

he was rewarded with a gratuity of £100—though brevet promotion was refused.

In June, 1904, he was promoted Lieut.-Colonel and again ordered to India, and, landing at Bombay in February, 1905, proceeded to Secunderabad for a few weeks until he took up the command of the 2nd Queen's Own Sappers and Miners, of which he had been Adjutant seventeen years previously. This was a busy and a happy time for him, as the Command was one for which he was well fitted, giving scope to his inexhaustible energy, initiative and cheerfulness. He did much during the four years he held the Command to improve the military and technical training of the Corps. He started a provident fund for the widows and orphans of the British Warrant and N.C. Officers attached to the Corps. He was instrumental in forming classes of instruction in military engineering for officers of other arms of the Service, for which there were exceptional facilities at Bangalore.

This was the period of Kitchener tests, and Anderson was fully alive to the importance of sapper companies being exercised during training and manœuvres in conjunction with other arms. He did much to assist in the framing of training programmes and to instil reality in the schemes for the annual training of the Bangalore Brigade. A portion of one year's Brigade training was devoted to an unusually complete lesson in entrenching. The corps was inspected by Lord Kitchener during Anderson's tenure of the Command.

His recreation during this time was shooting, and at week-ends and whenever work allowed he would bicycle for miles in the heat to his favourite snipe jheels and covers for a day in the open air with his gun.

Major-General Sir Francis Bond writes:—"For some years it was my privilege, as D.G.M.W. in India, to inspect my old Corps, the Queen's Own Sappers and Miners, when Anderson was in command, and I am always glad to think that I was instrumental, knowing of his excellent reputation, in getting him his appointment.

I can testify to the ability and zeal with which he commanded the Corps, and actively supported its high reputation. Beloved by his officers and men, he never failed to keep up a vivid interest in the technical and field work, and he always encouraged real comraderie with other troops in the Bangalore Brigade. With him work and fun went hand in hand, and amongst his many official duties and interests, time was always found for running a merry little paper, called "Camp Pie," which created much laughter amongst his comrades and friends in the Corps and the Brigade.

Later on in the days of the Great War, we were together in the War Office, and Anderson's ready assistance and unfailing grasp of sanitary conditions and up-to-date methods, immensely eased the strain of the Quartermaster General's branch which was charged

with the housing and billeting of all troops, and the provision of camps and hospital accommodation for the United Kingdom. In every part of this work, we consulted Anderson and his committee and always with advantage.

All this time he was conducting other work of intense value to the Intelligence in his General Staff capacity, and all with the same marked ability and thoroughness, maintaining the same admirable spirit as ever amongst his colleagues and friends. He took a keen interest in the R.E. Charitable Fund, and his loss to that committee as well as to the wider interests of the Corps, is very great.

Anderson's work throughout the time I knew him was full of energy devoted to the betterment of the interests of others, and the public service. He never thought of himself, or urged claims of his own."

An Officer (Major Berkeley Hill, I.M.S.) who served with him at Bangalore writes :—" General Anderson was one of the most gifted and delightful men I have ever known. He was my first C.O. and a better, kinder, or more lovable C.O. no man could have had than I had in the Commandant of the Q.O. Sappers and Miners. His loss will be deeply felt by all those whose privilege it was to work with him or under him, and among such mourners will be many Indians as well as Europeans."

On the termination of his period of command in June, 1909, he returned home, being promoted substantive Colonel and appointed A.D.F.W. at the War Office in August of that year. He also became *ex-officio* member of the Army Medical Advisory Board. Among other duties at this time he was engaged in compiling a memorandum on cryptography and codes and many of his suggestions were adopted in the official handbook.

In January, 1913, he was appointed Chief Engineer of the Eastern Command with the honorary rank of Brigadier General. He was serving in this Command when the war broke out ; and he was at once recalled to Army Headquarters and attached to the General Staff as Chief Cypher Officer for cypher and code work, for which his unique knowledge and wide experience in cryptography so eminently fitted him. He had to raise and train the *personnel* of the cryptographic bureau and to organize its work. In addition to his normal work in the bureau he instructed various naval officers in cryptography.

At the same time he was also appointed Chairman of the Army Sanitary Committee. Sir Alfred Keogh, then Director-General of Medical Services at the War Office, writes, regarding Anderson's appointment : " When in 1914 I was recalled to the War Office to reassume the direction of Army Medical affairs the necessity for a central organization for co-ordination of effort in the domain of disease prevention was at once apparent. The extraordinary efforts

which were subsequently made in the various theatres of war only emphasized this necessity. If ingenuity in improvisation of sanitary details was in the main the prevailing characteristic of the workers in the field, opposing principles of action were often discernible. The efforts of the various centres required correlation, newly acquired knowledge needed diffusion. The application of scientific discovery to disease prevention in war specially concerns the engineer officer and it was the recognition of this fact which made it a matter of concern that the President of the reformed *ad hoc* Sanitary Committee should be an officer of the Royal Engineers; an officer, not only possessed of special knowledge in his own sphere, but well acquainted with the factors concerned in the origin and dissemination of the diseases of armies. I succeeded in securing Brigadier-General Anderson for the post. It was one which required not only special knowledge but special qualities and the Army was fortunate that the duties appealed in a special degree to this officer. Astuteness, sagacity and power of discernment are qualities as essential to successful administration, as frankness and power of conciliation. All these qualities Sir Francis Anderson possessed in a remarkable degree. If he was tenacious of his own views, he was open to conviction, for he could always see the other point of view. This is not the time to set forth, even in the briefest manner, the services rendered by the admirable body over which Sir Francis Anderson presided, but when the work of the Committee is recorded, the share which he took in limiting the ravages of disease in the various campaigns of the Great War will be found to have been large. In a position of great difficulty he was eminently successful. His success was in great measure due to his personal qualities, for his was a lovable disposition."

