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THE ROYAL ENGINEERS JOURNAL.

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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 for 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.

CONTENTS.

R.E. WAR MEMORIAL.

SUBSCRIPTIONS to the R.E. War Memorial should be sent to

THE SECRETARY,
R.E. WAR MEMORIAL,
R.E. INSTITUTE, CHATHAM.

As it is estimated that sufficient funds are already available for the monumental portion of the Memorial it is anticipated that all future subscriptions will be devoted to the R.E. Memorial Scholarships for the children or dependants of officers and other ranks who have fallen or become permanently disabled in the Great War.

R.E. WAR MEMORIAL SCHOLARSHIPS.

THE following R.E. War Memorial Scholarships have been awarded :—

A SCHOLARSHIPS (£40 *per annum*).

Palmer, David B., son of the late Lieut. D. Palmer, R.E. (I.W.T.), for four years.

Baston, Maurice W. H., son of Sapper W. W. Baston, for four years.

Duff, Arthur L., son of Capt. A. J. Duff, R.E. (I.W.T.), for one year.

B SCHOLARSHIPS (£15 *per annum*).

Baker, Helena M., daughter of Sapper E. Baker, R.O.T.D., R.E., for three years.

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(£15 *per annum*). Blanch Arthur E., son of the late Sergt. A. E. Blanch, 5th Field Co., R.E., for 2½ years.

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Sergt.-Major A. White has joined the R.E. War Benefits Committee as Assistant Secretary.

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THE FUTURE OF TANKS.

By CAPTAIN AND BT.-MAJOR G. LE Q. MARTEL, D.S.O., M.C., R.E.

MANY papers and books have been written on the subject of tanks, but in nearly every case they have dealt with tanks in their present form or tanks in their immediate future. The tank referred to is always the bullet proof tank which can be compared with the destroyer in the Navy. Though both heavy tanks and light tanks were used in the war they were all of one class—the bullet proof class; other classes of tank which should be proof against shell fire were discussed during the war but did not materialize, and it was with the intention of collecting ideas as to the eventual future of tanks that the following notes were written by the author some three and a half years ago. It is not likely that any nation will be allowed to build a large tank army in peace time, but experimental tanks will be constructed and tanks will probably be used in small numbers for police work. If then we are eventually launched into another great war the fighting will probably again relapse into trench warfare, but the next stage will be a battle between the tank armies of both sides. The nation which can produce the largest and most efficient tank army in the shortest time will have an overwhelming advantage against its enemies. The closest co-operation will be required between the air force and the tank armies, but this subject is not referred to in these notes, which only deal with the methods of fighting and types of tank required. A certain amount of detail has been given as regards size of guns, speed of tanks, etc., with a view to producing a more realistic picture of what the future tank armies may eventually resemble; these details may prove to be inaccurate, though the latest types of tank have reached the specification laid down for the "destroyer tank" in most respects. As the construction of a "destroyer tank" has very nearly been achieved (and this was considered impossible at the time these notes were written), there would seem to be no reason why the other classes of tank should not eventually materialize. A discussion on this subject would be of interest.

TANK BASES.

All tanks will operate from a tank base. With the British Empire, these bases will be established in all our foreign possessions and

colonies, and in certain centres of the United Kingdom. A continental country, such as France, would establish bases near her frontier. Her tank armies would mobilize at these points, which would be some fifty miles behind her frontier, and about a hundred miles apart, and all operations would be carried out from these bases. Any tank base will be strongly defended against tank attacks. Wire entanglements will disappear as an obstacle in tank warfare and in their place we shall find any or all of the following, which would be constructed all round the tank bases:—

(1) A trench impassable to tanks.
(2) Continuous land mines.
(3) Pillars of wood or concrete sunk deep into the ground in a vertical position and projecting several feet from the ground, thus making an artificial forest of strong tree stumps.

The bases will also be protected by a tank garrison and probably by a fixed armament.

The whole object of the tank armies will be the destruction of the enemies' tanks. As the armies approach for the battle they will have to form advanced bases for stores and workshops, which will have to be very closely guarded. All stores will have to be convoyed from the bases to the advanced bases, as tanks have great powers of raiding. Railways will be particularly difficult to guard for this reason.

TYPES OF TANKS.

Excluding the specialist services such as the signal tanks, and the supply tanks, there will be three arms of the tanks:—

(1) The Destroyer Tank.
(2) The Battle Tank.
(3) The Torpedo Tank.

The destroyer tank will be the main arm of the service. It will do the present duties of the infantry and cavalry, and will have to fight the enemy tanks at close quarters and kill or capture his men. It will depend mainly on speed for its protection.

The Battle Tank will be used chiefly to strike the enemy's tanks from a distance, and to cover the advance of its own tanks.

The Torpedo Tank will be used solely for the destruction of the enemy's battle tanks. Let us now consider each type of tank in turn.

The Destroyer Tank.—The duties of this tank will be :—

(1) The destruction of the enemy's small tanks and the eventual destruction or capture of his men, his bases and all warlike stores.
(2) The defence of his own lines of communication and bases, and the defence of his battle tanks against the enemy's torpedo tanks.
(3) Reconnaissance and contra-reconnaissance work.
(4) Raiding.

Speed and large radius of action are essential ; the weight and hence the armour will have to be light, and it will not be possible to make the armour in any way proof against the fire from a similar type of enemy tank at close quarters. The efficient performance of the duties of a destroyer tank will therefore depend on :—

(1) Accurate and rapid fire against enemy tanks with a light gun.
(2) Speed.
(3) Making use of cover.
(4) Covering fire from Battle Tanks.

This tank will therefore be armed with one light automatic gun firing an armour-piercing shell and firing from the front of the tank. It will also be armed with one Lewis gun on either side for the destruction of men. The armour will be about ½ inch thick and be proof against armour-piercing bullets. A maximum speed of 20 m.p.h. should eventually be reached on level ground with this type of tank.

The Battle Tank.—The duties of all Battle Tanks will be the destruction of enemy tanks (usually from a distance) and covering by their fire the destroyer tanks. There will be three different types : light, medium and heavy.

(*a*) Light Type.—This type will have armour 1½ inches thick so as to be proof against the fire of the enemy destroyer tanks. It will be armed with a 3-inch gun firing armour-piercing shell and mounted in the front part of the tank. A light automatic gun will fire from each side of the tank for use against the enemy's destroyer and torpedo tanks. Duties :—

(1) Destruction of enemy small tanks.
(2) Destruction of enemy tanks of the same type as itself, which are holding up the advance of our destroyer tanks.

This type should attain a speed of 8 m.p.h.

(*b*) Medium Type.—This will be the mainstay of the battle class. It will have armour from six to eight inches thick. Each tank will

be armed with one 6-inch gun in front, and one light automatic gun each side as a protection against attack by enemy torpedo tanks. Its speed will probably be only two or three m.p.h. The duty will be the destruction of every type of enemy tank.

(*c*) Heavy Type.—The duties of this tank will be :—

(1) Destruction by shell fire at a long range of the enemy's bases, workshops and stores.
(2) Bringing shell fire to bear from a long range to any point where the enemy is assembling his tanks.
(3) Counter battery work on similar tanks belonging to the enemy.

In order to carry out these duties, this type of tank will require a howitzer of very big calibre.

A 12-in. howitzer will probably be the most suitable weapon. It would fire a H.E. shell. The armour will be merely splinter-proof, say half-inch thick, as it would be impossible to keep out a direct hit from the shells fired at it from a similar type of enemy tank. It would be protected by an escort of destroyer or light battle tanks. This type of tank could take very little part in an action until the enemy has established himself at some point or been driven back on his base. The speed of this tank would only be about 2 m.p.h.

The light and medium battle tanks would use direct fire almost entirely; the heavy battle tank would use indirect fire.

The Torpedo Tank.—The duty of this tank is the destruction of the enemy battle tank. It will carry a torpedo-tube which will fire straight to the front. This tube and the ammunition will be similar to the present big trench mortars. The tank will carry five torpedoes, which will weight about 100 lbs. each; it will also carry one Lewis gun. The success of this tank will depend almost entirely on the speed, which would be about 30 m.p.h. on level ground. The tank will be armoured with ½-inch armour plate and will be constructed as light and small as possible. The torpedo tank will probably have to operate by night or under cover of a smoke barrage. It will advance towards the battle tanks, using its speed and all existing cover, and will fire its torpedoes from a range of about 500 yards.

TACTICS.

The opposing armies leave their bases and manœuvre for position. The destroyers of the one side go forward at once to get in touch with the enemy and endeavour to destroy his destroyers. They are closely supported in this by light battle tanks. The medium battle tanks then arrive and engage in battle. When one side begins to gain the advantage and the enemy's screen of destroyer tanks is

broken, the torpedo tanks are launched to destroy the enemy's battle tanks. The enemy is then forced to retire to his defended base. Meanwhile the heavy battle tanks have been arriving. They may take part in the later stages of the fight, or they may not be used till the enemy is surrounded or driven back to his base in which case they would very soon bring about his surrender.

Organization.

The whole tank force will be organized in two or three armies. Each army will be organized in corps and divisions. Heavy battle tanks will be corps troops. Medium and light battle tanks will be divisional troops. A division will have one wing of destroyer tanks. This wing will consist of four squadrons, and each squadron of four groups of five tanks each. A division will also have one squadron of torpedo tanks organized in the same way as the destroyer tanks.

Headquarters.

Headquarters will fight as follows :—

Army Headquarters—at advanced bases.
Corps and Divisional H.Q.—in unarmed tanks with 8-in. armour and protected by an escort.
Wing Headquarters—in unarmed tanks of the destroyer type.
Brigade H.Q. of Battle Tanks—with their Division or Corps H.Q.
Squadron H.Q. Destroyers—in the ordinary destroyer tanks.
Squadron H.Q. Torpedo Tanks—in ordinary torpedo tanks.

Branches of the Tank Army.

Just as there are specialist branches in our present army, so there will be specialist branches with special tanks in the tank army. These branches will be :—

(*a*) Royal Engineers.
(*b*) Signals.
(*c*) Supplies.
(*d*) R.A.M.C.

We will take these in turn.

Royal Engineers.—The Royal Engineers will require tanks of the destroyer class to go with the destroyer tanks and their duties will be :—

(*a*) To destroy enemy railways, bridges, etc.
(*b*) To remove tank obstacles, natural or artificial, which the destroyers might meet.
(*d*) To construct tank obstacles.

These tanks will have approximately the same speed and armour as the destroyer class, but will be armed with one Lewis gun only

in front. The Royal Engineers will also require supply tanks such as those described below, to carry tools and materials for constructing and removing tank obstacles.

Mechanical excavator tanks will also be required for making cuttings through very steep banks and also for digging tank obstacles.

Signals.—An efficient signal service between the three arms of the tank army will be of utmost importance. Every tank in the army will be equipped with a signalling lamp for use by day or night up to five miles. Communication between the fighting tanks will be mainly carried out by means of these lamps. Each Squadron Commander will have a special wireless tank for communication with his Wing Commander, and communication between all headquarters will be maintained by these wireless signal tanks.

Supplies.—Supply tanks will not be armed or armoured. They will only have a thin steel covering to keep off splinters. They will be all of one type except that the details of the body work will be altered to suit the stores they have to carry. They will carry a load of five tons and will travel at 15 m.p.h. Supply columns will generally have to be escorted. Their duty will be to supply every type of tank with food, fuel and ammunition. Lorries (probably with the vital parts armoured) will be used in the back areas.

Workshops.—Each wing will have one workshop, consisting of eight tanks of the destroyer class. These tanks will be unarmed and will carry fitters, spare parts and hand tools only. They will be used to give first aid to all destroyer tanks, and will save the destroyer tanks having to carry a large number of spare parts and tools.

In addition to this wing workshop there will be a division workshop, which will have one section for the repair of each type of tank. This workshop will consist chiefly of tanks of the supply type, carrying fitters, hand tools and spare parts; a few light lathes and drilling machines, etc., will also be carried.

There will be extensive workshops at the advanced base and the base. Tanks will return there for their periodical overhauls and for all extensive repairs.

R.A.M.C.—The R.A.M.C. will have ambulance tanks of the supply type for conveying wounded to the collecting stations, where they will be transferred to motor ambulances.

GENERAL DESCRIPTION.

Every tank will be made water-tight, and have a small screw at the back so that it can float and be propelled slowly across a river.

The smaller tanks will almost certainly be driven by petrol engines, but the larger type might be propelled by steam.

NOTES ON THE RE-ORGANIZATION AND TRAINING OF INDIAN SAPPER AND MINER FIELD COMPANIES FOR MODERN WARFARE.

By CAPT. H. A. JOLY DE LOTBINIÈRE, M.C., R.E.

THESE remarks are primarily intended for R.E. officers at present serving with S. and M. Companies abroad, and are the outcome of the writer's personal experience during the War, and the result of conversations with other Company Commanders. At the same time it is hoped that they may prove of interest to officers on the British Establishment who have to contend with some of the problems which confront his Indian *confrère*.

The Indian Sapper and Miner Companies as organized at present are intended principally for mountain warfare on the frontiers of India against an uncivilized enemy; as such, their present equipment and transport are admirable. In the future, however, Indian Field Companies may be employed in countries like Asia Minor, Syria, or Africa, and against troops trained in modern warfare. To meet these conditions the present organization needs remodelling.

The main factor in introducing any changes is the matter of expense, and any ideas involving a considerable outlay will most certainly be impracticable at the present time; so that the present war establishment cannot be materially altered, or any drastic changes in equipment and transport be considered.

I propose dealing with the various points under separate headings and will commence with:—

A.—PERSONNEL.

The main difference between the Indian and British company is that the former instead of being one homogeneous unit like the latter, is composed of at least two separate and distinct races as far apart from each other as regards religious differences, as the Catholic Sinn Feiner is from the Protestant Orangeman. This in itself is a difficult proposition to deal with; but when we have two separate classes amongst the men of one sect—the yeoman farmer or *zemidar* who forms 95 per cent. of the pioneer element in the unit, and the skilled artisan or *mistri* who takes the place of the tradesman in a British unit—the question becomes further complicated.

