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THE ORGANIZATION AND TRAINING OF THE R.E. FORTRESS SERVICE.

By COLONEL W. BAKER BROWN, LATE R.E.

IN the new edition of *Engineer Training*, published in 1912, a very valuable advance has been made in defining the duties of Engineers in war, and in the instructions for training to fit all ranks to carry out those duties.

But it is noticeable that in Part II. which is headed "The Employment of Engineers in War," the only phase of war which is dealt with is that of an expeditionary force acting in an unknown country. I am far from saying that this is not a most important part of our duties, and I would go further and say that in many respects it is the most difficult, as the need of rapid decision and execution with a minimum of men and materials demands a very high standard of individual technical knowledge and much previous training before a unit can become efficient.

On the other hand the fact remains that the largest of the groups of units, into which the Corps is now divided, is the group which provides for the Engineer duties in fortresses. This group comprises some 30 companies, and there are affiliated to it a large number of Territorial and local forces who look to the R.E. for instruction and example in carrying out their work. It seems therefore desirable to lay down some rules for their organization and employment.

Having recently completed a tour of four years as a C.R.E. in one of our largest fortresses abroad, I may be allowed to indicate briefly what I consider the best methods of obtaining the required standard of training and the difficulties likely to be met with.

Interdependence of Field and Fortress Duties.—Much of the work in fortresses is of a technical nature, requiring a large proportion of specialized workers who must be highly trained in their particular branch. At the same time, and this is a cardinal factor of the organization of the R.E., all our actual experience of war has shown that in addition to the call for the skilled services of the field units allotted in peace to the various commands which compose our expeditionary force, there will be demands for many other forms of skilled Engineer assistance at the base, on the lines of communications, in siege works, or in the preparation of semi-permanent defences. And such demands have always been met in the past by

drawing largely on the fortress service, not only by units but by individuals.

It is thus essential, and this point is emphasized in *Engineer Training*, that the whole of the R.E. fortress service should be trained in Engineer duties in the field, in addition to their special training in fortress duties.

DUTIES OF R.E. IN A FORTRESS.

Work to be Done in Peace.—1. Erection, maintenance and running of defence electric lights, both fixed and mobile.

2. Erection, maintenance and working of the military telephone system except those portions which are maintained by the Post Office in Great Britain and Ireland.

3. Construction and maintenance of fortifications and permanent entrenchments, including living accommodation for their garrisons; military roads; magazines and storehouses; sites for camps.

4. Maintenance, and in some cases construction, of barracks and other military buildings.

5. Preparation of detailed schemes for strengthening the defences on the outbreak of war.

6. Assistance in the training of other troops, such as running electric lights for artillery training or advice on entrenchments for infantry.

Work to be Done in War.—This is practically a continuation of the peace duties, on a larger and more strenuous scale. Thus:—

1. Electric lights will be run all night for many nights in succession.

2. Additional telephone lines must be run and offices opened to link up the extra defences to be constructed under Subhead 5. Telephone exchanges must be manned night and day.

3. Forts must be prepared for war; musketry parapets completed; obstacles erected or improved; dressing stations arranged; reserve water supply and adequate sanitary services provided for the war garrisons.

4. As barracks will in many cases continue to be occupied, their maintenance, especially of the water and sanitary services, must be continued as in peace. Some of the barracks may have to be converted into hospitals.

5. The schemes for strengthening the defences must be put into effect; entrenchments constructed; as these may have to be occupied for some weeks, special attention must be paid to surface drainage, water storage and sanitation, and in many cases the shelters in works may develop into semi-permanent buildings of iron and concrete.

Works.—I think all Engineer officers will agree that the above summary fairly represents the necessary duties of Engineers in

fortresses except as regards the administrative duties connected with barrack construction and maintenance. There are still some officers who look on such employment as a corvée or forced labour, put on to the Corps in order to make a financial saving on the estimates. I do not think that a detailed consideration of the case will bear out this opinion.