In a letter to Lady Anderson Sir Alfred writes :—

"I had the greatest admiration and respect for him, but in addition I owe him a deep debt of gratitude for, at a time of great personal anxiety, he was good enough to come to my aid to relieve me in one department of my work of a great anxiety and responsibility. I trusted to him so completely that I never had the least anxiety after he took over the committee which under him did so great a work which only the initiated could fully appreciate. He was a truly good and great public servant."

In another letter the following occurs :—

"I am so conscious of your husband's great services to the State. . . ."

Sir Frederick Treves, writing to Lady Anderson, says :—

"General Anderson had an extraordinary knowledge of his profession in all its technical details. He had a very receptive mind and was always anxious to get hold of new ideas. He was most liberal in his views and most indulgent to the views of others. He made an excellent chairman, just, judicious, business-like and a

model of courtesy. Outside his work he was the most genial companion possible, kind, considerate, unselfish. His humour was remarkable and as a conversationalist few could equal him. It was always a great pleasure, and indeed a great privilege to be associated with him in any 'mission'—or tour of inspection. His heart was in his work and what he did he did well. I should imagine that he had not an enemy in the world. Possibly one of his most marked characteristics was his quite astonishing ingenuity."

Sir Arthur Newsholme, a member of the committee, writes:—

"As a member of the Army Sanitary Committee I had, especially during the earlier period of the war, almost weekly opportunities of meeting General Anderson and of admiring and appreciating his courtesy to all his colleagues and to the many officers and men whom we met in our visits of inspection; of realizing his resourcefulness in emergencies and the practical character of the advice he gave and his broadmindedness in giving due weight to medical as well as to the engineering considerations. It was on the due balancing of these two aspects of the subject that the success and results of the work of the Army Sanitary Committee depended, and of the importance and value and success of the work of that committee there can be no doubt. In the instances in which the counsel given by him as to the drainage arrangements, etc., of camps was not adopted, subsequent events showed that much financial loss had resulted therefrom. The stupendous task of securing elementary sanitation for the hundreds of thousands of men who were rapidly aggregating in immense camps was only rendered possible by active and continuous co-operation of military and civil authorities, and on the military side it was largely owing to General Anderson's work that this was rapidly and successfully accomplished. His colleagues will always remember with admiration General Anderson's exceptionally fine mental qualities and with gratitude his geniality and kindness and his helpfulness on every occasion."

The Star and Garter Committee of the British Red Cross on forming an expert committee to advise on the class of patient to occupy the Star and Garter Home at Richmond sought Anderson's help as a member of the committee. Anderson was a Fellow and also Vice-President of the Royal Sanitary Institute and a member of the Army Hygiene Advisory Committee.

He was continued in employment beyond the date of the Armistice, and only retired as lately as the 1st November, 1919, after nearly 42 years' service.

For his services in the War he was appointed a Companion of the Bath in January, 1917, and made a Knight Companion of the British Empire on the King's birthday, in 1919.

There is no doubt that the great strain of the War, coupled with the incessant travelling both in the United Kingdom and in France

entailed by his duties on the Army Sanitary Committee, together with the grief at the loss of his gifted and beloved younger son, Major F. Sainthill Anderson, M.C., R.F.A., killed in action in France, in August, 1918, undermined even his strong constitution for with scarcely any warning he died suddenly of heart disease on the 6th March last. He was on the point of moving with his family to Ballydavid, Co. Waterford, a place which he had recently acquired with the intention of establishing his home in a neighbourhood he had known since childhood. His body was taken to Ballydavid House and he was buried at the Abbey Church of Waterford, the funeral being a military one.

Besides his great interest in cryptography he devoted much attention to mechanical aids to mathematical computations and produced a "Gunners' Slide Rule" for which he received the thanks of the Secretary of State for War. Anderson's patent Improved Slide Rule is also well-known. At the time of his death he had taken out a patent for an ingenious "Abacus," or circular calculating machine. This is a circular form of the slide rule.

Anderson was a keen Mason and was a member of the Waterford Lodge and when at Bangalore was elected Worshipful Master of Lodge United Service at that station.

Anderson's character was a peculiarly lovable one. He was the staunchest of friends and always ready to help lame dogs over stiles. Many must remember with thankfulness his generous help in time of trouble. His retentive memory and ready wit made him the best of good company. His activity of brain and body was exceptional and this activity he retained to the end. His death came as a surprise and shock to his many friends who grieve for the early passing away of one of the best of fellows.

W.H.

REVIEW.

THE PROJECTION OF MAPS.*

The subject of map-projections has always been a thorny one, mainly because the writers who have investigated the theory have dwelt in different spheres from the map-makers who have had to make practical use of the projections. The two classes have possessed moreover no weights and measures in common: the mathematician estimates the value of a projection by means of different systems of errors; the map-maker's ideas of value are governed by such considerations as simplicity, economy, uniformity with his other projections, possibilities of future expansion, and the general utility of the finished map. It is at times a question whether to subordinate utility to mathematical accuracy or *vice versa*. The problem has been deemed worthy of study by some of the most eminent mathematicians of history, but the surveyors who work upon maps have neither the power nor the leisure to scrutinize theories. The co-operation of two different classes of men is thus required. The projection of maps may be likened to the erection of a column in architecture; the mathematical theory forms the base, the map forms the capital. The base by itself is useless, the capital is the architect's aim.

Although the subject of map-projection has been exhaustively dealt with by numerous writers, there are very few books that can be said to have successfully bridged the gap between the mathematician and the map-maker, between the base and the capital. Authors harass students with descriptions of numerous projections that have no practical use; they do not sufficiently explain the particular employment for which each of their many projections may be considered suitable; and they close their investigations before they have crossed the border-line between theory and practice.

The author of the book under review was Deputy Surveyor General of the Malay States, and the map-maker would expect to receive from him a helpful exposition. But Mr. Young is a skilled mathematician, and his book leans more to the mathematical side than to the practical. As an investigator Mr. Young deserves to rank with the eminent authorities of the past; his knowledge of theory is exceptional, and he is one of the few living authors who can be fairly regarded as experts. But his absorption in the scientific side of the problem, and his pleasure in grappling with mathematical difficulties have led him to curtail the practical side to such an extent that the professional map-maker will derive little advantage from his book. This is to be regretted; the map-maker is in want of a post-war exposition of useful and employable projections, and it would be difficult to find an author more qualified by experience to write one than Mr. Young.