As matters are at present the unskilled farmer looks down on the village carpenter or blacksmith as being practically his servant in the villages; such being the case, artificers make poor N.C.O.'s and Indian officers as a rule, and in consequence stand a poor chance of promotion—which certainly affects their recruiting. The suggested remedy for this state of affairs will be dealt with later.

The organization of the Field Company is the 4-section (or platoon) system, but with no headquarters section, a most serious defect. Although in 4 sections the company is actually divided up into half companies in the matter of equipment, etc., and no cut and dried section organization exists, as in a British unit, which can send a section away at a moment's notice. These half-companies are, as a rule, composed of men of one caste, *e.g.*, Pathans, or Panjabi Mussalmans and Sikhs, Mahrattas or Hindus. Recently the three-caste system in one unit has been introduced to facilitate the matter of reinforcements, a most difficult problem; but from the C.O.'s point of view it is not an ideal arrangement by any means.

In the recent campaigns in Mesopotamia and Palestine where troops operated over large areas, and units were naturally scattered, it was found essential to break up the companies, usually with a half company and two sections in separate localities; but occasions occurred when all four sections were separated.

Owing to the shortage of skilled artificers, and to the caste system, it often resulted in sections being sent away with practically no tradesmen, thereby greatly reducing the efficiency of the section. This was partially obviated by transferring men from one section to another (within caste half-companies), but the defects of this will be apparent to all.

To meet this great difficulty it is suggested that a headquarter section be formed, containing all the artificer ranks of the unit. These would be roughly divided into equal portions of Hindu and Mussalman. The remaining four sections would contain all the pioneer ranks of the unit, that is to say sappers who have been taught the elements of carpentry and blacksmiths' work during peace time in barracks.

General Thuillier in his lecture at the S.M.E. suggests the proportion of sappers to pioneers as 1 : 3, or 25 per cent. of artificers in the unit. This principle applied to an Indian unit would mean that out of a war establishment of 150 sappers, 38 would be artificers and 112 pioneers. In adopting however the 5 section organization, it is proposed to keep the original number of sappers (artificers and pioneers) as at present, *i.e.*, 150, and to make each section 30 strong, excluding N.C.O.'s.

The advantages claimed for this system are that when a section is ordered away, the needful artificers can be attached to it whilst it is away from H.Q. Only such artificers as would be specially

needed would be sent, and if any particular work was being undertaken by the section, such as building, all the masons of that caste could be sent, without in any way upsetting the section organization as happens at present. Whilst at Headquarters all the artificers could be employed in the company workshops or on special works.

This system would keep the artificers and pioneers apart as regards promotion, and enable men of the former class to rise to the rank Havildar, and Havildar Major. The standard of the artificer must be considerably raised in order to cope with the technical work a company is called on to perform nowadays. If this is to be done, men must be attracted to the service by higher rates of engineer pay, and better chances of promotion. At present engineer pay is woefully inadequate for artificer ratings, and a man can earn far higher wages in civil life; and the result is that in war-time all the best men enlist in the hastily raised Labour Corps, who pay high rates for skilled artisans.

It is suggested that in every company there should be at least 3 "A" rate artificers, and 4 men trained as petrol engine drivers and fitters. At present the latter are almost non-existent. Special care should be taken in peace time to teach artificers the erection of pumping-plant, engines, etc., and repairs to same—as companies will frequently be called upon to execute this kind of work in the field.

The alternative to this suggestion would be to have three companies organized as at present, and to have an R.E. Headquarters (Works) Company or large section; or, as was done in the Egyptian Expeditionary Force, have 2 S. and M. Companies brigaded with 1 British company, the latter remaining with R.E.H.Q. and acting as a Works Company. The objection to both of these suggestions is the expense entailed.

The following further changes in *personnel* would appear advantageous:—

(*a*) *Officers.*—During the war the War Establishment was raised from 4 R.E. officers to 5, but even this increase is not sufficient. Experience proves that there must always be someone at Headquarters to deal with correspondence, administration, animals, etc. This cannot be one of your section officers, who should be with his section on work—a most necessary proceeding—for an Indian officer or Section Havildar can rarely be given a plan or sketch, and be relied upon to carry on without a British officer to supervise his work.

In consequence, whenever the C.O. has to spend the day reconnoitring a position with the brigade or with his C.R.E., or choosing suitable sites for a water supply, etc., he often returns home at the end of a long day to find 3 or 4 hours of strenuous office work ahead of him, as, with the quality of soldier clerk provided at present, the brunt of the office falls on the C.O., which is no small task when one recollects

the enormous numbers of returns alone that have to be compiled, to say nothing of company accounts, etc. Indian officers are useless for this kind of work, and British N.C.O.'s are not intended to be employed as clerks.

Apart from office work, there is at present no particular officer to whom one can allot the care of equipment, stores, rations, animals, clothing. As a rule, this work devolves on the next senior officer, who is a Section Commander, in addition to his other duties, and who is expected to go on work like the other officers of the unit. As a result, his extra duties suffer, and when most wanted, he finds that he has to proceed on detachment with his section, leaving his work to be done as a rule by the O.C. Unit. Such a state of affairs would never be tolerated in a British unit, but it is what most C.O.'s of Indian units have had to face during the War.

The obvious solution to this is to increase the War Establishment of British Officers to that of a British unit, thus giving the C.O. a Captain at H.Q. who would be entirely responsible for the aforementioned duties, leaving the C.O. free to concentrate entirely on his proper job, and at the same time ensuring that the Section Officers really are section officers in the same sense that a Platoon Commander really does command his platoon. It is certain that the interior economy of the unit would run more smoothly than at present, and certainly the care of the transport and upkeep of equipment would greatly benefit, by this arrangement.

(*b*) *British N.C.O.'s.*—All O.C.'s S. and M. Cos. will agree that two properly trained and efficient R.E. N.C.O.'s increase the efficiency of the unit enormously. They are so to speak the link between the officer and the tradesmen. With the tremendous amount an R.E. officer is supposed to know these days, it is almost impossible for him to be an expert in carpentry, or blacksmiths' work ; thus the position of a British N.C.O. is two-fold. Firstly, he is the technical adviser of the C.O. when professional knowledge of various trades is required ; and secondly, he supervises the work and training of the artificers.

On service it is usual to employ one of these N.C.O.'s in the capacity of C.Q.M.S., in fact to a certain extent he performs the duties of the Company Captain. This means that only one British N.C.O. is left to both supervise the work in the company shops, and at the same time to go out on to any works where his superior technical knowledge is required. This means a loss of efficiency, which could be avoided by increasing the War Establishment by one R.E. N.C.O. This would give the O.C. two British N.C.O.'s for works entirely, and would leave one other to understudy the Company Captain, and to assist him by drawing rations and making out indents, etc., for engineer equipment. Men with some knowledge of machinery and fitters' work should as far as possible be posted to Indian companies.

(*c*) *Indian Officers.*—The present establishment of 4 is thought

sufficient, though to bring them up to a level with the infantry it is suggested that the half-company Indian officers should both be Subadars, instead of one Subadar and three Jemadars as at present. The Company Havildar Major would remain at H.Q. and act as Indian officer to the H.Q. section, which would be under the Company Captain.

(*d*) *Indian N.C.O.'s. Havildar Establishment.*—For the H.Q. section one artificer havildar is suggested, in addition to the C.H.M. and the C.Q.M.H., who would always be at H.Q., together with the Driver Havildar; in all, 4 havildars at Company H.Q. With the sections would be 4 section havildars: in all, 8 havildars; no increase to establishment being incurred.

Naik Establishment. At. H.Q. 2 artificer naiks are recommended, and also 1 engineer equipment naik, and 1 quartermaster's naik to take charge of stores and rations. At present these last two highly responsible posts are held by lance-naiks, who, as soon as they become thoroughly conversant with their work, are generally promoted naiks, or if not promoted are passed over as being too useful to leave their appointments; thus making these responsible appointments thoroughly unpopular amongst the budding N.C.O.'s of the company, who see in them the grave of their ambitions. The driver naik would also remain at H.Q. as a rule, unless half a company was sent on detachment: making in all 5 naiks at H.Q. For the Sections 2 squad commanders are sufficient: making in all 13 naiks as against 11 at present authorised; an increase of only 2.

(*e*) *Indian Other Ranks.*—It is suggested that in addition to the N.C.O.'s enumerated above, who are part of the H.Q. section, the following be added:—2 fully qualified farriers, 1 being unable to cope with 113 animals; 1 wheelwright; 1 ward orderly; 2 clerks. The 2 buglers authorised are quite unnecessary; thus the total increase to present sapper establishment would be 1 farrier and 1 wheelwright.

With the driver establishment should be 8 spare sapper drivers to act as grooms and horseholders. At present no grooms are authorized and as it is usually impossible to obtain private *saises*, it means that the working strength of the unit is depleted to provide these men. Of these 8 men, 6 would be for officers' horses, and 2 would be for the horses of the 3 British N.C.O.'s and the S.A. Surgeon.

(*f*) *Followers.*—These notes will not attempt to deal with the question of private followers, a burning one, which concerns the whole of the Indian Army on service, except in so far as the grooms mentioned above are concerned.

An establishment of 5 sections instead of 4 would mean an additional sweeper and *bheesty*—a fifth cook already being allowed, presumably to meet the needs of the 3-caste system. This increase would be balanced by the decrease of 2 *saises*, for the British N.C.O.s' horses mentioned above.

It is suggested that these 16 followers be armed and trained sufficiently to take a hand in cases of emergency. They would assist in decreasing the baggage guard, always a drain on a company's working strength. They would form part of a properly enlisted corps, and be treated not as menials but as soldiers. This would greatly increase the self-respect of these classes in the Army, besides increasing their discipline and usefulness.

The following table will show the suggested alterations in the War Establishment of a Field Company, S. and M., as compared with the authorized establishment of a company in the E.E.F. (shown in brackets.) The table shows an increase to War Establishment of 5 sapper ranks and 8 driver ranks; surely not too great a concession for the increased efficiency obtained, especially as the 8 driver ranks would have to be found from amongst either the sapper establishment or the attached S. and T.C. transport in any case.

B.—EQUIPMENT.

(*a*) *Engineering.*—It is not possible in the space of these notes to more than touch on one or two salient points regarding the alteration of the present scale of equipment laid down.

Assuming that the present method of carrying engineer equipment in 80 lb. loads in boxes, etc., is retained, it is suggested that all the second line loads (32 in number) be made part of the H.Q. equipment—the 4 sections retaining their present equipment consisting of 4 loads each, of 20 picks and 20 shovels, mining and demolition gear. When sections are ordered away from H.Q., such loads of second line equipment as are specially required could be sent with the section, the senior artificer sent with them being made responsible for their care.

Of the 32 second line loads, it is suggested that loads 49 and 50 (wrappers, canvas and mule rugs) be altered, and loads containing stocks and dies up to 4 in. for pipe work and pipe cutters, be substituted. These latter, though not actually authorized by M.S.T., were usually carried by companies, the result being to add to the weight on already heavily loaded waggons. The present loads could easily be distributed amongst the waggons of the unit, and on the spare mules and horses.

Two loads of saddlers' and tinsmiths' tools appear unnecessary, and were never carried in the writer's company; one load being amalgamated, thereby saving one mule, upon which it is proposed to carry a level, an instrument frequently required and seldom available in S. and M. units. Some better method of dividing up the carpenters' tools into 4 boxes should be adopted, thus enabling each section to be sent away fully equipped. The number of 26-in. handsaws too, need increasing from 10 to at least 20.

	B.O's.	B.N.C.O's.		Total I.O's.	I.O.R.'s.	Drs.	Total.	Public Followers.	Remarks.
British Officers ...	6 (5)								
B.N.C.O.'s ...		3 (2)							
I.O.'s and S.A. Surgeon ...				5 (5)					
Havildars ...					7 (7)	1 (1)			(*a*) At present included in total of 150 sappers.
Naiks					12 (10)	1 (1)			
Sap. Artificers ...					30 (*a*)				
Sap. Pioneers ...					120 (150)				
Drivers						26 (18)			
Clerks					2 (*a*)				
Ward Orderly ...					1 (*a*)				(*b*) Includes 1 B.N.C.O.'s cook.
Farrier					2 (1)				
Wheelwright ...					1				
Buglers					(2)				
Cooks								6 (6) (*b*)	*Note.*—2nd Line Transport *personnel* and private followers are not shown.
Bheestys ...								5 (4)	
Sweepers ...								5 (4)	
Syces								(2)	
	6 (5)	3 (2)	9 (7)	5 (5)	175 (170)	28 (20)	208 (195)	16 (16)	

The foregoing alterations do not necessitate any increase in the actual number of existing loads.

(*b*) *Water Gear.*—The issue of water gear to S. and M. units was only recently made, and is not as yet authorized in War Establishments (India). The value of such equipment is obvious to all, and no arguments in favour of its retention need be urged. The present scale in the E.E.F., viz., 12 L. and F. pumps, 8 600-gallon troughs, 4 2,300-gallon tanks, together with pipe wrenches, spare parts and repair material were found to be sufficient. Iron (and not leather) charsas can be carried when troops are operating in a country containing deep wells and cisterns.

This equipment is capable of being divided up into 4 equal loads, for which each of the 4 sections is made responsible, as being part of the section equipment.

C.—TRANSPORT.

The combination of pack and wheel transport authorized for companies in the E.E.F. cannot be bettered for warfare in semi-civilized countries, such as those in which Indian troops may be called upon to operate.

At present 18 1st line mules are allowed, including 2 spares, and 42 2nd line pack mules (including 10 for 1st line transport, *i.e.*, water and ammunition). No spares, however, are authorized for the latter, which means either "dumping" a load when a mule goes sick, or else placing it on one of the company waggons, and thereby overloading the heavy vehicle. Four spare pack mules should be allowed in addition to Nos. 17 and 18. The water gear is normally carried on 4 G.S. waggons (6-horse), and the baggage, stores, etc., on 4 L.G.S. waggons.

The advantages claimed for such a high proportion of pack animals is, that although roads will probably exist along which the baggage of the force can be carried on wheels, yet the water supply and various works will occur in spots inaccessible to wheeled transport. Whenever a reconnaissance has shown that this will be the case the majority of the 2nd line engineer equipment loads can be placed on the G.S. waggons, and the water gear made up into convenient pack loads, and sent off with the sections. This method was adopted by several Sapper companies in Palestine and proved to be highly successful. Tool carts, though more economical in horse flesh and far handier and compact than the numerous pack loads, suffer from the lack of advantages just pointed out.