Mr. Young has displayed much originality in his new treatment of the conical projections, but his descriptions of his own original steps are so

* *Some Investigations in the Theory of Map Projections*, by A. E. Young; published by the Royal Geographical Society, 1920.

abbreviated that he will not receive the credit he deserves. His plan of altering the scale error at the centre of the map in order to reduce the average scale error is the most valuable contribution that has been made to the subject for years.

Many surveyors have to work with rectangular co-ordinates and to consider the convergency of meridians: Mr. Young's references to these points are too brief. His new method of reducing the errors of the Cassini projection is useful and shows a grasp of the subject, but its novelty is not sufficiently emphasized.

An illustration of the want of unity between mathematicians and draughtsmen is to be seen in the conservative retention of Mercator's projection in modern atlases. Whilst the mathematician has been discussing the complexities of obscure projections, the draughtsman has continued to employ a projection which falsifies geography and which ought never to have been used for educational purposes.

The chief practical difficulty of the past has been due to the great number of projections, which have been thrust before the map-maker for his selection. He will therefore be astonished to learn from Mr. Young's book that the very best projection of the conical class was one invented in 1758 by the Rev. Patrick Murdoch and which has been subsequently forgotten. Whilst this projection possessing all the virtues has been allowed to sink into oblivion, many projections without any virtues at all have been continually brought to notice.

Another feature of Mr. Young's book will come as a surprise to map-makers. The latter class have always accepted the results presented to them by eminent mathematicians without question. But Mr. Young repeatedly points out mistakes in the mathematics of the highest authorities. According to Mr. Young (page 2) Sir George Airy "made a slip in his solution" and "Airy's erroneous tables have unfortunately been incorporated in later publications." Mr. Young also shows (page 4) that Clarke made an error in his calculations, and (page 72) that Jordan's formula was wrong, and (page 75) that even Helmert's formulæ for convergency were incorrect. Each of these mistakes may have been individually unimportant, but their cumulative effect is disconcerting. All these mathematicians were surrounded with computers, and their work could have been checked before it was published.

No discussion of map-projections is now complete unless it refers to the changes which the views of geographers have undergone since the end of the nineteenth century, when the Paris conference issued its recommendations for an International Map of the World. Old-established mapping offices were then led to look into the projections which they had inherited and which they had hitherto reverenced as the mystic symbols of ancient wisdom. Their examination showed that a want of understanding had separated the mathematicians and map-makers of the past. The utility of a map had too often been subordinated to mathematical difficulties. A geographer now realizes that he only requires three projections in order to make good maps of a whole continent; he requires one projection for his small-scale geographical maps, another for his topographical maps on all their various scales, and a third for his revenue surveyors who have to work with rectangular co-ordinates.

The definite recommendation of the polyconic projection by the International Conference brought more light to mapping offices than the technical treatises had done. This projection is becoming widely adopted for maps on various scales. The advantages of having maps on the larger scales all fitting into the smaller are great; projections are becoming unified, margins made coincident, overlaps eliminated. Co-operation in a map of the world is moreover teaching a surveyor to look beyond his own borders; he can no longer give to his projections such final limits, as his predecessors were apt to do; he must allow for possibilities of expansion.

Mr. Young discusses the "best" projection for a long narrow country like Italy; by "best" he means the projection that will show a minimum error. But a question, that will occur to many map-makers, is whether any map of Italy will be found satisfactory if it excludes the Alps, the Adriatic and Sardinia; if these areas are included, Italy can no longer be regarded as a narrow strip. Moreover the Italian Survey has already adopted the polyconic projection for its maps on the scale of 1/million, and this step may render the same projection convenient for other scales.

In discussing the "best" projection Mr. Young does not mention the scale of the map, which he is contemplating. The problem for the best projection of a given area is dependent to a certain extent upon the scale of the forthcoming map. One projection may suit a wall-map on a scale of thirty miles=one inch, and another projection may be more suitable for a large scale map (one mile=one inch) published in numerous sheets.

The conical projections, as they are generally understood by geographers, have their pole corresponding with the pole of the Earth, so that meridians of longitude are directed towards the pole of the projection. Dr. Hammer has suggested conical projections, in which the pole of the projection does not correspond with the Earth's pole. An artistic cartographer will dislike the mathematical conception of a cone placed askew on one side of a spheroid, and his objections will have Mr. Young's support. The latter writes that "when the pole has a skew position the map has an ugly appearance," and that the only "useful" position is when the pole corresponds with the Earth's pole. Hammer's idea is thus vetoed on practical grounds.

S. G. BURRARD.

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65 R.E.

A SHORT RECORD OF THE SERVICES OF THE 65TH FIELD CO., R.E. (Cambridge, W. Heffer and Sons, Ltd. 1920).

This is the record of the services of an R.E. Unit of the New Army, from its formation in 1914 to its demobilization in 1919. It served in Gallipoli, Salonica and Palestine, and was one of the R.E. Companies in the retreat from Serbia in 1915. The record is most instructive from the fact that it records the personal experiences of officers and men which will never appear in any official history, and gives an insight into the life and trials of the human units of an R.E. Coy. which is invaluable. The book is well illustrated by photographs, but it is a pity that there

are no maps. A feature of the book is the list of names and addresses of old members of the Unit given in the appendix. The final page of the record shows the family feeling that existed in this and, I believe, all good R.E. Units. One of the photographs contains the picture of a fox terrier dog—Jumbo. Jumbo was a dog of large experience—he was picked up by the Headquarters of C.R.E. 27th Division at Mericourt on the Somme in September, 1915. He was then starving and attached himself to us. I can remember one day there was a scare of mad dogs in the area and the edict went forth that all dogs were to be destroyed. All dogs but Jumbo disappeared, though I imagine that camouflage, not execution, was the cause. Jumbo was *persona grata* at Divisional Headquarters and I remember that much amusement was caused by his being found in the Divisional Commander's private office some days after the edict for the execution of dogs had gone forth. Jumbo attached himself personally to Captain Noble, D.S.O., my adjutant, and followed him everywhere, even into the front trenches; one of his amusements being to jump over the parapet and to run about amongst the wire. Noble took him to Salonika when he went out and kept him with him everywhere. What happened to him ultimately I do not know, but I trust he is at peace wherever he is; he was a very nice dog.