With the 5-section system, 1 extra L.G.S. waggon for the baggage and stores of the H.Q. section would be imperative, and in addition an extra G.S. waggon for H.Q. stores, mess, etc., would prove invaluable.

Thus it can be seen that under this scheme each section would be

a self-contained unit, and in nowise dependent on H.Q. for transport, as each of the 5 sections would possess 4 engineer pack-mules, (H.Q. section not included) 2 1st line transport mules, 1 G.S. waggon and 1 L.G.S. waggon.

The 4 spare draught animals and drivers allowed in the E.E.F. were found to be sufficient.

The whole of the 2nd line drivers who are supplied by the S. and T.C. on mobilization should be permanently attached to the unit throughout the whole of the operations. They should be under the command of a Kot-daffadar, and treated in exactly the same way as the sapper element of the company. There is far too much tendency in many units to look down on and belittle the transport drivers, who as a rule do sterling work under very trying conditions. If this was done, better discipline would prevail, and the O.C. company would find a great improvement in the turnout of his transport, and a better sense of discipline and *esprit de corps* amongst his attached *personnel* than usually exists at present.

No increase of *personnel* over and above that laid down for the second line transport establishment in the E.E.F. would be required, except the 2 drivers needed for the 4 spare pack mules, and the *personnel* for the 2 extra vehicles proposed.

If an assistant *salutri* or driver qualified in veterinary work could be attached to each company, he would prove of great assistance to C.O.'s, as the average R.E. officer comes out to India with very little experience of animal management, and it is only after many years of experience that he really becomes qualified to treat a sick horse or mule, which he has frequently to do on service, where veterinary officers are few and far between.

D.—Training.

It is thought that more attention should be paid to the training of men in temporary hutting, water supply and camp drainage than is done at present. This might economically be accomplished by employing sappers on military works when suitable works occur.

Very few Indian sappers (pioneer class) can use the simplest tools with any degree of speed or skill, the prevailing spirit, certainly amongst Panjabis, being to call in an artificer for the most trifling jobs. This is due chiefly to the relations already spoken of existing between the *zemindar* or farmer, and his village artificer. Higher rates of engineer pay might to a certain extent encourage the pioneer to work at his trade, but frequent re-testing for engineer rates would do more than anything to keep a man up to the mark in his particular trade.

The value of constant practice in peace time of night work and getting on to work rapidly and noiselessly, cannot be too greatly insisted upon.

Among the driver establishment more pains should be taken to teach the men equitation and horse-mastership. This cannot be properly done unless the officers themselves are well versed in horse-mastership, and not merely in riding alone.

At present peace training suffers from lack of officers—2 R.E. officers being the authorized establishment, of whom one officer is frequently away on some course, or else acting as C.O. to another unit, leaving the unit for all practical purposes with only one officer. At present the Company Commander is principally occupied in doing the duties of a C.Q.M.S., pay corporal and clerk ; and in consequence cannot spare any time for real hard training and learning his profession.

Three officers should be the minimum peace establishment of a Sapper company, and in addition each company should be supplied with 2 properly qualified military clerks, who join the unit as trained men, and not as beginners, hardly able to read and write English. This can never be the case until the right class of man is attracted into the service by equal or better rates of pay than he can earn in civil life.

E.—Employment in War.

Sapper companies should not be called upon to perform tasks which the infantry are capable of performing themselves, such as wiring and digging. Sapper companies were often employed on these jobs in Mesopotamia and Egypt ; but this was partly due to the infantry not having been sufficiently trained in peace time to carry out these works, and partly from a lack of material with which to carry out works similar to those carried out by R.E. Field Companies in the line in France.

The writer has primarily intended these remarks for units of the 1st and 3rd Sappers, whose composition include Pathans, P.M.'s, Sikhs, Hindus and Mahrattas ; and not so much for the 2nd (Q.V.O. Madras) Sappers, whose composition more nearly approximates that of a British unit.

The writer also begs to be excused if he has misquoted any numbers, etc., in these notes, but this paper has been written without any of the official text-books to hand.

THE PROPORTIONING OF CONCRETE.

In the course of the last few years, a great deal of attention has been given—especially in the U.S.A.—to the correct proportioning of the ingredients of Portland cement concrete, so as to obtain a sound concrete of any required strength, at a minimum cost.

The present somewhat rough method of specifying a 1 : 2 : 4, and 1 : 3 : 6 or other mixture will, if the correct amount of water be used, give a strong or weaker concrete with sufficient accuracy where small quantities of concrete are involved, and where the expense of supervising would overbalance any saving in materials.

But where very large quantities of concrete are being placed, considerable economy will result from a more accurate proportioning of the Portland cement, fine and coarse aggregates and added water, in spite of the rigid supervision that is then necessary in order to ensure that the specified proportions are adhered to.

In the construction of roads, carrying heavy motor traffic, it is becoming more and more evident that a water or tar bound macadam has not sufficient rigidity, and that unless the foundation is more than ordinarily unyielding corrugation and pot holes result from the inability of the roadway to properly distribute the concentrated wheel loads. Accordingly, roadways of concrete and reinforced concrete have been and are being experimented with, usually with conspicuous success.

It is found that although the prime cost of a concrete road is rather high, yet the cost of maintenance is so low that taken over a period of years there is generally a very marked saving in the use of this new method of road construction.

In the year 1919 over 4,000 miles of concrete road were in use in the U.S.A. and this length is being rapidly added to.

It is particularly for the purpose of road construction that a table of concrete properties has been got out by Professor Abrams, of the Structural Materials Research Laboratory, Lewis Institute, Chicago, and is now reproduced by the kind permission of Mr. A. N. Johnson, Consulting Highway Engineer, Portland Cement Association (U.S.A.) The use of this table is clearly shown in the explanatory notes which accompany it.

It is necessary to add that at least as much care must be taken in properly proportioning the water that is added to each batch of concrete.

It is found that sufficient water must be used to make the mixture workable, and that such quantity of water is more than enough to hydrate the Portland cement. Any excess of water over the minimum

required to enable the cement to set and to render the mixture workable, has a marked effect in reducing the final strength of the concrete.

The mixture given by the table would also be suitable for high-class reinforced concrete work, and for mass concrete where impermeability is required. It is hoped that in due course it will be possible to publish additional tables of mixtures yielding concrete of less strength, for more ordinary purposes.

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ABRAMS' TABLE OF PROPORTIONS AND QUANTITIES FOR CONCRETE FOR ROAD CONSTRUCTION.

By A. N. JOHNSON. Consulting Highway Engineer, Portland Cement Association.

The accompanying table shows the various proportions by which to combine a variety of fine aggregates, five selected sizes, with various sizes of coarse aggregates. The fine aggregates, or sands, shown in the table include, first, one with all particles passing a sieve with 28 openings per linear inch and another with 14 openings, one with 8, one with 4 and a sand with $\frac{3}{8}$-inch size particles down. The range of coarse aggregate is apparent from the table.

To determine whether a given aggregate is to be classed as 3-inch or $2\frac{1}{2}$-inch or 2-inch, or whatever the upper limit of size may be, there should be not less than 10 per cent. of the sample between the upper limit and the next lower size. Thus, if a material is to be classed as a 3-inch aggregate there should be not less than 10 per cent. of the total volume of the sample between the 3-inch and $2\frac{1}{2}$-inch sizes; otherwise it will be classed as $2\frac{1}{2}$-inch size. Similarly, if there are 2-inch pieces it will be classed as 2-inch aggregate if there is not less than 10 per cent. between $1\frac{1}{2}$-inch and 2-inch sizes.

For fine aggregates there should be of the coarser material not less than 15 per cent. between the coarser size and the next smaller screen opening. Thus, if a fine aggregate is to be classed as $\frac{1}{4}$-inch size there should be not less than 15 per cent. between the $\frac{3}{8}$-inch screen and the $\frac{1}{4}$-inch screen.

With the $\frac{1}{4}$-inch sand down, the one usually specified, and with the coarse aggregate varying from that held on a No. 4 sieve to that passing a $1\frac{1}{2}$-inch opening, the usual proportions of 1 : 2 : 3 were taken and, with a workable plasticity or practical consistency, such a mixture produces a concrete with a crushing strength at 28 days of 3,000 pounds per square inch in the form of 6×12 inch cylinders. All of the other proportions and combinations are computed to give the same strength concrete as the 1 : 2 : 3 mixture.

The table is based upon the results of a number of years' investigations by Professor D. A. Abrams of the Structural Materials Research Laboratory, Lewis Institute, Chicago, and is founded upon the general principle which his investigations have established, namely: that the strength of a concrete mixture depends primarily upon the ratio of the amount of water to the amount of cement. The smaller the amount of water that can be used and at the same time produce a plastic or a workable consistency, the stronger will be the concrete.

A variation in the grading of aggregates produces a variation in the strength of the concrete merely because the different gradings to produce a similar consistency or plasticity will require different amounts of water with a given amount of cement. It is thus that the grading affects the resulting strengths of concrete; but in all of the combinations or mixtures shown in the table the cement factor is varied with the variations of the aggregates used so as to produce a constant strength concrete.

It should be noted that Professor Abrams' investigations have demonstrated that the resistance to abrasion varies according to the compressive strength of the concrete.

The practical application of this table is apparent. It shows that a wide variety of fine and coarse aggregates may be combined so as to produce the same strength concrete, and, therefore, makes it practicable to use many supplies of materials not at present available under most specifications which confine the sizes to be used within narrow limits.

Practically all state highway specifications require that the sand or fine aggregate shall vary from $\frac{1}{4}$-inch down and that the coarse aggregate shall vary from $\frac{1}{4}$ inch to $1\frac{1}{2}$ inches and in some cases as large as 3 inches. The table, it will be noted, includes very many other selections.

In all cases it is to be assumed that all aggregates that are to be used irrespective of size or grading are to be of material, structurally sound, clean and free of organic impurities.

The table contains in the upper line of each block, the proportion of cement, fine and coarse aggregate to be combined, while immediately below in each square are given the quantities that are required for a cubic yard of concrete, the cement quantity being given in barrels and hundredths of barrels and the quantities for fine and coarse aggregates being given in hundredths of cubic yards.

It should be borne in mind that the quantities shown in the table are for a cubic yard of concrete as determined from laboratory measurements, and that for the purpose of ordering materials or making estimates of the total cost of materials for a given piece of work these quantities should be increased from the amounts shown by such estimate of waste for the aggregates as experience in handling the work, according to the particular method to be employed, has indicated as necessary.

The following example will make clear the use of the table :—

It will be supposed that one sand is that usually specified, from ½-inch down, and must be shipped in at a cost of $2 per cubic yard and that one coarse aggregate, varying from ¼-inch to 2 inches, must also be shipped in at a total cost of $3 per cubic yard ; that there is available locally a supply of sand and coarse aggregate, each being rather fine, the sand varying from ⅛-inch down which costs $1·50 per cubic yard, while the coarse aggregate varies from ¼-inch to 1 inch and may be secured at a cost $2·50 per cubic yard. The cement in each case is assumed to cost $3 per barrel. The cost of a cubic yard of concrete using the materials to be shipped in would then be as follows :—

1·52 barrels cement	@ $3·00 =	$4·56
·43 cubic yards of sand	@ $2·00 =	·86
·81 cubic yards of coarse aggregate ...	@ $3·00 =	2·43
Total cost of materials for 1 cubic yard concrete		$7.85

Using local materials the cost would be :

1·72 barrels cement	@ $3·00 =	$5·16
·46 cubic yards of sand	@ $1·50 =	·69
·66 cubic yards of coarse aggregate ...	@ $2·50 =	1·65
Total cost of materials for 1 cubic yard concrete		$7.50

Thus the local aggregate, in this instance, although fine and requiring more cement, will produce a yard of concrete at less cost. In general it will be found that the use of finer sand or finer aggregate increases the amount of cement, the opposite being true for coarser sizes. Thus a coarse aggregate with all of the fine material removed, varying from 1 inch to 3 inches in size, combined with sand varying from ¼ inch down, uses 1·49 barrels of cement ; whereas an aggregate varying from 1 inch to ¼ inch combined with the same sand, ¼ inch down, requires 1·67 barrels of cement for a cubic yard of concrete.

If the producer of aggregate materials can say what are the sizes of aggregates he can furnish they can be used to make a concrete of a given strength. Should concrete of a strength other than 3,000 pounds per square inch be desired, then another table would be calculated with the proportions and quantities required accordingly ; but the table given here is confined to the use of concrete for concrete roads where a better quality and greater strength are required than is necessary for concrete for many other structures.

Those who wish to study more fully the basis upon which this table is prepared should consult the bulletins of the Structural Materials Research Laboratory, Lewis Institute, Chicago, particularly Bulletin No. 1.

Abrams' Table of Proportions and Quantities for One Cubic Yard of Concrete

Based upon laboratory investigations, using approved materials, compressive strength, 28 days, with workable plasticity, 6 by 12-inch cylinders, 3,000 pounds per square inch.

SIZES		FINE AGGREGATES, SCREEN OPENINGS PER INCH														
		0-28			0-14			0-8			0-4			0-3/8 In.		
COARSE AGGREGATES Inches	Cement in Barrels Aggregates in Cubic Yards	Cement	Fine	Coarse	Cement	Fine	Coarse	Cement	Fine	Coarse	Cement	Fine	Coarse	Cement	Fine	Coarse
No. 4 Screen to 3/4	Proportions	1	1.3	2.4	1	1.6	2.4	1	1.8	2.3	1	2.0	2.3	1	2.7	1.5
	Quantities	1.96	.37	.69	1.85	.44	.66	1.82	.48	.62	1.75	.52	.59	1.79	.72	.40
No. 4 Screen to 1	Proportions	1	1.3	2.7	1	1.6	2.6	1	1.8	2.6	1	2.0	2.5	1	2.6	1.8
	Quantities	1.90	.36	.76	1.77	.42	.68	1.72	.46	.66	1.67	.50	.62	1.72	.66	.46
No. 4 Screen to 1 1/2	Proportions	1	1.2	3.1	1	1.6	3.2	1	1.7	3.1	1	2	3	1	2.4	2.4
	Quantities	1.82	.32	.84	1.68	.40	.79	1.63	.41	.75	1.61	.47	.72	1.62	.57	.57
No. 4 Screen to 2	Proportions	1	1.2	3.5	1	1.5	3.5	1	1.6	3.7	1	1.9	3.6	1	2.2	3.1
	Quantities	1.75	.31	.90	1.63	.36	.85	1.55	.36	.85	1.52	.43	.81	1.53	.50	.70
No. 4 Screen to 2 1/2	Proportions	1	1.1	3.8	1	1.4	3.9	1	1.6	4.0	1	1.8	4.0	1	2.1	3.5
	Quantities	1.72	.28	.97	1.58	.33	.91	1.51	.35	.89	1.49	.40	.88	1.50	.45	.78
No. 4 Screen to 3	Proportions	1	1.1	3.9	1	1.4	4.1	1	1.5	4.1	1	1.7	4.1	1	2.0	3.7
	Quantities	1.69	.28	.97	1.58	.33	.97	1.49	.33	.90	1.49	.37	.90	1.49	.44	.81
3/8 to 3/4	Proportions	1	1.3	2.3	1	1.7	2.3	1	1.9	2.3	1	2.2	2.2	1	2.8	1.4
	Quantities	1.96	.37	.67	1.85	.46	.63	1.82	.51	.62	1.75	.57	.57	1.79	.75	.37
3/8 to 1	Proportions	1	1.3	2.6	1	1.7	2.6	1	1.9	2.5	1	2.2	2.4	1	2.7	1.7
	Quantities	1.90	.36	.74	1.77	.44	.68	1.72	.48	.64	1.67	.54	.59	1.72	.68	.43
3/8 to 1 1/2	Proportions	1	1.3	3.0	1	1.7	3.0	1	1.9	3.0	1	2.1	2.9	1	2.6	2.2
	Quantities	1.82	.35	.80	1.68	.43	.75	1.63	.46	.73	1.61	.50	.68	1.62	.63	.53
3/8 to 2	Proportions	1	1.3	3.3	1	1.7	3.4	1	1.8	3.5	1	2.0	3.4	1	2.4	2.9
	Quantities	1.75	.34	.86	1.63	.41	.83	1.55	.42	.80	1.52	.45	.77	1.53	.62	.66
3/8 to 2 1/2	Proportions	1	1.3	3.7	1	1.6	3.7	1	1.7	3.9	1	2.0	3.8	1	2.3	3.3
	Quantities	1.72	.33	.95	1.58	.37	.87	1.51	.37	.87	1.49	.44	.84	1.50	.51	.74
3/8 to 3	Proportions	1	1.2	3.8	1	1.6	3.9	1	1.7	4.0	1	1.9	4.0	1	2.2	3.5
	Quantities	1.68	.30	.95	1.58	.37	.91	1.49	.37	.88	1.49	.42	.88	1.49	.48	.77
1/2 to 3/4	Proportions	1	1.5	2.3	1	1.9	2.2	1	2.1	2.2	1	2.3	2.1	1	2.8	1.3
	Quantities	1.96	.44	.67	1.85	.52	.61	1.82	.56	.59	1.75	.59	.54	1.79	.75	.34
1/2 to 1	Proportions	1	1.5	2.5	1	1.9	2.5	1	2.1	2.4	1	2.3	2.4	1	2.8	1.6
	Quantities	1.90	.42	.70	1.77	.50	.66	1.72	.53	.61	1.67	.57	.59	1.72	.72	.41

Abrams' Table of Proportions and Quantities for One Cubic Yard of Concrete

Based upon laboratory investigations, using approved materials, compressive strength, 28 days, with workable plasticity, 6 by 12-inch cylinders, 3,000 pounds per square inch.

SIZES		FINE AGGREGATES, SCREEN OPENINGS PER INCH														
COARSE AGGREGATES Inches	Cement, in Barrels Aggregates in Cubic Yards	0-28			0-14			0-8			0-4			0-⅜ in.		
		Cement	Fine	Coarse	Cement	Fine	Coarse	Cement	Fine	Coarse	Cement	Fine	Coarse	Cement	Fine	Coarse
½ to 1½	Proportions	1	1.4	2.8	1	1.9	2.9	1	2.1	2.9	1	2.2	2.8	1	2.7	2.1
	Quantities	1.82	.37	.75	1.68	.47	.73	1.63	.51	.69	1.61	.52	.66	1.62	.65	.51
½ to 2	Proportions	1	1.4	3.3	1	1.9	3.3	1	2.0	3.4	1	2.2	3.3	1	2.7	2.7
	Quantities	1.75	.36	.86	1.63	.46	.79	1.55	.46	.78	1.52	.50	.74	1.53	.62	.62
½ to 2½	Proportions	1	1.4	3.6	1	1.8	3.6	1	1.9	3.7	1	2.1	3.7	1	2.6	3.1
	Quantities	1.72	.35	.91	1.58	.43	.85	1.51	.42	.83	1.49	.46	.81	1.50	.57	.69
½ to 3	Proportions	1	1.3	3.7	1	1.8	3.8	1	1.8	3.9	1	2.1	4.0	1	2.4	3.3
	Quantities	1.68	.33	.92	1.58	.42	.89	1.49	.40	.86	1.49	.46	.88	1.49	.53	.63
¾ to 1	Proportions	1	1.7	2.4	1	2.1	2.4	1	2.4	2.1	1	2.6	2.2	1	3.1	1.5
	Quantities	1.90	.48	.68	1.77	.55	.63	1.72	.61	.53	1.67	.64	.55	1.72	.79	.39
¾ to 1½	Proportions	1	1.7	2.7	1	2.0	2.8	1	2.3	2.7	1	2.5	2.7	1	3.0	2.0
	Quantities	1.82	.46	.73	1.79	.50	.70	1.63	.55	.65	1.61	.59	.64	1.62	.73	.48
¾ to 2	Proportions	1	1.7	3.1	1	2.0	3.1	1	2.3	3.1	1	2.5	3.0	1	3.0	2.4
	Quantities	1.75	.44	.80	1.63	.48	.75	1.55	.53	.72	1.52	.56	.67	1.53	.68	.55
¾ to 2½	Proportions	1	1.7	3.3	1	2.0	3.5	1	2.3	3.4	1	2.4	3.4	1	2.9	2.8
	Quantities	1.72	.43	.84	1.63	.47	.83	1.51	.52	.76	1.49	.53	.75	1.50	.64	.62
¾ to 3	Proportions	1	1.7	3.5	1	2.0	3.7	1	2.3	3.7	1	2.4	3.6	1	2.8	3.1
	Quantities	1.68	.43	.88	1.58	.47	.87	1.49	.51	.81	1.49	.53	.79	1.49	.62	.68
1 to 1½	Proportions	1	1.7	2.8	1	2.0	2.9	1	2.3	2.7	1	2.6	2.6	1	3.1	2.0
	Quantities	1.82	.46	.75	1.68	.50	.73	1.63	.55	.65	1.61	.62	.62	1.62	.75	.48
1 to 2	Proportions	1	1.6	3.2	1	1.9	3.5	1	2.2	3.3	1	2.4	3.3	1	3.0	2.6
	Quantities	1.75	.39	.83	1.63	.46	.85	1.58	.51	.76	1.52	.54	.74	1.53	.68	.59
1 to 2½	Proportions	1	1.4	3.4	1	1.9	3.8	1	2.0	3.7	1	2.3	3.7	1	2.7	3.1
	Quantities	1.72	.35	.86	1.58	.45	.89	1.51	.44	.83	1.49	.51	.81	1.50	.59	.69
1 to 3	Proportions	1	1.3	3.6	1	1.8	4.0	1	2.0	3.9	1	2.2	3.9	1	2.7	3.3
	Quantities	1.67	.33	.90	1.58	.42	.94	1.49	.44	.86	1.49	.48	.86	1.49	.59	.73

FROM THE AISNE TO YPRES, 1914.

FURTHER INCIDENTS IN THE STORY OF THE 59TH FIELD COMPANY, R.E.

By BRIG.-GENERAL G. WALKER, D.S.O.

(*Continued*).

Our time on this front was now drawing to a close, as the Indian Corps were arriving in France and one of its Divisions (Lahore) was to relieve us. The relief began on the right, the 15th Brigade I think being the first. There was a certain amount of trouble in the relief as the Germans apparently knew of it and took the opportunity to test the value of the Indian native troops. They did this to some purpose at one point, for they cleared out the 8th Gurkhas, after knocking out all their officers. I found a crowd of the little men in my farm, which was 5 miles from the scene of action, next morning. After enquiry, they told me that their Paltan (Battalion) was destroyed; they certainly seemed to have been dispersed. However, the rot was stopped by bringing in British troops and, after stabilization, the relief of the line proceeded. Our casualties during this period were 2 officers wounded, and 2 killed and 5 wounded amongst the men.

Our left (14th Brigade) came last and we were relieved on October 30th, my work being taken over by a Company of the 3rd (Bombay) Sappers and Miners. I can't remember the number of the unit but I know that it was what used to be the old 4th Company of that Corps, which I had myself commanded as a subaltern in 1896. Eighteen years before as a subaltern, I had been in precisely the same position in the Indian Sappers & Miners as I was at the moment in the British Service, *i.e.* the Commander of a Field Company. This Sapper & Miner Company was commanded by Captain Paris, R.E. They had a most unfortunate experience a few days after, in fact I think it was the day after they relieved us. They were ordered together with a Sikh Regiment to make a counter attack on Germans, who had entered Neuve Chapelle. For some reason they did this under the 3rd British Division. The attack was most gallantly executed and quite successful, but the Force lost all their British officers, either killed or wounded. The native troops held on as long as they could, but, as no support was forthcoming, they had eventually to retire and this they did under their native officers and in good order.

The G.S.O.3 of the 3rd Division told me that it was one of the

most gallant feats that he had ever seen and regretted that circumstances should have been such as to necessitate the use of Engineers on such a service. I saw the Subadar of this Sapper & Miner Company in hospital at Boulogne some months after and he told me the story of his experiences. He ended up by saying that, when they could hold out no longer, the Company had retired "section by section," and that they could do no more. Poor old man, he was utterly broken down when I saw him, both in body and mind, and I remember him as a smart young Sikh to whom I had given his first stripe. I don't think any of the British officers of this unit escaped. Paris I know was a wounded prisoner, and Hayes-Sadler was killed. Our time on this front was now over and on October 31st we marched out of Le Touret at 12.30 p.m. We marched north via Merville to Vieux Berquin, where we spent the night of the 31st, and then on to Courte Croix farm near Flêtre and not far from Bailleul, where we came under the 13th Brigade. We were told we were to have a rest and on arrival at 10 a.m. started to settle down. However, our rest was short-lived as at 2 p.m. we were on the road again for Bailleul. On arrival at this place I got an order to put the men in motor buses and go to Ypres. I asked how the tools were to go and the Staff seemed astonished that there were such things. However in about an hour the order was cancelled and we passed through Bailleul and on to Dranoutre where the 15th Brigade under Count Gleichen were assembling. His Staff Captain found us our billet and there we settled in. The place was afterwards known as Engineer Farm and was occupied by us at intervals for a long time (1st November).

The 5th Division were now supposed to be in reserve. I have no memory of what the Infantry were doing. We were taken over by the C.R.E. and put to work on a second line that ran in front of Neuve Eglise and behind Wulverghem and thence South towards Nieppe. The line had been laid out I believe by the Engineer-in-Chief, anyhow I know that we were visited one day by his assistant. He was much surprised at the number of times I wanted to sit down that day—I wonder if he knew how tired I was!

Our workmen were civilians and very good work they did. We got a little shelling but very little and it was all day work, so we got good nights in bed. It was such a relief—it bucked up the men a lot as may be imagined. All this time the Cavalry were holding or trying to hold Messines in front of us and I have no clear recollection of what happened from day to day—except that the British eventually retired from Messines but not so far as the line on which we were working. However, we were not to be left very long at this work. On the 6th November about 6 p.m. we got orders to march next day to Ypres and to report to the 1st Corps. The 17th Company of the 5th Division were ordered also and we marched together.

We had a starting point given to us on the Bailleul-Locre road for 11 a.m. (7th) and off we went. Such a tedious trek—a bad road crowded with the remains of the 7th Division coming back from Ypres. I met their Signal Company on the road and its O.C. gave me a most lurid description of the situation, which we were on our way to face. However, it was a fine day and the sun was shining, we were fit and well and the future might bring what it would for all we cared. We went through Locre, La Clytte, Dickebusch to Kruisstraat, where we halted to feed, while I went on to find the 1st Corps H.Q. It was located at Trois Tours Chateau near Brielen.