G. WALKER, *Colonel.*

107TH FIELD COMPANY, R.E.

(Darlington, Wm. Dresser and Sons, 41, High Row. 1920).

The book under review is the second volume of these recollections. It has been compiled by the Editor, Captain M. J. Rattray, with a view to providing a souvenir for the late members of the Unit and their friends. The book is well illustrated with photographs and there are useful maps. The experiences of this Unit commenced on 25th November, 1914, when it was formed under the command of Captain Eustace, R.E. at Chatham. It went to France in the 26th Division in 1915. This Division was put into the 12th Corps and went to the line on the Somme in September, 1915. From thence it went to Salonika with the rest of the 12th Corps in November and December, 1915. The book gives a very good account of the Salonika campaign from the point of view of an R.E. Field Company, and further interest attaches to the account from the fact that the 107th was the only R.E. Company to cross the Danube and enter Roumania, after the collapse of the Bulgarians and Turks. The Company was disbanded in the Balkans when the 26th Division was broken up.

G. WALKER *Colonel.*

OLD EUROPE'S SUICIDE.

By BRIG.-GENERAL C. B. THOMSON. (George Allen and Unwin. 5/-).

This little book contains a clear and delightfully interesting account of recent history in the Balkans.

F.E.G.S.

NOTICES OF MAGAZINES.

MILITÄR WOCHENBLATT.

No. 23.—*Study and Criticism of Military History.*—General Ludendorff contributes an article on the study and criticism of military history. He first of all points out the importance which has been rightly attributed to it in the German Army, and then proceeds to indicate the lines which should be followed.

Since human nature does not change, the study of all campaigns, however far distant in time or place, is of value, but for the purely technical military side, the most modern have a greater value than the older ones. Not only do the constant developments in armament and equipment make this the case, but strategical ideas are continually growing and must be kept pace with.

The study of the world war is a task that should be undertaken not only by soldiers, but by every German man and woman, so that the degree of political education reached by their enemies, which gave them the victory, may also be attained by Germans. He declares that only by this means can Germans cease to be an unpolitical nation of unpractical dreamers and acquire the will to power, so strongly developed in the tough and stiff Anglo-Saxon race.

He repeatedly emphasizes the need for strict and impartial accuracy in compiling history, but would have it combined with warm patriotic feelings. The examination of official records will, he regrets, be held up by all governments for many years, but he hopes that, meanwhile, all that is possible will be done to place on record accounts of events, obtained from those who actually directed or took part in them. While war diaries have a certain value, he does not think too much reliance should be placed on them, because there was so often not enough time to compile them properly. He admits that he never looked at the G.H.Q. diary, nor did he take any special steps to have his telephone conversations recorded.

Private diaries and the reports of returned prisoners of war must be studied and the scope of the history must be enlarged to include such subjects as the economic situation, the U-boat campaign, the relations between the Army and the people, and the effects of propaganda; but above all he demands searching examination as to the truth of all state ments, so that legends, many of which have been purposely circulated, may be eliminated, and accuracy, which is the foundation for all useful criticism, unfailingly ensured.

The Marne Campaign of 1914 is General von Kuhl's account. As chief of the General Staff of the 1st Army he has special knowledge of events and he recounts them clearly and well. He brings out particularly, how the Schlieffen plan of an overwhelmingly strong right flank was spoilt by those who tried to combine this with strength elsewhere, and thus fell

between two stools. The 1st Army was too weak and G.H.Q. wished its weakness to be compensated for by mobility. The most important decision made by the 1st Army was that of the evening of the 2nd September, when it was determined to attack the flank of the French Army falling back in front of von Bulow, and when this decision was adhered to, in spite of the protests of G.H.Q. This movement undoubtedly lightened the task of Manoury and the British, although the 1st Army, by its quick move back to the Ourcq, got well out of a disadvantageous position without much loss. The reviewer thinks that the leading of the 1st Army in August and September was, on the whole, a first rate performance.

The Revolutionary Army.—The Communists have got as far as publishing a book entitled *The Revolutionary Army* wherein are laid down the principles to be followed in the Army which is to arise after the establishment of a communistic state. The organization of this Army is to follow that of the old Imperial force, but the recruit is to be taught his trade in from 1½ to 3 months, with short refreshing trainings in subsequent years. The leaders are to be drawn from *personnel* so trained, and not from any professional class of soldiers. The writer quite sees that such an army will probably have to give ground before its enemies in the first place, but finds definite advantage in this fact, by reason of the guerilla war which will spring up behind the backs of the invaders. The *M.W.B.* thinks that the invaded population would probably prefer the rule of their enemies to that of the Communists, and would wish that the author could go through the test of war with his precious army, were it not for the slaughter of his innocent followers that would be involved.

Cost of War Material.—Among other examples of prices in 1914 and 1920 are the following :—

	1914.	1920.
Rifle	50 marks.	800 marks.
Field gun	12,500 ,,	164,500 ,,
4.2 howitzer shell ...	50 ,,	865 ,,

In view of these the *M.W.B.* is no longer surprised at the Reichswehr estimates.

No. 24.—*Study and Criticism of Military History (continued).*—General Ludendorff concludes his remarks on military history. He warns the critic against trying to prove theories, but advises him to follow the causes of failure down to the last detail. If this brings him up against the reputation of any individual, he must proceed with caution, so as not to wound susceptibilities unnecessarily, but all the same he must face his facts, and no military leader should fear impartial and well considered examination of his actions. On the other hand one-sided and destructive criticism, based on prejudice, can only serve to undermine authority, and must be steadfastly avoided, especially in these days when so many bad influences are abroad. The words of the old training manual must be remembered, "Neglect and omission are more blameworthy than mistakes in choice of methods." The reader of criticism must also weigh up his author, to see whether he is

really equal to his task, and not take all that he reads as infallible, merely because it is in print. Lastly General Ludendorff wishes to see the great deeds of the Army brought well to the front, so as to give its enemies no cause to rejoice in the downfall of that of which they still stand in fear.