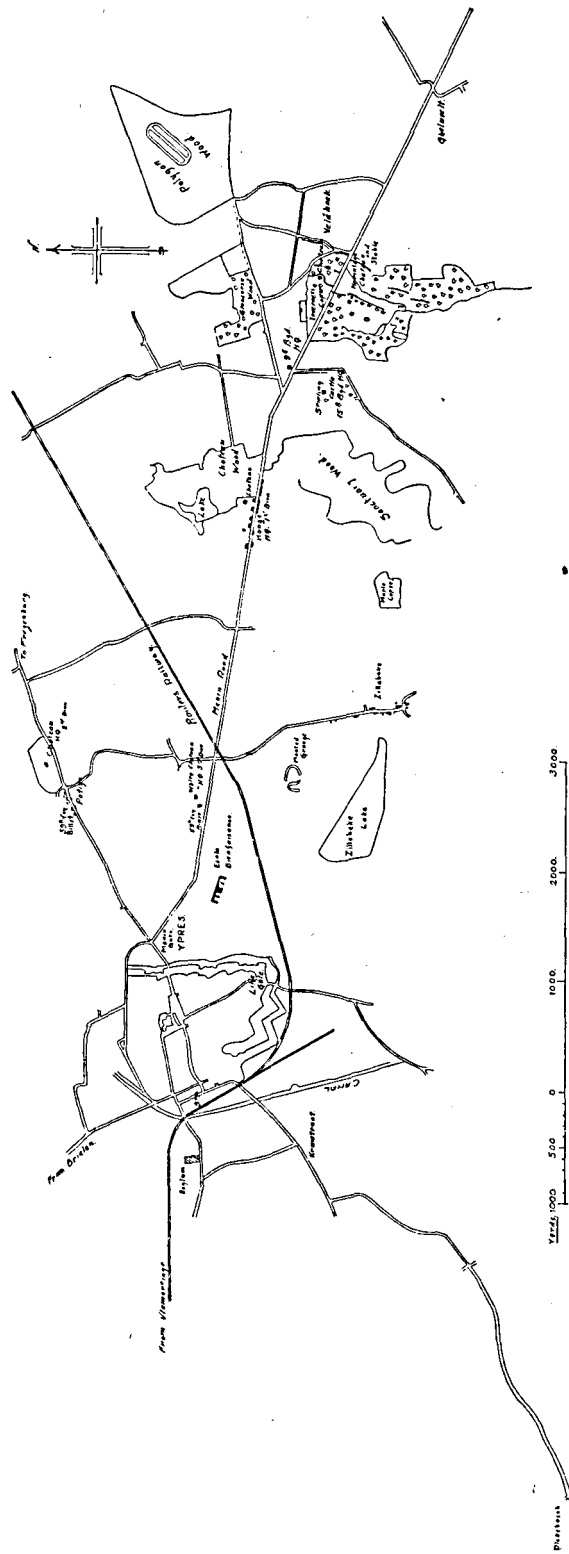
I saw a lot of French troops in Brielen village and they had heavy guns all over the place. I received orders to go to 3rd Divisional H.Q. at the White Chateau on the Menin Road, East of Ypres, an unsavoury spot if ever there was one. It was just where the Roulers tramway crossed the Menin road and has now I fancy disappeared. When I last saw it in May 1915 it was a ruin and uninhabited. I got back to Singer and the two Companies about 6 o'clock and we started off again for Ypres. No guide and none of us knew the way. Ypres was in flames, or the main street was at any rate, and undergoing quite a heavy bombardment, quite the usual thing as we had reason to know later. A kindly policeman, on hearing our destination, advised us to avoid the centre of the town and to take the road round the Southern ramparts, (the old Chemin des Rondes) until we got to the Menin Gate, where we were to turn to our right. We followed his advice. The old-time defences had been laid out as gardens and it was very hard to see which was the road. It was pitch dark under the trees and we had a miserable time finding our way. One of our troubles was that the pontoons, with their 6-horse teams, were too long for the turns in the roads. However, we got through all right and met the 56th Company R.E. at the Menin Gate en route to rejoin their Division (3rd), so we were all bound on the same errand. We all got to 3rd Divisional H.Q. about 10 p.m.—12 hours on the road. We were ordered to join the 9th Infantry Brigade (Brig.-General F. Shaw) and to get on with it at once. We were to billet in the stables of the Chateau. I left the Company under Johnston to have a meal and went on to see my Brigadier, telling Johnston to follow to Hooge or thereabouts when ready. I found General Shaw in a little hovel, which was his H.Q., on the Menin Road about a mile beyond Hooge, a little further back than Stirling Castle, but on the North side of the road. I found them all quite cheerful and very glad to see me. The Divisional Staff (Sir F. Maurice G.S.O.1) had given me to understand that we were in for a warm time on this bit of front, and he was a true prophet, but there were no signs of anxiety in that cottage. I served for 14 days with this Brigade and nothing could exceed the kindness of the Brigade Staff or their solicitude for the

welfare of myself and my men. Many a night when I went in the Brigadier would say: "Lie down and have a sleep until I am ready," and put me on his own bed. We were often short of sleep in those days. We were engaged I soon discovered in a battle since known as the 1st Battle of Ypres. We were hanging on by our eye-lids, but no one seemed to be worried and everyone was cheerful. Such an asset that is to a soldier, to be able to laugh at any rotten thing that happens. A serious-minded man who never laughs and has an irresponsible conscience may make money, but he will never be a soldier, and I suppose that is the reason that no good soldier ever makes money.

I should say that the troops in the lines here were considerably mixed up. We (9th Brigade) held the ground astride the Menin Road including Herintage Chateau on the South side. (*Plan* III). The Brigade consisted of the Royal Fusiliers, Scots Fusiliers, Northumberland Fusiliers, and Lincolns. Which the Battalions were I can't remember. The Battalion Commanders were McMahon, (killed while we were there) Douglas-Smith, Yatman, and Smith, the last three survived and became General Officers. My work with them was only at night and I remember meeting Yatman long after when he said to me: "I know your voice but I don't remember ever having seen your face before." Similarly with Smith. My recollection of him was that he was a very tall man who always wore a very long uniform overcoat. Months after when I met him in daylight as a Brigadier in another Division I found that he was quite a small man. I suppose it was the long coat that misled me.

On the left of the 9th Brigade was the 1st Division and Fitzclarence's Brigade was their right formation; on the right was the 15th Brigade (Count Gleichen) of the 5th Division, beyond him the 8th Brigade (McCracken) and 4th Guards Brigade (Lord Cavan). Singer with the 17th Company R.E. was with Count Gleichen and was my R.E. next-door neighbour, on my right. Hooge was still a village and the Chateau was standing. The 1st Division H.Q. were in the village living in quite nice houses. The 2nd Division H.Q. were at Potizje. Between Hooge and our White Chateau the ground north of the Menin Road was covered with horse lines and Field Ambulances. However, these were soon moved back.

The Menin road was our main artery and was constantly shelled but seldom hit. I only had two people hit on it during a fortnight and we went up and down twice a day. Our transport at night with food and stores used to go up through Hooge and halt at the commencement of what is now known as Inverness Copse, where the ration carriers used to meet them. This fact emphasises the difference between the intensity of the shell fire in 1914 and that to which we were subjected in 1918.



PLAN III.—*First Battle of Ypres, November, 1914.*

I was going up to the trenches one evening and had just reached the border of Inverness Copse when I heard a man screaming. Thinking that someone had been badly wounded and was in need of help, my orderly and I made a search round and found a private soldier of a distinguished regiment sitting at the bottom of a wet ditch, singing lustily, but incoherently. He was flanked by two empty rum jars, the contents of which I imagine he had consumed as he was absolutely "blotto." He was, I believe, the happiest man in the Army at the time, as it was a horrid wet and cold night. So impressed was I with the comic aspect of the situation that I am afraid I left him in peace. Poor thing, he had suffered much and his lapse, except for the curtailment of the alcoholic refreshment of some of his fellows, had done little harm.

I fear that there has been but little mention so far of the R.E. work done at this time by the Company. It consisted of assisting the Infantry in wiring and completing their trenches. There were no materials for revetting and tools also were short. One night we got a present of 800 sandbags from Divisional Headquarters. They came up in state in a motor car, and goodness knows whence they had been obtained. I think it was the most handsome present I ever received. Our trenches were mostly 3′ × 3′ traversed fire trenches—they were not continuous but traced to give mutual support. The wiring was poor and scrappy also, and Germans often came through to snipe us in the woods. Our business was to put this right. There were no trimmings of any sort and the work entailed little but severe manual labour. The Company was on its legs daily from about 4.30 p.m. until 7 a.m., two 3-mile marches being done in that time as well as the work.

The following story will show how little was thought of entrenching work by some people :—

The left of the 9th Brigade was forced back one morning and the next night a new retrenching line had to be dug. A party of 200 Infantry was detailed for the job under me. On arrival I found that these people had no picks or shovels and thought I would supply. They had left their own 5 miles behind with the transport. I got some tools for them from a neighbouring Battalion and we set to work.

These men held the trenches that night on completion and in the morning were in their turn driven back. The next night another working party of the same Battalion was detailed to make a new retrenchment and the same demand was again made for tools. When I asked where the previous night's tools had gone to, the Battalion Commander said quite cheerfully: "Oh, the Bosche got those this morning when we fell back." Even then some people had not learnt that, in some situations, a pick and shovel are of more value than a rifle. The French were very different. The French

infantry that I saw at this time went into the trenches with their arms slung and every man shouldering a shovel.

In spite of this casualness the Infantry were splendid. Nothing seemed to put them off. The Northumberlands had an advanced Company commanded by a man called Gordon. He was well in front of the general line and had poor support on each flank. He had splendid trenches deep and safe and was heartbroken when ordered to withdraw to conform with an adjustment of the lines, though both his flanks were entirely in the air by that time.

I spoke above of the scrappiness of the wire. Yatman, of the Northumberlands, and I were making a tour one night and were on our way to visit Gordon in his advanced post. We had to cross a bit of open heather land between him and the Lincolns on his right about 300 yards wide. The ground was covered by fire by day but there was no wire there so far.

On our way I heard a groan and on looking about we found a young German officer lying wounded in a hole. He had no belt but I can remember his neat boots and gaiters still. He was shot through the leg somewhere and affected to be in great pain. He would only talk German but seemed to understand English for, when I said we would leave the blighter until we came back, he at once cried: "Kamerade, Kamerade." We got back all right and brought him in and then we found a German rifle, with bayonet fixed, lying near him. He apparently had been in command of a sniping party and got laid out early in the adventure, for, when we got into the line again, we heard that there had been a great sniper hunt in our absence. The Lincolns bagged six—properly dead too, none wounded. Flint told me that he left his section to assist in one hunt. A fat German had got down into the bottom of a brambly ditch and was forcing his way along on his hands and knees trying to evade the attentions of a Lincoln man, who followed him along the edge, vociferating: "Come out you blighter, come out." The Englishman eventually got tired of the performance and jumped down into the bramble on top of the Bosche and finished him off with his bayonet and a rifle bullet. I don't know whether the Germans got anyone that night. I imagine not but there was a good deal of promiscuous shooting.

(To be continued).

MEMOIRS.

MAJOR ARTHUR FFOLLIOT GARRETT, O.B.E.

BY the premature death, in most tragic circumstances, of Major Garrett, the Public Works Department of India loses a brilliant officer and the Central Provinces in particular sustain an irreparable loss.

The youngest son of Mr. W. Raymond Garrett, of Kilgaran, Co. Carlow, Major Garrett was born on 27th April, 1875, and was educated at Clifton College, whence he passed second into Woolwich; and the fact that he passed out of Woolwich first of his year and gained the Pollock Medal marked him out as an officer of outstanding merit.

Major Garrett decided on an Indian career, and on arrival in India was posted to the Military Works Service at Karachi, but was shortly afterwards transferred to the Railways Branch of the Public Works Department, where the early years of his service were spent at Sharigh on the Quetta line, and on the survey of the Kohat Bannu line, and later on Famine Relief Works in Rajputana in the great famine of 1899. A short period of 18 months as Assistant State Engineer of Jeypore State, under the late Colonel Sir Swinton Jacob, K.C.I.E., from whom he received his first training as an Irrigation Engineer, was followed by a further period of employment on railway surveys in the exceedingly trying climate of Sind, when a short course of study in a garrison class at Kasauli for promotion to his captaincy proved a welcome and much needed change.

It was about this time that Major Garrett formulated his theory of arched masonry dams, a form of construction that had previously met with little acceptance by engineers throughout the world, due perhaps to a lack of complete appreciation of the problems involved; Major Garrett was, however, no mere theorist, and as State Engineer of Alwar State, was the first to put his theory into practice in the construction of the Agar dam, thereby effecting a saving of 30 per cent. in the cost of construction. The theoretical considerations involved and a short account of the Agar dam were set forth in a paper contributed by him to the *Royal Engineers Journal* and published in the year 1908.

From Alwar Major Garrett was transferred to the Irrigation Branch of the Public Works Department and was posted to Raipur

Major A ff Garrett RE

in the Central Provinces, and it was in this work that he found the best scope for his abilities. His investigations into the theory of flood storage in reservoirs, shortly after his taking up the new appointment, completely revolutionized the design of reservoir spill-ways in the Central Provinces, and have resulted in a vast saving of expense to Government. The results were embodied in a pamphlet and adopted by Government as a basis for all future designs. These investigations were hardly complete, however, before Major Garrett was at work on a set of hydraulic diagrams for the design of irrigation canals; these diagrams, which received the highest commendation from Sir John Benton, K.C.I.E., then Inspector-General of Irrigation, were based on Kutter's formula for the flow of water in rivers and channels, and made it possible to ascertain at once by simple inspection the best section of channel for any given conditions. They have since been largely adopted in every province throughout India and, it is believed, have proved of great utility in Mesopotamia; it is impossible to exaggerate the amount of time and labour saved by their use and this work alone will keep his memory green so long as water is harnessed for the use of man.

A further set of diagrams for the design of notched falls on canals and the publication of a comprehensive collection of formulæ and diagrams for use by all hydraulic engineers followed in quick succession, when his labours in this direction were interrupted by his recall to military duty on the outbreak of war in 1914.

First of all employed in training the 65th Field Company at the Curragh during the winter of 1914—15, he proceeded with them to Gallipoli, where he was wounded by a sniper's bullet, which passed through his neck, and after a short period of convalescence, was ordered to India in March, 1916, where he was specially selected as A.C.R.E., Karachi.

His life thereafter, until his return to the Irrigation Department at the end of 1919, was one of continual overwork and strain, first of all at Karachi and then at Rawal Pindi, with hardly a day's leave, which would have been trying enough to a man in the best of health; and, just as there appeared a chance of his getting back to the work and life he loved in the Central Provinces, in response to repeated and urgent requests from the Government of those Provinces, the Afghan war broke out and Major Garrett was appointed C.R.E. of the 2nd Division. The severe hot weather which followed in Peshawar completely undermined his health and despite a few weeks' rest in the hills preparatory to rejoining his post as Superintending Engineer in the Central Provinces, he fell an easy victim to influenza shortly after his return, and this illness appeared finally to destroy all his powers of resistance. Malaria in an acute form supervening, he was ordered home immediately, but passed over in his 45th year on March 28th, 1920, in a hospital at Marseilles,

where he was buried with military honours in the new British military cemetery at Mazargues. His wife, Ida, who survives him and whom he married in 1900, is the daughter of the late Rev. J. F'A. Gavin.

Space does not permit of more than a passing reference to the fact of his being a keen astronomer, who restored the old Observatory at Jeypore whilst Assistant State Engineer there, and of his having twice gained the Montgomerie Memorial prize.

He had a brilliant future before him, and was to have been Chief Engineer of his old Province in India on the retirement of the present incumbent.