No. 25.—*The Roumanian Campaign.*—The first volume of General von Falkenhayn's account of the Roumanian campaign is published. After mentioning the embarrassment which the hesitating attitude of Roumania caused the central powers, who wanted the country, both on account of its resources and for access to Turkey, he describes the formation of the 9th German Army, which was destined to free the invaded Hungarian territory. The battle of Hermannstadt is rated as a second Tannenberg, on a smaller scale. In both cases an encircling attack was conducted against one army, while a second, which if rightly handled would have brought the Germans to disaster, was successfully held off. The battle was full of very critical moments, as the 1st Austrian Army failed and Roumanian attacks threatened to crush the weak German left flank. In spite of all danger, von Falkenhayn pushed his plan through and in four days, from the 26th to the 29th September, disposed of the 1st Roumanian Army. The following days were, however, full of anxiety for the Germans, but Falkenhayn's determination never to be forced into the defensive, which he says he could never have successfully maintained with his numerically inferior forces, was justified. In 18 days his army advanced 200 kilometres, fought three battles, and beat two armies, in spite of almost impassable mountain tracks. Von Falkenhayn complains that G.H.Q. interfered in some cases, without proper knowledge of the situation, but it is admitted that on the whole the higher command gave him every assistance possible in view of the critical situation on the other fronts.

The Bavarian Heavy Artillery.—This, before mobilization, had a strength of only about 4,000 officers and men, and 500 horses. In the spring of 1918 the continual demands for heavy artillery brought these figures to 46,000 and 22,000 respectively. In killed alone, losses amounted to 234 officers and 4,600 other ranks. The *M.W.B.* states that the greatest testimony to its performances lies in the fact that the Allies have determined to abolish it.

Army Orders.—The way in which N.C.O.s and men can qualify for commissions is laid down. Selected candidates have first to pass a general knowledge examination, and next an officers' qualifying test. They will then be allowed to go, in October, 1921, to the School of Arms, where there are further obstacles to be overcome before they can get their commissions.

The 30.5 cm. Austrian Howitzers.—It is stated that neither these nor the 42 cm. German howitzers were the invention of the Skoda works. Their development was entirely due to a military technical committee.

Bridge Building in the English Army.—A short note extracted from a Swiss military quarterly review, is given on the Bridging School at Aire. It is stated that the activities of the R.E. in bridging were of a wide scope. In 1918 they built 1,200 bridges with a total length of 8,100 metres.

In Battle Undefeated is the title of a book contributed to by all the famous German fighters, from Hindenburg to Richthofen. It is compiled in popular form, and, as its title indicates, is intended to raise the confidence of the German people.

No. 26.—*Increase of Pensions.*—The Reichstag has voted an increase in the pensions of all on the old scale. Present prices had placed the old pensioners in a very hard position and the increases which are quite substantial, will be welcomed. As the cost to the State is put at 500 million marks, it has been decided that income from other sources shall be taken into account, and a reduction in pension be made if a limit of total income is exceeded. With the exception of this clause and of one or two others, the *M.W.B.* approves of the measure which may therefore be considered as fairly generous. Some examples of pensions under the new scale are as follows :—

					Marks.
Lieutenant	with 10 years'	service	... ...		5,676
Captain	,, 25 ,,	,,	... ...		11,577
Major	,, 30 ,,	,,	... ...		15,328
Colonel	,, 40 ,,	,,	... ...		21,420
Maj.-Gen.	,, 40 ,,	,,	... ...		28,420
Lt.-Gen.	,, 40 ,,	,,	... ...		33,420
G.O.C. in C.	,, 40 ,,	,,	... ...		41,420

These figures include a bonus for high cost of living.

The Policy of the Entente Powers towards Russia.—The writer begins by stating that the Entente abandoned the Czar as soon as the danger of his concluding a separate peace arose, and goes on to say that, as soon as the war ended, divergencies in *Entente* policy began to appear. The one main point, on which all agreed, was that Bolshevism must not be allowed to spread. Views as to the best way to prevent it doing so are, however, so varied, that very little is actually effected. In France the main object is to save the 25 milliards advanced to the Czarist government. She must therefore always try to upset a government which repudiates this debt, and, to do so, has in turn supported Judenitch, Denikin, Petlura, and Wrangel. The only assailant of the Soviets whom France did not support was Bermondt, the reason being that he did not advance the second French object, namely to separate Germany and Russia as much as possible.

Poland was always sure of France's support because she fulfilled both her requirements. Even the senseless Polish attack on Kieff was lent every possible assistance on the off-chance that thereby the Bolsheviks might be brought down. August, 1920, was a time of danger to French interests ; Poland seemed on the point of collapse before the Red armies, and the only solution of the difficulty appeared to lie in the understanding with Russia, which England wished for. In such a case the 25 milliards were lost, hence redoubled support to Poland with, so far, successful results. But the future does not look bright. If only the Soviet government would recognise the pre-war debt, England and France could advance, side by side, but this the Bolsheviks will not do and England has little interest in pressing the point (!). If England concludes

a trade agreement France will openly stand aside from it, but will encourage private trading, so as not to be out of the hunt for Russian custom altogether.

All the same she will always be on the watch for a chance to upset the Bolsheviks.

England's chief interest, as mistress of the seas, lies in keeping Russia shut off from them. Her other objects are, to have a share in exploiting Russia economically, and to keep Bolshevik ideas out of British Asiatic spheres of interest. British policy has been accused of inconsistency even more than French, but the accusation is only well founded as regards the methods with which it is pursued. Her support of Kolchak and Denikin was continued only so long as the plan of closing the seas to Russia was thereby forwarded. As soon as there seemed to be a prospect of a new Great Russia arising through the downfall of the Soviet government, British support lost its object. It became more advantageous to hold Bolshevik and anti-Bolshevik balanced against each other, since a united Russia would certainly seek re-union with the border states and thereby access to the sea. England therefore supports the border states, but cares no longer for shutting off Russia from the Black Sea, since, by the treaty of Sevres, she has the key of that outlet in her pocket.