By his death, the Central Provinces sustain a loss which it is impossible to measure, and the officers of the Irrigation Department lose a chief who was beloved by all who worked under him.

COLONEL K. A. JOPP, LATE R.E.

ON the 15th May, 1920, at Atheldane, Westgate-on-Sea, there passed away Colonel Keith Alexander Jopp, one of the very few surviving officers of the Royal Engineers who joined the Corps through the Honourable East India Company's College at Addiscombe.

Born at Ootacamund, in India, in the year 1838, he was the son of Colonel John Jopp and Eliza, daughter of Colonel Tom Morris. He was educated at Cheltenham College, where his name is still to be seen on the schoolroom wall among the list of distinguished scholars. Here he was successful in winning first prize in practically every subject, with the exception of the one in which he probably had most right to expect success, namely in painting. In this subject he had the misfortune to be pitted against no less an opponent than the late Mr. Breton Riviere, R.A., who pre-deceased him by only three weeks. From here he passed into the East India Company's College at Addiscombe, heading the list of candidates and retaining his position at the head throughout the whole of his two years at the college. On passing out he was awarded both the Sword of Honour and the Pollock Medal, as well as a large number of other prizes. He was gazetted Ensign in the Royal Engineers, and appointed to the Bombay Presidency, in September, 1857, being then only 19 years of age.

His war service included the Abyssinian and Afghan campaigns. In the former he was among the very first to set foot on African soil, being included in the advance reconnoitering party sent out in September, 1857, under the command of Colonel W. L. Merewether, C.B., R.E. During this campign much heavy work devolved on him, he was responsible for the clearing of the road to Magdala. In the final dispatches of this campaign which were written by Colonel

Phayre, R.E., the name of Colonel (then Lieutenant) Jopp was accidentally omitted, but the omission was noticed by Lord Napier, who immediately wrote a special dispatch requesting that his name be included, as he had rendered very valuable services throughout the whole campaign.

The whole of Colonel's Jopp's service was spent in India, with the exception of a short period at Chatham. He married Mary Egerton Smith, daughter of the late Adam Freer Smith, and leaves a son and a daughter. He possessed a high sense of *esprit de corps*; in his eyes the Royal Engineers could do no wrong, and any slight suggestion to the contrary made in his presence was sure to receive a severe rebuke.

Although he lived to the ripe old age of 82 years, he retained his strength and great vitality almost to the last. He passed away in his sleep, without any pain or suffering, mourned by his son and daughter and his grandchildren, to whom the latter years of his life had been devoted. He was carried to his last resting place in Birchington Cemetery, covered with the Union Jack which he had served so faithfully.

GENERAL G. W. WALKER, COLONEL COMMANDANT, ROYAL ENGINEERS.

GENERAL George Warren Walker was the sixth child of General George Warren Walker and his wife, Anna Marion Patton. His father commanded the Meerut Brigade during the first Afghan War, and his maternal grandfather was at one time Governor of St. Helena. He was descended from the Northallerton branch of the Walkers of Tilehurst. He was born on the 6th April, 1823, at Colombo, where his father was at that time Deputy Adjutant-General, and was educated at Addiscombe as a cadet of the East India Company's Service, from which college he gained a commission as 2nd Lieutenant in the Madras Engineers on the 9th December, 1842. On the 15th November, 1858, at Inverness, he married Margaret Jessie Anderson, by whom he had nine children, three of whom survive him. He was promoted Lieut.-Colonel on 30th September, 1866, and Major-General 6th March, 1868. He held the office of Chief Engineer and Secretary to Government of Madras in the Public Works Department from May, 1872, to 1st February, 1877. He left India in April, 1877, and was promoted Lieut.-General 15th April, 1878, General 28th November, 1885, and Colonel Commandant Royal Engineers 25th July, 1899. In July, 1905, he married his second wife, Mrs. Augusta Mary Turner (*née* Marshall), who died in January, 1918. Of his five grandchildren three served in the European War, and one, Gervase Mapletoft Warren, a Lieutenant in

the 3rd Battalion Leicester Regiment, was killed in France in 1918. General Walker died on the 4th July, 1920, at 4, Forester Road, Bath, the residence of his daughter, Miss I. M. Walker, and was buried in Lansdown Cemetery, Bath. The funeral was of a private nature. Major and Brevet Lieut.-Colonel H. Trevelyan R.E., attended to represent the Royal Engineers, and a wreath was sent by the Assistant Adjutant-General, R.E., on behalf of the Corps.

CORRESPONDENCE.

ORGANIZATION AND EMPLOYMENT OF ENGINEERS IN WAR.

To the Editor of the R.E. JOURNAL.

SIR,—I would like to take advantage of Major-General Thuillier's invitation to discuss the points dealt with by him in his lecture, which was reported by you in your issue of May, 1920.

Infantry, dismounted cavalry, and artillery should be trained to carry out all tactical engineer services not requiring the services of artizans or engineers, but including such services as require knowledge of "bush carpentering," such as ordinary revetments. All other engineer services should be performed by the engineers under the command of the C.R.E., either on the demand of Brigadiers or other Commanders, or initiated by the C.R.E. or his officers and approved by the Divisional or other Commander. The military engineer should be the specialist in defence work of every description, and Brigadiers and other Commanders should be in a position to call on the C.R.E. for the assistance of officers and other ranks when required. On the other hand, the C.R.E. should be in a position to call on Brigadiers and other Commanders for unskilled assistance in the execution of engineer services when necessary.

The C.R.E. should be a in a position to depute a Company Commander or other officer as his representative in any section of the defence. It is highly undesirable to place engineers permanently under the command of any person except the C.R.E. But this may be done for the purpose of special operations and moving warfare on the understanding that when the army comes to rest such engineers shall at once revert to the command of the C.R.E., or as may be decided by the Divisional Commander.

I am of opinion that a suitable proportion of engineers to a complete division is :—

(*a*) Three Field Companies (old style), together with pioneers attached or three double companies, including pioneers, as apparently is intended under the new proposals.

(*b*) One A.T. Company for back area and domestic work and for service to the artillery.

(*c*) One Pioneer Battalion, which, together with other Divisional Pioneer Battalions, can be brigaded under the C.E. for special service.

The whole should be under the command of the C.R.E., who should have the necessary rank, especially in view of the possibility of the Commander of the Pioneer Battalion being a senior Lieut.-Colonel. Hence the C.R.E. should be a Colonel.

The C.R.E. should have staff consisting of an Adjutant, a Field Engineer (civil), and a Field Engineer (mechanical).

The above proportion is insisted on for the reason that engineers have always hitherto been overworked, and the third Field Company not in the line has rarely been given an opportunity to rest, refit, reform, and re-train. The C.R.E., owing to lack of staff, has always been overworked, and has been far too immersed in details to enable him to carry out the higher duties of his high position in a manner free from petty worries.

I regret that Major-General Thuillier places the onus of obtaining information and of establishing *liaison* with the Divisional Commander and Divisional Staff on the C.R.E., and on the C.R.E. alone. My views run on totally different lines. There is only one person in a Division on whom this onus should rest and that is the Divisional Commander. We have heard far too much about the whims of Divisional Commanders in their treatment of C.R.E.'s and Engineers, implying inefficiency of Divisional Commanders in their management of the Divisional Engineers. This attack is not directed against Major-General Thuillier.

As everyone who has any knowledge whatever of military engineering in the field knows, engineer services take far longer to mature than any other service carried out in the field. For this reason C.R.E.'s have to consider possibilities as regards future operations and decide on probabilities and discuss the same with the Divisional Commander with a view to a final decision as to carrying out such services, often before a definite decision as to operations is made, and thus, it is fully recognized, often taking a good many risks.

It is, in 90 per cent. of cases, not sufficient to wait until the General Staff issues its formal orders, even if such was possible it would be highly undesirable to let the enemy guess at probable movements by violent activity and by turning certain areas into hives of industry at the last possible moment, unless, of course, this is part of a scheme of deception.

The C.R.E. therefore, must be, in my opinion, as fully informed by, and as fully in the confidence of, the Divisional Commander as is the G.S.O.I., and should be fully informed of all secret and confidential matter as is the latter officer. I need hardly point out that it is exceedingly annoying to a C.R.E. to find that quite junior staff officers are often entrusted with secret matter which is not communicated to himself and which often profoundly affects his schemes, but is not recognized by the Divisional Commander and staff as doing so. It is extremely galling also to a C.R.E. to have to be continually asking for information from the Divisional Staff.

The Divisional Commander invariably sets the tone at a Divisional Headquarters. If he manages the C.R.E. properly and treats him properly, all will be well, provided always the C.R.E. is a white man and efficient. If the Divisional Commander does otherwise the staff will

treat the C.R.E. as a foreman carpenter and all will go wrong unless the C.R.E. has sufficient strength to stand up to this treatment, and even he will go down in time.

Major-General Thuillier touches on the question of engineer intelligence. In my experience the Intelligence Staff have not been successful in producing engineer intelligence, chiefly owing to the fact that no military engineer exists on Intelligence Staffs, but also owing to want of knowledge on the part of those staffs as to what military engineers want to know and ignorance of who, from, and how, to elicit the necessary information.

In my opinion a military engineer with a suitable staff should study future campaigns together with the General Staffs at the War Office, and military engineers should be represented on the Intelligence Staffs down to that of the army, or of lower formations if the necessities of the campaign require it.

A striking feature of engineer intelligence is that the Intelligence Staff is so often prepared to accept engineer intelligence as true, provided the agent is trustworthy in other branches and irrespective of whether he is qualified to give opinions on engineer questions. Another remarkable point as regards intelligence is the inclination to accept information from the Air Force as regards such matters as roads as definite and final.

Engineer *liaison* with other arms is a most important point, but requires the appointment of more officers than at present. Engineer information during operations is often a most important and difficult service, especially when moving warfare has been definitely established for a time. The C.R.E. may make certain that information even on such an important point as water will not come through the wires in anything like a respectable time, as the wires will be always congested by General Staff priority messages. The only possible method of getting engineer intelligence back to C.R.E.'s is by motor-bicycle, but no provision is made for this in Establishments. The C.R.E. even has no car.

Yours, etc.,

R. P. T. HAWKSLEY, *Lieut.-Colonel, R.E.*

REVIEW.

DETERIORATION OF STRUCTURES IN SEA WATERS.

FIRST REPORT OF COMMITTEE OF INSTITUTION OF CIVIL ENGINEERS. (H.M. Stationery Office). Price 30/-.

In the summer of 1916 the Council of the Institution of Civil Engineers appointed a strong committee, including some of the leading Harbour Engineers, to investigate the question of the effect of sea water, in various localities, on structures of timber, metal and concrete. A grant in aid of the cost was promised by the Government. The Port Engineers at some 46 ports scattered all over the world, were appointed correspond-

ing members of the committee and invited to furnish reports of the structures in their charge. These reports, together with much other valuable information, are included in the weighty volume now under review, which is liberally illustrated with plans of ports, diagrams of structures, and numerous photographs. The committee is carrying out various experiments in home and other waters, but as these will necessarily take some considerable time, the results will be published in a later volume.

The present book opens with a brief abstract of papers on the subject, collated from the proceedings of the Institution of Civil Engineers, dealing separately with timber, concrete, and iron and steel. Next is an article on the value of timber as a material for marine structures, with some botanical observations and notes. Following this is an extremely valuable paper by Dr. N. T. Calman, of the British Museum, on "Marine Boring Animals." The best known and most pestilent of these is the *Teredo* or "ship-worm." Its usual length is about 16 inches, but in tropical waters it sometimes reaches to four feet or even more. The *teredo* makes its way into timber through a small hole and then, by means of a shelly boring apparatus at its head, drills a tunnel, following the grain of the wood and, in a pile, usually in an upward direction. The bore hole is generally about half an inch in diameter and has a hard lining deposited in it. Being an expert miner the *teredo* works round knots, and never breaks into neighbouring burrows. The animal cannot live more than a few hours without access to salt water, and consequently is not found above the level of high water at neap tides. The only sign externally that it is at work is the minute entrance hole, and consequently a pile may be reduced to a mere shell without any indication of what is going on. The *teredo* is most prevalent in tropical waters, but is found in all seas. It cannot live in fresh water or where there is much sewage pollution, and it does not thrive in muddy water. The "gribble" (*Limnoria lignorum*) is quite a different animal, resembling a wood louse, but not more than $\frac{1}{8}$th of an inch in length. The mischief it does is altogether out of proportion to its size. The burrows are about $\frac{1}{20}$th of an inch in diameter and from $1\frac{1}{2}$ to 2 inches in depth, but, being oblique, seldom penetrate more than half an inch. In a very short time the *Limnoria* will eat into the whole surface of wood, between low water and half-tide levels, till it becomes a spongy mass. This is washed away by the waves and a fresh surface exposed to attack. In this case the ravages of the animal are quite obvious.

Other pests are the *Sphæroma*, allied to *Limnoria*, and the *Chelura Terebrans*, a wood-boring Crustacean.

Dr. J. Newton Friend contributes a chapter on "The Corrosion of Iron and Steel," in which he explains the difference between rusting and graphitization. Cast iron is especially liable to the latter form of deterioration when immersed in sea water: the metal is converted into ferrous oxide and retains its shape, but becomes so soft that it can be cut with a knife.

The action of water on iron is dependent on the amount of salinity and also on the temperature, with curious variations. Thus at 11°C. undiluted sea water is more corrosive than fresh. At 13°C. the two

waters are equally corrosive. Whilst at higher temperatures sea water is less corrosive than fresh.

Dr. Newton Friend discusses the relative corrodibilities of wrought iron and steel, and comes to the conclusion that no general rule can at present be laid down. Much depends on the position of the metal and the kind of corroding medium. As regards cast iron further research is necessary.

A large number of reports from corresponding members of the committee are printed. These refer to nearly all the more important ports in home waters and in the Dependencies and Crown Colonies. They contain a mass of valuable information. Unfortunately, space does not admit of their being referred to in detail here. Mr. M. F. G. Wilson, a member of the Special Committee, contributes notes on the reports, and states the broad general conclusions to be derived from them as regards the following structures, viz., timber, reinforced concrete, ordinary concrete, iron and steel. In conclusion we have the "General Report of the Committee embodying the results of their investigations to date."