As regards England's other two objectives, she hopes to make the opening of commercial relations with Russia conditional on the cessation of Bolshevik propaganda in Asia. As this condition appears likely to be fulfilled, and as the closure of the seas is satisfactorily assured, England may be said to have achieved her objects. Official recognition of the Soviet government is only a formality and of little importance.

America's attitude has been one of aloofness. She cares only for economic relations as soon as the Bolsheviks fall from power, an event which she thinks will soon take place.

Japan, like England, wants to keep Russia from the sea. She, therefore, favours the establishment of East Siberian buffer states, which shall be under her thumb. At the moment the Chita government is very Bolshevik, so Japan holds fast to the Pacific ports.

Italy wants commercial relations, but fear of Bolshevik infection, and of her allies, has so far prevented her from effecting them.

Russia fully appreciates the advantage she gains from the differences between the *Entente* powers and openly mocks their disjointed attempts to bring her government to the ground.

Attack and Counter Attack on Officers.—The Munich branch of the German Officers' Association has attacked the *Vorwarts* for speaking of the "contemptible corps of officers," and also Scheidemann for saying in the Reichstag "The officers have to thank the self-restraint of the men for the fact that on the 9th November, 1918, they lost no more than their epaulettes and badges." The *Vorwarts* replies to the attack by accusing the officers' corps of the murder of Liebknecht, Rosa Luxemburg and sailors, of the Kapp "putsch," of ill-treating their men, and of looting and atrocities.

L. CHENEVIX-TRENCH, *Major, R.E.*

REVUE MILITAIRE GÉNÉRALE.

August, 1920.

Falkenhayn. The Breach and its Exploitation, by General Lavigne-Delville.—General von Falkenhayn in his book "*The German Supreme Command and its Essential Decisions* (1914-16)" gives interesting information on the problem of breaking the enemy's line, on the condition necessary for its accomplishment, and on its utilization by the strategic reserves, and primarily by the larger cavalry formations. Falkenhayn shows that the problem is solvable, was in fact solved on seven occasions during his tenure of command, but failed on six other occasions. It should be noted that the attack on Verdun is represented as undertaken only with the object of exhausting the French, and not with any design of effecting a breach, and he over and over again insists that on the Russian front the defeat of their armies, and destruction of their offensive capacity for the time being was all that was aimed at, and not the annihilation of their forces, as much owing to the inferior offensive capacities of the Austro-Hungarian army as to the Russian facility for slipping out of a trap. Falkenhayn shows that to effect a breach two conditions must obtain; preponderating superiority, greater than was thought necessary before the war, in men and materials on the side of the attacker, and moral inferiority on the side of the attacked. In the cases of the seven successful breaches both these conditions held, in the six unsuccessful attempts one or other was absent. As regards these deductions it may be remarked that the enemy must stand to receive the attack. He might refuse the battle and withdraw to another position, but this procedure has limits. The Allies fell back in 1914 and saved themselves from envelopment, but at the price of abandoning the richest regions of France. On the other hand the Russians never hesitated to fall back, the immense size of their Empire allowed of it, but it is questionable whether that action did not sap the moral of the army and also of the whole nation, and the same remark holds good of the German retreat in 1918. A local retirement may be made on two conditions, that a strong position exists in rear, and that te ritory of little value is given up, but a general retirement would probably mean abandoning resources necessary for carrying on the war, and to retain these the last man must be sacrificed. It is to be hoped that in future France will have an army capable of carrying on a war from the outset on enemy territory, and not run the risk again of losing her fairest provinces. The breach once effected it remains to exploit it. The higher formations of infantry are assembled to widen the gap, and hold it open for the passage of the higher formations of cavalry. Not one of the breaches mentioned was exploited, and in each case the failure to reap the full fruits of the victory was due to lack of troops, but in some of the cases the possibility of such a success had not been anticipated. Two may be advantageously studied more closely, those effected by the Germans against the Russians at Tarnow in May and June, 1915, and at Lublin-Cholm on 16th July, 1915, both of them desired and prepared for by the German G.H.Q. In May a German and an Austrian Army were engaged (16 divisions infantry of which 7 were German). There was an Austrian cavalry division with each army. The breach made in the

Russian lines extended for 160 kilometres, and the troops on each flank were badly shaken on a total front of 350 kilometres. Thus each division in the attack operated on a front of 10 kilometres, too extensive an extension, but deemed by Falkenhayn a sufficient density in view of the small value of the opposing force. The attack exhausted the infantry, and there were no fresh troops to push the advantage. Italy was about to enter the war, the attack halted, and the Russians formed a new defensive line. However the Germans determined to follow up their advantage although unable to count on strong help from Austria now occupied also on the Italian Front. Two infantry divisions from France, and two from Poland, were hastened over to Russia, a renewed attack in June was again successful, and Lemberg fell. In spite of a strong rumour of an Anglo-French offensive Falkenhayn determined to push on, but could send few reinforcements, and the force was now, owing to losses, inferior to that engaged in May and June. However, another cavalry division was added. He was not sanguine of continued success, and considered the country beyond the Bug unfavourable for further offensive operations. The Russian front was again broken on 16th July, and up to 9th August great results might have been expected, but again the attack was exhausted, and by 9th September the Russians reformed their line after a retreat of 300 kilometres in 35 days, and losing 650,000 men in prisoners. In consequence, Falkenhayn broke up Mackensen's command, distributed his troops to other fronts, and sent him to command against the Serbians. Why was the cavalry distributed between the two armies and not concentrated as a reserve, to exploit the breaches successively made? Mackensen does not seem to have realized the necessity for such a concentration, or was withheld by higher orders from arranging it, but that does not excuse Falkenhayn who was in supreme control of the war, and responsible for the distribution of troops on the various fronts. Again the group of armies of the East under Hindenberg comprised 39 divisions of infantry and 8½ cavalry divisions. All or part of the latter might apparently have been employed as exploitation troops either by Mackensen or Hindenberg. At the end of April Hindenberg's was the largest mass of cavalry which existed during the war on any front. His orders were to attack the north wing of the Russian Army, and by making a display of force along his whole front to mask the despatch of units to Galicia, and to organize an extensive cavalry raid behind the Russian front. The raid failed; based on the idea that the Russian dispositions had not been changed after the winter campaign in Mazuria, it encountered the Russian reserves in refused echelon behind their threatened flank. Cavalry could not attack unbeaten troops, and another reason given by Falkenhayn for the failure is that the cavalry advanced split up to such an extent that some fractions were mere patrols, too scattered for efficient unity of command. The cavalry retired, and formed a screen before an enemy little disposed to be aggressive, but as it was too late to employ them otherwise, they were left where they were, and Falkenhayn claims that they fulfilled the mission given to them. This is doubtful, at any rate they would have been employed to greater advantage in exploiting Mackensen's successes. It was possible to have transported them to

Galicia in spite of Falkenhayn's assertion that the German railways on the East were insufficient for the execution of any lateral movements to any particular sector of the Russian front. The reason for the non-employment of the cavalry must be sought elsewhere, either in lack of influence of the supreme command over certain of their subordinates, or in a false conception of the uses of cavalry. The German high command had a remarkable grasp of the constitution, employment, and distribution of reserves, and its partition of them amongst the various fronts was masterly. There may have been a crisis of authority. Leaving aside difficulties with Austria-Hungary, mainly political, it was a question of the subordination of the German Army Commanders, and no doubt the victor of Tannenberg was not an accommodating subordinate. It is to him perhaps more than to others that Falkenhayn addresses an impersonal reproach accusing them of considering their own particular task the most important, and the troops allotted to them as their own property, and certainly on one occasion Falkenhayn had to invoke the Emperor's orders to induce Hindenberg to part with certain troops required by the supreme command for a general reserve. However this may be the German High Command seems to have misunderstood the services that cavalry can render. Of the three essential roles of the higher cavalry formations, reconnaisance, screening, and exploitation, a study of the war seems to show that the High Command was able in certain cases to dispense with the first, utilize the second, and did not believe in the third. (The arguments in favour of the first two deductions are not reproduced here as they do not bear on the subject). As regards the third, had von Moltke after the French defeat at Charleroi sent in pursuit a strong force of cavalry held in reserve for that purpose it may be said at the very least that the re-organization of the units would have been less easy and slower, that the sadly large losses in prisoners would have been far heavier, and that the stand would not have been on the Marne, but further south. Moreover if von Moltke had, instead of sending Marwitz in between the armies of von Kluck and von Bulow, employed his force in front of the IVth Corps operating from 4th September on Dammartin, Claye, and Lagny, he might at least have delayed the arrival of the French VIth Army, or rendered its action less energetic. Again on 21st March, 1918, when connection between the British and French lines was severed, the great question asked was "Have the Germans any cavalry?" By 27th it was known that they had none. Also on 27th May a German irruption crossed the Chemin des Dames, the Aisne, and the Vesle, a great gap was made in the French line, and hardly closed by hastening up cavalry reinforcements, but no German cavalry appeared to press the advantage, and their infantry advance gradually lost power. Had German cavalry been available it is questionable where the French lines would have been re-established. Thus Falkenhayn only followed the example of von Moltke, and preceded Hindenberg, in underestimating the third role of cavalry. It may therefore be concluded that this was the German doctrine. On the other hand, wherever the French anticipated making a breach, a reserve force of cavalry was always at hand to utilize it profitably, but unfortunately the opportunity did not occur. Which theory is correct is proved

by the victory, but to this negative proof positive proofs may be added. On four occasions during the war operations have resulted in the final annihilation of an enemy, the two Serbian campaigns, and those in Roumania and Palestine. Of the first two full details are not available, but it may be noted that after the battle of Dobropolis the French cavalry carried out a pursuit towards Monastir, and one as far as Belgrade. In Roumania Mackensen constituted two corps of cavalry and after the battle of Targu-Jiu, in which he had hoped to effect a breach, he sent his cavalry into the plain to exploit the victory. Though hindered by the numerous water-courses of Wallachia this cavalry entered Bucharest on 5th December, having covered 400 kilometres in 18 days, taking numerous prisoners, and opening the way for the infantry. In Palestine in 1918 the battle on the front Jaffa-Jerusalem was undertaken to open the way for the British cavalry (accompanied by some French squadrons), who passed through a breach opened and kept open by the infantry. In two days these corps arrived at Naplus in rear of the enemy, in six more days had reached the Jordan, and three days later Damascus. The result was the capture of two Turkish armies with artillery and transport, and General Liman von Sanders only escaped owing to the speed of his motor-car, while his papers and part of his staff were captured. Judging from the one-sided evidence which alone is available to the public on the conduct of the late war it may be said that complete success is only obtainable when there is cavalry at hand to ensure it. Who knows that the fear of cavalry exploitation may not have had its influence in deciding the German Colossus to save his life by unconditional surrender. More fortunate than the French, the Italian cavalry was able at the end of their campaign to exploit completely the victory of Vittorio-Veneto. On 29th the Austro-Hungarian front was pierced in the centre, the Piave crossed, and the first exploitation unit reached Vittorio, 20 kilometres from the front, that evening. The breach having been widened and kept open, the cavalry corps of the Count of Turin (3 and soon 4 divisions) anticipated the enemy in his second position on the Livenza if he had wished to make a stand there, and even in the third, the Tagliamento, if he could bring his last reserves there. On 30th the cavalry corps crossed the Brenta, on 31st was at Sacile on the Livenza. On 3rd November it crossed the Tagliamento on a front of 40 kilometres. On 4th, collecting prisoners by the way, and even whole units of the staff, the Italian cavalry was in sight of the Isonzo, 50 kilometres from the Tagliamento. There was cavalry wherever it was required on a front of 100 kilometres, and no reorganization on the part of the enemy was possible. The armistice stayed further action. The writer here enters a plea for the maintenance of a strong force of cavalry in the French army of the future, and closes with an exhortation to his countrymen to face the cost of the insurance premium which is paid in the maintenance of an army, warning them that the expression *la revanche* once used with bated breath in France, is now openly spoken in Germany, and that the latter may be able to draw on the resources of Russia, in spite of the obstacle of Poland.