Timber.—No known timber will resist the attack of marine organisms. Greenheart is by far the best. Injections of creosote prolong the life of timber but do not provide immunity. The harder the timber the less creosote it will absorb and consequently the less protection is obtained. Charring is beneficial for a time. Piles are frequently cased in sheets of Muntz metal on felt, with satisfactory results. Nearly all reports, however, state that Muntz metal made in the last few years is of inferior durability. Wooden piles are sometimes cased with concrete. In tropical waters *teredo* and *limnoria* will eat through piles 12 inches square in a few months. As a protection against the latter, flat-headed "scupper" nails are sometimes driven into piles as closely together as possible. The rusting together of the heads makes a continuous covering.

Reinforced Concrete.—This material is now extensively used in substitution for timber in the construction of piers and jetties. It is not possible yet to estimate its life, but some valuable lessons have been learnt. It is essential that the reinforcement should be in its proper place so that no portion of it should have less than 1½ inches of concrete covering it, 2 inches is better. Cases are reported of failure due to stirrups being within ½ inch of the face of piles. The result is corrosion of the metal and splitting of the pile. The concrete should be made as impermeable as possible. Piles are sometimes coated with tar or other substances. Spots of rust appearing on the surface should at once be cut out, the metal cleaned of rust, and the concrete made good. A number of valuable specifications for the concrete are given in the reports. There is no doubt that wharves of this material, at any rate in tropical waters, will long outlive timber structures. One objection to them is that they are much more liable to injury from being bumped by vessels coming alongside. Timber fenders should always be provided. The jointing of diagonals and uprights requires to be done with great care otherwise damp will penetrate to the reinforcement.

Ordinary Concrete.—The reports on this material are, with few

exceptions, satisfactory. Structures are either of mass concrete laid *in situ*, or of blocks made in a yard, and after being carefully seasoned, lowered into position by means of "Titans." It is of great importance that the face should be as impermeable as possible. All concrete is, of course, more or less porous. Some few years ago a report, not referred to in the work under review, was published on concrete structures in harbour works in the United States. It appeared from this that in many places, especially in warmer waters, the sea had an alarming effect resulting from its chemical action on cement. A report from Halifax, N.S., describes extensive damage to concrete-in-mass piles, caused by frost. At high water the surface is slightly penetrated by sea water, freezes and expands, thawing again with the rising tide. The face then falls off in powder. In seven years the damage was, in places, 15 inches in depth.

Iron and Steel.—Cast-iron piles, with wrought-iron super-structure, have been used for wharves, etc., for many years. In later years wrought iron was substituted for cast, and more recently mild steel has been used. There are cast-iron piles still standing which were driven more than 70 years ago. There is frequently more deterioration of metal structures above high water mark, due to atmospheric effects, than below. The reports describe in great detail various methods of protecting metal work either by tarring or the use of paints and other substances.

The volume is a mine of information for all engineers who have to do with the construction or maintenance of structures in sea water in any part of the globe. Before submarine mining companies were abolished, R.E. officers had charge of numerous piles and wharves. There must, however, be a good many apart from these. Every branch of the Corps Library should have a copy.

WM. PITT, *Colonel, late R.E.*

NOTICES OF MAGAZINES.

THE MILITÄR-WOCHENBLATT.

No. 98.—*The Military Importance of Waterways.*—Major von Steffen states that the use of waterways to ease the load which military operations impose on railways, has now become essential. Behind the German lines on the Western front there were 2,300 kilometres of navigable waterways, but traffic was considerably influenced by the fact that there were no less than 465 locks, and that the largest vessel that could be used universally was one of no more than 280 tons. In 1916 the canal system was placed under railway administration and in June, 1918, it had at its disposal 464 tugs, 79 motor boats, 3,161 barges, 225 cranes, 12 dredgers, and 719 draught animals; 52 yards and depôts undertook the maintenance of this material. In addition to one construction and four operating companies, 9,747 inhabitants of the

occupied territory were employed. After the offensives in the spring of 1918 the opening up of the Lys, the Somme and Aisne canals was undertaken with such energy that by July of that year no less than 190 kilometres of waterway had, in spite of considerable demolitions, been made navigable. From April to June, 1918, 12 million tons were carried, an average of 100 kilometres, and from September, 1917, to June, 1918, 400,000 men; thus relieving the railways of the equivalent of nearly 1,000 fully loaded railway trucks. In spite of the limitations placed on the use of the canals by military conditions, the traffic on them was nearly double that of peace time. Finally, when they could no longer serve their proper purpose they became of considerable tactical use, and the inundations which they made possible afforded no little relief from pursuit during the German retreat.

Roll of Honour.—Infantry Regiment No. 395 (formed in September, 1916).—52 officers and many other ranks killed.

No. 99.—This number appeared on 27th March, instead of on the 17th. The delay is attributed to the Revolution and the general strike which followed it. The subscription is raised from 20 to 32 marks a year.

German East Africa in the World War.—The writer, an old East African, is naturally enough very proud of the wonderful success the Germans had with their native troops in that campaign. They were so devoted to their masters that even when the latter were interned at Tabora and Dar-es-Salaam they brought them food, news, and even money. When mobilization was ordered, far greater numbers presented themselves than could be embodied, and many time-expired Askaris came forward unasked; there was never a thought of conscription. When von Lettow, after his 10 months' crusade in Portuguese territory, turned back into German East Africa, all the old Askari who had been wounded and left at their homes earlier in the war thronged to join him. The writer bitterly regrets the loss to the enemy of that beautiful colony to which he and so many others had devoted their life work. He hopes, however, that Germany will follow the example of Japan, who after the treaty of Shimonoseki, when Germany deprived her of the fruits of victory, held no meetings for the furthering of universal disarmament, made no burning protests in the name of justice or humanity, but kept silence, smiled, even served and at times went hungry, but always worked. Till at last the day of reckoning came in August, 1914, and she demanded interest and compound interest. So should Germany seek her revenge.

Atrocities.—The usual appeal for evidence regarding atrocities on the part of Germany's enemies continues to appear, and a notice regarding arrangements for defence of those for trial at Leipzig is given. Plenty of publications alleging cruelties committed by the Allied troops also appear.

The Channel Tunnel from a Military Standpoint.—General von der Boeck considers that the opposition to the project, which has always come from military quarters in England, is no longer so well grounded as before the war. He points out that the tunnel could never be seized by a *coup-de-main*—at any rate by Germany—and that even if the continental end was to fall into hostile hands, no use could be made of

it till a sea borne force had seized the English end, together with sufficient ground for elbow room; a condition which presupposes the destruction of the British fleet. On the whole he considers the advantages of the tunnel to England far outweigh its disadvantages.

No. 100.—The leading article discusses at length the causes and consequences of the March "Putsch." The writer blames both sides, the Reds because they had planned a Red Terror and very nearly succeeded, and the Junkers because they had not planned enough and failed miserably. The unfortunate Government, lying between the two extremes, catches it worst of all.

Anxiety is expressed regarding the punishment to be meted out to the Junkers, and the fate of Russia, and the Kerensky Government is held up as an awful example of what happens if passions are once loosed against the "officer class." The writer hopes that the amnesty granted to the Reds will also be extended to the Junkers, and emphasizes the value of the latter's services to the Government in the November, 1918, Revolution and subsequently.

In discussing the attitude of the Entente, France heads the "hate" list, England and Belgium following at some distance. Churchill's speech, "The danger to Europe, which lay once in Germany's strength, now lies in her weakness" is heartily approved, at least the last part is, and the usual remedy of a stronger army advocated, with Bolshevism as the alternative.

Peace between Poland and Russia appears far distant, but the writer does not venture again to prophesy regarding the future of the campaign, and confines himself to a further plea for a stronger German army to meet any unforeseen contingencies from that quarter.

President Wilson's League of Nations is laughed at and a separate peace with America hoped for.

Officer Prisoners of War.—The publishers of the *M.W.B.* state they are in a position to offer a few linen night shirts to officer prisoners of war, who on return from captivity find themselves without means of support!

France's Armed Forces.—Some figures dealing with these receive the comment that they do not show many signs of disarmament. The Soviet armies are estimated from an extract from the Russian Press to consist of 16 corps and 8 cavalry divisions, in all 400,000 bayonets, 20,000 sabres, 15,000 machine-guns and 3,500 guns; behind these there is a reserve of a million more men. Yet another demand for a larger German army follows.

Honours.—The Bavarian Government is distributing a number of honours gained before the Armistice; Prussia still withholds them because they were abolished after the Revolution. The *M.W.B.* thinks this very unjust.

Official Notices.—Von Reinhardt says that cases have come to the notice of the Ministry of Defence in which German officers attached to foreign commissions of control have met with obstruction and even disrespect from other German officials with whom they have to deal. It must be remembered that the task which these officers have under-

taken is a very distasteful one and must not be made more so by the action of those officers and officials with whom they come in contact.

No. 101.—The output of military books continues to increase; whether in this case supply creates demand or *vice versa*, it is difficult to say, but every number of the *M.W.B.* contains reviews, usually eulogistic, of fresh works by German military authors. Possibly the enforced idleness imposed by the terms of the Treaty on so many officers and the dissolution of the Great General Staff have something to say to it, together with the fact that the publishers of the *M.W.B.* are also great publishers of military works in general. Lieut.-General von Schwarte has collected the views of 19 different authorities, each expert in his own line, and merged them into a book entitled "The Military Lessons of the Great War." General Freytag-Loringhoven compresses the subject "The Higher Command" into a space of 17 pages, and says that every effort must be made to prevent the next war becoming one of positions, in which only the lower arts of leadership can be exercised. He also declares that a war of manœuvre necessitates more decentralization of command than one of positions. Artillery, engineers, cavalry, machine-guns, aeroplanes, etc., all receive consideration, but as the whole is compressed into one moderate-sized volume, each can only be treated in the roughest outline.

Germany, the Entente and Bolshevism.—When will the danger of Bolshevism be appreciated? It must either be destroyed or allowed to spread its imperialist ideas all over Europe and Asia. France is declared to be mad, but the other Allied Powers are beginning to appreciate the situation. They must, however, understand that the use of all weapons is called for and not merely of economic ones. The article is of course another plea for a larger army to be left to Germany.

The Trial of War Criminals.—All who are on the list, and their representatives, are urgently invited to address themselves to the Leipzig Defence Association which has very important information for them. It is also notified that the working up of all their cases is in the hands of the state-attorneys who are pledged to secrecy and cannot be called as witnesses.

The Prussian Cadet Corps ceased to exist on 10th March. Major-General von Reinhardt issues a farewell order and looks forward to better days to come.

Roll of Honour.—Reserve Infantry Regiment No. 66.—100 officers and many other ranks killed. A young pioneer subaltern, who survived seven severe wounds during the war is noted as having been killed by a German's bullet during the recent disturbances.

No. 102.—Ex-Governor Dr. Seitz, contributes a long article on the dismissal of Bismarck based on the hitherto unpublished documents dealing with this event.

Roll of Honour.—The Reichswehr publishes its first rather pathetic roll of honour—11 officers killed during the March disturbances in the industrial districts.

No. 103.—*The Military-Political Situation in the World.*—The article deals chiefly with the internal state of affairs in Germany. The Govern-

ment is blamed for weakness and tenderness towards the Reds and for insults to the only really sound members of the community, the officer class. The French General Nollet, chief of the inter-allied commission of control in Berlin, is charged with seeing bogies and inducing France to act as she did in the Ruhr district. The wish is expressed that he should give place to a nice quiet general who would make no trouble. Differences of opinion among the Allies are noted, but it is thought doubtful whether Germany will be able to derive any advantage from them. The Reds fought very poorly against the Government troops, but nevertheless managed to inflict appreciable losses, particularly in officers. The auxiliary forces, such as the "Zeit-frei-williger" and "Einwohner wehr" though in one or two cases they were not a success, on the whole did useful work in preserving order and protecting lives and property. This is in itself quite enough reason for those who wish to render Germany powerless to demand their abolition, and strangely enough even in Germany itself there are plenty of enthusiastic pacifists who make the same demand and would even wish to include the Reichswehr. Thus enemies within and without are working for the destruction of all power of resistance to the disintegrating influences of the age and this with the storm cloud of Bolshevism rising blacker and more threatening every day. Will the Government show any backbone or will it surrender all power to the small Bolshevist minority which seeks to establish a tyranny of blood and terror?

The Officer in Present Days.—The late Minister of Defence, Herr Noske, wrote in the *Vorwarts* a strong defence of the officers, stating that they were loyal, in many cases to the death, during the Kapp affair and deserve the thanks and not the curses of their countrymen. In spite of this, however, the feeling against them is steadily rising, and the editor of the *M.W.B.*, in hope of preventing what will, if continued, drive the officers into the arms of the extreme Reds, publishes an article of which the following is a précis:—"Whether an officer is monarchist or republican does not affect the following considerations. Recently every decent officer has been obliged to ask himself if he can any longer stop in the army. After the revolution of November, 1918, the officers remained at their posts and brought the Army back across the Rhine in safety. Part of them were then discharged and part retained. The ruling thought among the latter was that they must stay on to save a general collapse, and they were right. The next thing was that they were abused all round, the Government doing nothing to protect them, until presently there came the danger from the Poles and from the Spartacists. Then a different tune was called. The officer was quite good enough to go and be killed, and by his sacrifices he saved the Government and the country. Those who had made all the trouble were not, however, prosecuted with any effectiveness and were soon at their pestilential work again, while the Government, by constantly giving way, managed to retain a deceptive state of calm. This caused many officers to ask themselves what was the use of risking their lives to win victories for a Government that did not know how to use them, but when quieter times came they all put in steady work for the reconstitution of such

forces as the country still possessed. As these latter days have shown, their work again saved the Government from expulsion, and the country from disaster; Chancellor Ebert has shown his gratitude by stirring up the people against their saviours and, in order to curry favour with the Reds, attributed the Kapp 'putsch' to the 'officer caste' which had in fact very little to do with it. It was really civilians in conjunction with a few short-sighted officers and was hopeless from the outset. However, the Government set a general strike going, and when Kapp collapsed, thanked the working-classes for what had really been accomplished by the officers. The late Chancellor actually expressed his gratitude to the scum who had fought against the Reichswehr for their loyalty to the Government, and the rioters went scot free. All indications point to a resumption of the activities of the Reds, and officers must demand that their position be safeguarded and that they shall not be sacrificed on all occasions. They still serve, not for their meagre pay, but for love of country, and if they throw in their hands the Government will be obliged to have recourse to a corps of officers serving for profit. When that happens the country will soon understand that the old officers were the back-bone of the army. If the real officers spirit is destroyed, the army is also destroyed and the destruction of the State will quickly follow." Things have indeed changed since the days of Zabern.