A. R. Reynolds.

PROBLEMS

A CORRESPONDENT has sent the following extract from the *Morning Post* and enquires why the Problem is considered to be of such great importance :—

A series of nine public lectures on "Problems in Science" are being delivered at King's College on Wednesdays at five o'clock, and the first of these was given by Professor J. W. Nicholson yesterday on the subject of "Mathematics."

Dr. Nicholson said that it was not easy to make mathematics a simple subject to understand for the lay mind. Yet it was all-important, for it figured in all the three faculties of arts, science, and engineering. Many problems remained to be solved. The solution of one of them would gain a prize of £50,000 from the Academy of Science at Vienna. Briefly it might be explained as follows :—

If a larger number (N) is broken up into smaller numbers, find for all cases a proof for the formula

$$N = p^n + q^n + r^n + \ldots .$$

where p, q, r, etc., are different numbers, and "n" the same index for all the different numbers. About 100 solutions a year have been sent in regularly for the past 20 years, none of which have been right.

PROBLEM 14 (Colonel C. L. Young).

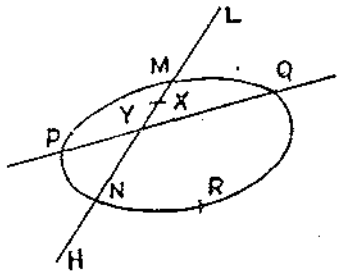
Each player plays once with and twice against each other player; devise an arrangement satisfying these conditions. How many such arrangements are there? The following games are given for 8 players, A, B, C, D, E, F, G, H :—A B *v.* G H; E F *v.* C D; A C *v.* B D; E G *v.* F H; A D *v.* E H; B C *v.* F G; A E *v.* C G; B F *v.* D H; A F *v.* B E; D G *v.* C H; A G *v.* D F; C E *v.* B H; A H *v.* C F; B G *v.* D E. Total, 14 games. How many other possible arrangements of partners are there under the above conditions?

PROBLEM 20 (Solution).

If the straight line $lx + my + n = 0$, meet the conic

$$ax^2 + 2hxy + by^2 + 2gx + 2fy + c = 0$$

in the points P and Q, find the equation of the pair of lines HP, HQ, the co-ords of H being $x'y'$.



Co-ords of H are $x'y'$.

Let L be any point and $x''y''$ its co-ords. Consider any point X on HL and let the ratio $HX : XL = \lambda : \mu$.

Then co-ords of X are

$$\frac{\mu x' + \lambda x''}{\lambda + \mu} \qquad \frac{\mu y' + \lambda y''}{\lambda + \mu}.$$

Now if X is on the conic

$$ax^2 + \text{etc.} = 0,$$

The following equation must be satisfied :—

$$a(\lambda x'' + \mu x')^2 + 2h(\lambda x'' + \mu x')(\lambda y'' + \mu y') + \text{etc.} = 0$$

which is equivalent to

$$\lambda^2 S'' + 2\lambda\mu T + \mu^2 S' = 0 \quad \ldots\ldots\ldots\ldots\ldots\ldots (1).$$

Where $S'' \equiv ax''^2 + 2hx''y'' + by''^2 + 2gx'' + 2fy'' + c$

$S' = ax'^2 + 2hx'y' + \text{etc.}$

$T = x''(ax' + hy' + g) + y''(hx' + by' + f + gx' + fy' + c.$

Similarly if X be on $lx + my + n$, then

$$l(\lambda x'' + \mu x') + m(\lambda y'' + \mu y') + n(\lambda + \mu) = 0$$

must be satisfied, which is equivalent to

$$\lambda L'' + \mu L' = 0 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (2).$$

Where $L' = lx' + my' + n$

$L'' = lx'' + my'' + n.$

If then X coincide with either P or Q both equations 1 and 2 are satisfied.

If $\lambda : \mu$ be eliminated between 1 and 2 we get

$$L'^2 S'' + 2TL'L'' + L''^2 S' = 0 \quad \ldots\ldots\ldots\ldots\ldots\ldots (3).$$

Now equation 3 gives a relation between the co-ords of any point $x''y''$ on the lines HP, HQ and $x'y'$.

If then we write xy in place of $x''y''$ in 3 we get the equation of HP, HQ, which accordingly is

$$L'^2 S + 2TL'L + L^2 S' = 0.$$

Where

$S \equiv ax^2 + 2hxy + by^2 + 2gx + 2fy + c$

$L \equiv lx + my + n$

$T \equiv x(ax' + hy' + g) + y(hx' + by' + f) + gx' + fy' + c.$

PROBLEM 23 (A. F. S. Hills, Esq.)

It is regretted that a mistake has been made in the statement of this problem. The following is correct :—

In the following long division sum all the figures, except those shown, have been replaced by crosses. The division is complete, *i.e.*, the divisor goes into the dividend without remainder. Show that there are four solutions.

```
× × ×)× × × × × × 4 (× 4 × ×
       × × ×
     ---------
       × × 4 ×
       × × × ×
     ---------
         × × × ×
           × 4 ×
         -------
           × × × 4
           × × × 4
           =======
```

PROBLEM 24.

Correct solutions have been received from Lt.-Col. Allan J. C. Cunningham, Major C. R. Satterthwaite, O.B.E., Major P. G. H. Hogg, D.S.O , and Capt. F. Buero (Secretary, Academia de Ingenieros, Spanish Army).

New problems will be found in the SUPPLEMENT TO THE R.E. JOURNAL.

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