The Significance of the Adhesion of Scandinavia to the League of Nations.—This it is stated, will considerably modify the politico-military situation in the North as regards Germany. During the war the neutrality of the three northern states prevented England from landing troops in Jutland or establishing a naval base in South Norway. Had she been able to adopt any such measures, Germany would have been obliged to maintain considerable forces to counteract them. No doubt England thought that the drawbacks consequent on a breach of neutrality would outweigh any advantages to be attained. Now, however, that is all changed, and it is a measure of the weakness of Germany. The intention of the Entente to surround Germany has been accomplished and in future Scandinavia must be prepared not only to extend favourable neutrality towards Germany's enemies, but even to take part in active operations by land and sea. Of Norway and Denmark nothing else was to be expected, as they had already sold themselves to England, with Sweden, however, it was different, and nothing but an intense propaganda has succeeded in turning her towards the League of Nations. She will see her mistake when the bill for the increased armaments, she will now be forced to maintain, comes in. The writer cannot be congratulated on the delicate handling of his subject.

Allied Missions.—Noske issues an Army Order regarding behaviour towards Allied Missions of Control. Apparently some difficulties have been placed in their way and he says that such conduct which only serves to prolong the supervision by the Allies, must stop at once.

Roll of Honour.—Alsatian Pioneer Battalion No. 15.—32 officers and 1,113 other ranks killed or missing.

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

REVUE MILITAIRE GÉNÉRALE.

February, 1920.

The Transformation of the German Army, November 1918 to November, 1919.

Under the pressure of circumstances the external aspect of the German Army has changed, but its spirit remains the same, as has been announced by General von Leckt, since his appointment as Chief of the General Staff. The Imperial Army is re-incarnated as the Reichswehr, and the three successive steps are :—

(i.) The demobilization of the Imperial Army,
(ii.) The creation of the Reichswehr,
(iii.) The organization of camouflaged reserves,

which will be treated separately.

The steps to be taken for the demobilization of the Imperial Army were studied at the end of 1916, based on the victory of the Central Empires and of progressive military disbandment, combined with economic reconstruction. Release was to be given in the following order :—

(i.) The oldest classes, commencing with fathers of large families.
(ii.) Pivotal men.
(iii.) Men who had guaranteed sources of livelihood.
(iv.) Men whose places had been reserved.
(v.) Men with no assured means of existence, who should be temporarily retained with the colours, and released as work could be found for them.

The defeat of the Central Powers rendered this plan nugatory, the German revolution broke out amongst a disillusioned people disgusted with war, and immediately on receipt of news of the Armistice all units not bound by the strict discipline of the battle-front dissolved to their homes. The provisional Government clearly saw that it must accept as a fact what it could not prevent, and, attempting to regularize the movement, promised demobilization in the shortest possible time, enjoined calm and patience, and all military and civil authorities, soldiers' councils, and people' commissaries preached order as a fundamental condition of rapid demobilization. The Government renounced the original scheme and adopted the simple plan of demobilization by classes.

The demobilization of the home army was at first far from methodical, and various instructions, some contradictory, were issued by several authorities, but all contained two points in common, an appeal for calm and patience, and the acceptance of the fact that the offenders; though in fact deserters, were on leave, and were to be disbanded wherever they were with as few formalities as possible. In the middle of November, 1918, the Minister for War published general instructions stating that it was impossible to disband the whole army, that the oldest classes up to 1899 inclusive would be released first, but that specially employed men could only be discharged when relieved.

Alsace Lorrainians, and inhabitants of the Rhenish Provinces, except the 1818 and 1819 classes, were to be released immediately if they so desired. Every man who had quitted his unit, no matter for what motive, should apply to the nearest military authority, either for regular leave, in which case he would be informed of the formalities to be observed, and ultimately of the date of his discharge, or for a transport order to rejoin his unit. Those who complied would receive a bonus of 50 marks and a complete civil suit, and few failed to avail themselves of the concession. Those who rejoined, and those of the 1916 to 1919 classes were specially pressed to do so, were to be absorbed in the nearest depôt, since to send them back to their units would involve transport as for mobilization. All men necessary for the economic life of the nation, if not belonging to the immediately demobilizable classes (1890 to 1906), nor to those to be retained with the colours (1916 to 1919 classes) were also to be released as soon as possible. However, these regulations could not be applied blindly. Many of the demobilizables had no means of subsistence and would have to join the unemployed, and many specially employed could not be spared. The former were allowed to remain with the colours, and the latter were to be retained until they could be relieved by men of the younger classes. Failing sufficient of the latter being available, volunteers were to be called for from those already demobilized, and this system rapidly extended. The troops of the field army, after a short period of effervescence, retained their discipline. The Government, at first inclined to release them, ended by sending them back to their depôts in order to reduce unemployment, and units belonging to the occupied areas were allotted fresh regions. Units were allowed to demobilize direct (1) professional classes, (2) Alsatians, Lorrainians and inhabitants of the occupied territories. Units considered necessary as frontier guards were retained, being brought up to establishment from the non-demobilizable men of the rest of the army. Besides his bonus, route, and suit of clothes, each man was given rations for three days, and in case of need the Mayor of his Commune, provided his papers were in order, could give him a ration card for another week. He was entitled to free lodging when he could not join his home in the day, or at large centres for a short period if he was seeking employment. Measures were also taken to provide employment as soon as possible, and workmen's unions succeeded, when the Government had failed, in inducing employers to take back their old hands. The measures taken for the relief of the unemployed, however, resulted in a direct encouragement of idleness. The order for general demobilization was dated 10th January, 1919. The Provisional Government was forced by public opinion to abandon its first intention of retaining with the colours the 1916 to 1919 classes, but deferred the demobilization of the 1918 and 1919 classes until the volunteer and Reichswehr formations were well developed. Under the pretext of guarding against danger from Bolsheviks and Poles, six *corps d'armée* on the East frontier were considered as still mobilized and authorized to retain parts of the 1917 and 1918 and all the 1919 classes, but the strength still proving insufficient, in spite of volunteer formations, these six corps proceeded to recall the classes already demobilized. Also all

units of the old army could retain provisionally all who wished to remain with the colours, re-engaging them for short periods of 15 days to three months, if they had no means of subsistence, or wished to transfer to the Reichswehr. The latter category produced so many men that strict selection was possible and all political suspects could be eliminated. As a result the army, which by 1st April, 1919, should have been reduced to cadres of long service soldiers only, presented no very skeleton-like appearance, and actually on that date consisted of about 300,000 men. The demobilization of the cadres proceeded with systematic deliberation. The demobilization machinery, consisting of the Army Corps staff, four subordinate (divisional or brigade) staffs, and battalion demobilization centres, found it necessary continually to augment their numbers, and eventually dispersing units came to equal in strength the units demobilized. Staffs of fortresses in the occupied areas were suppressed, also some of the army and fortress inspectorates, but schools for officers, N.C.O.'s and cadets, directorates and the higher inspectorates were retained, all that could be being transformed into civil offices, the remainder being incorporated in the Reichswehr. The demobilization centres were nominally retained to deal with repatriated prisoners of war, but instead of keeping the latter only for the short time necessary to complete administrative formalities, delayed their departures for two or three months on the pretext of re-establishing their health, which had been undermined by harsh treatment in enemy countries. The defeat and revolution, the fall of the monarchy and flight of the Emperor inflicted a serious blow to the feelings of the officers. At first many resigned, but the crisis past, enrolled in powerful leagues (Deutscher Offizierband, National Verband Deutscher Offiziere) and supported secretly by the Provisional Government the officers regained faith in themselves and their country, and the creation of volunteer corps and the Reichswehr opened a field for their activities. Although the acceptation of the treaty of peace left a large number of officers unemployed, on 11th November, 1919, nothing had been done to deal with their cases. Measures had, for diplomatic reasons in order to prove to the Entente the good faith of the German Government, been proposed, but came to nothing. So far was the Government from wishing to reduce the strength of officers that they have commissioned university candidates and N.C.O.'s.

To sum up. On 11th November, 1919, the old Imperial Army had ostensibly been dissolved. In fact it still existed, and there remained with the colours all the 1919 class, the specially employed, those re-engaged for short periods, and an increasing number of repatriated prisoners of war. Again certain units had been exempted from demobilization. The above gives a total of 150,000 to 180,000 men. The training cadres are intact, their distribution is as before the war, and all the large army directorates, schools and inspectorates, still function.—(*To be continued*).

A. R. Reynolds.

CURIOSA MATHEMATICA.

Write the following numbers by the use of no numeral other than 2 (not even 0). Any letter or recognized mathematical symbol may be used :—

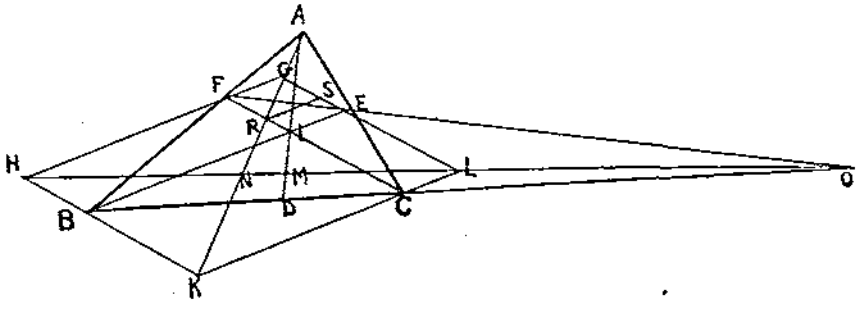
69 (using five twos only).
91 (using six twos only)
93 ,, ,,
133 ,, ,, without making use of the number 222
137 ,, ,, in two ways
147 ,, ,,
149 ,, ,,
483 ,, ,,

C. R. SATTERTHWAITE, *Major, R.E.*

PROBLEMS.

PROBLEM 9 (Solution by Lieut.-Colonel J. M. Wade).

A triangle ABC is such that the lengths of the bisectors BE, CF of the angles ABC and ACB are equal. Prove that AB = AC.



ABC is a △ such that BE, CF bisect the angles B and C and BE = CF prove AB = AC.

Through B, F, E, C, draw the parallels HBK, HFG, GEL, LCK to BE and CF. Join AK, HL. Produce HL to meet BC in O. Join AO. Draw RS parallel to BE.

Then the following can be proved :—

(i) FE passes through O.
(ii) KRG passes through A. } By use of Menelaus' Theorem.
(iii) HKLG is a rhombus.
(iv) KG, HL bisect one another perpendicularly.

(v) AD, AO are harmonic conjugates with respect to AB, AC, because BCEF is a quadrangle.

(vi) DAO is a right angle (follows from v and because I is the incentre).

(vii) FRSG is a rhombus.

(viii) FI and FR are both in the same direction, being both inside $\triangle$ ABC and rhombus GHKL.

If AB is not equal to AC, suppose AB the greater, then it follows that

(*a*) BI > CI, since $\angle$ ICB > $\angle$ IBC.

(*b*) CF − CI > BE − BI.

(*c*) FI > IE > RS > FR, since FRSG is a rhombus.

(*d*) AMO is exterior and opposite to angle ANM of the $\triangle$ ANM.

(*e*) Angle AMO is less than a right angle (follows from vi).

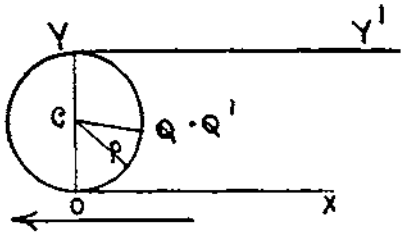
(*f*) Angle AMO < ANM, the latter being a right angle by iv, and this is impossible.

Hence, as the hypothesis AB > AC leads to an absurdity, it is wrong. Similarly AC is not greater than AB. Therefore AB must be equal to AC.

A correct analytical solution received from 2nd Lieut. W. E. C. Pettman.

PROBLEM 10 (SOLUTION).

A corkscrew is held with its axis perpendicular to a horizontal table, under what circumstances is the shadow of the screw thrown by the sun on the table a cycloid?



Direction of sun.

OPQY is the plan of screw on the table. This plan is circular and of radius (*a*). The screw is supposed to start from P, and to rise uniformly counterclock through a height (*h*) in an angle 2π, the angle PCO = α.

The axis of x, OX, is so chosen that the plane of xz passes through the sun which is at infinity.

The axis if (z) is vertically upwards through O, and the axis of Y is OY $\perp^r$ to OX.

The sun's rays make an angle β with the table. Q is a point on screw and $\angle$ OCQ = $\theta \angle \pi$.

Then co-ords. of Q are $x = a \sin\theta$, $y = a(1 - \cos\theta)$, $z = \frac{h}{2\pi}(\theta - \alpha)$.

If the ray through Q meet the table in Q^1.

Then the co-ords. of Q^1 are $x = a \sin\theta + \frac{h}{2\pi}(\theta - \alpha)\cos\beta$, $y = a(1 - \cos\theta)$.

These equations represent in general a trochoid, and cannot represent a cycloid unless $\frac{h}{2\pi}\cot\beta = a$.

If this relation exist, and if the screw is placed so that $\alpha = 0$, the above equations become $x = a\theta + \sin\theta$, $y = a(1 - \cos\theta)$, which are the co-ords. of O if the circle OQY roll on YY^1 parallel to OX through an angle θ.

Note.—This problem works out quite easily provided the axis of x is suitably chosen.

Correct solutions have been received from Lieut. R. H. Nisbet and Major G. E. Painter.

PROBLEM 11.

The following interesting problem has been sent me by a brother officer:—

Given a triangle ABC and a point O, it is required to draw through O a line bisecting ABC.

PROBLEM 12.

Find the remainder of 47^{7385} when divided by 17.

J. M. WADE, *Lt.-Col.*

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