The arguments for the inclusion of barrack work among the duties of the Corps may be stated as follows :—

1. The work involved in the construction of fortifications is admittedly work which should be done by military engineers, but this work involves questions of living accommodation for the garrisons and this touches all the engineering problems which are involved in barrack construction and maintenance.

2. The work required from Engineers on the line of communications, or in rear of the field army, and much of the work with the army itself, is very similar in kind and even in degree to the work done under the barrack estimates. *Engineer Training*, Sect. 96, para. 5 (ii.), (iii.), (iv.) and (v.), Sect. 98, para. 1 (iii.), Sect. 102, para. 1 (i.), (ii.), (iv.) and (v.), Sect. 107, para. 1 (ii.), (iii)., (iv.) and (v.) and Sect. 108 all refer to Engineer works of the class I refer to.

3. For the reasons given in *Engineer Training*, para. 11 (i.), it is rarely possible to actually practice such duties during manœuvres. On the other hand the supervision of barrack work gives invaluable practice to our officers in dealing with the supply of stores, supervision of military or civil labour, or work with contractors, and encourages habits of foresight and economical use of men and material. All of this forms excellent training for our duties in war. *Engineer Training* in many places lays stress on the necessity of preliminary preparation of plans, careful reconnaissance and deliberate collection of stores. Employment on works gives practice in all these points.

4. In the case of N.C.O.'s and men, "works" give excellent opportunities for employing men at their trades as laid down in *Engineer Training*, Sect. 8 (ii.).

Some officers while admitting the above arguments are of opinion that sufficient employment on works could be obtained by limiting the duties of the military engineers to the charge of fortifications, military roads, and other works of a distinctly military nature, leaving barracks to be looked after by a civil department. But quite apart from the inconvenience of having two Engineer organizations in each fortress, I am decidedly of opinion that, at stations abroad at least, such an arrangement would not provide full employment in peace for the officers and men of the military engineer service who must be maintained in readiness for war, and would not give an adequate training in certain trades and branches of engineering.

Indeed I would go further and say that if by any chance barrack services were removed from the R.E. we should find our technical efficiency fall off so much, that we should ask permission to revert to the present system.

All previous experience shows that if a separate department was established for the execution of barrack works, it would almost at once go through two stages. First, there would be a demand to give the department military rank and position, so as to give it a proper status with the officers and men occupying the barracks. Second, in all fortresses, the staff for barrack works would be required to assist the military engineers in the first preparation of the fortress for defence when mobilization is ordered; this would involve a demand for a modified form of military training for this department. The final result would be the production of a military engineering organization, much as we have it at present.

To sum up, my conclusion is that our employment on works is an essential portion of our training as military engineers.

But the employment on barrack work should not be such as to exclude or unduly limit other forms of training, and to ensure this certain conditions must be fulfilled which I may state in order :—

1. The number of R.E. allotted to a fortress must be calculated in the first place on the duties which have to be performed in war after allowing for the fullest possible use of any local forces which can be raised.

2. As this number will never suffice to carry out all the barrack works, it must be supplemented by civilians directly engaged to work with the R.E. or by contract labour.

3. In arranging the work to be done by R.E. or civilian labour, the training of the R.E. must be considered. For instance, it is seldom wise to detail an R.E. for permanent charge of a pumping engine which has to work continuously throughout the year as that would interfere with other forms of training. On the other hand an R.E. might quite usefully be detailed for temporary charge during the sickness or absence of the civilian. Again the excessive employment of N.C.O.'s and sappers on purely clerical duties is likely to adversely affect their training as tradesmen.

4. The whole works organization should be on a military basis, following as closely as possible the probable war distribution of the R.E.

5. The charge of engineer works must be considered as an important administrative duty, demanding from all ranks a high standard of efficiency, care and zeal in execution, and involving long working hours.

6. The carrying out of works services is subject to certain limitations which impose greater strain on the staff for works at certain times of the year. Such times should not be selected for carrying out other forms of training such as musketry and fieldworks.

7. It is seldom possible to entirely stop works services so that at all times of the year some officers and men must be available to supervise works.

These last two considerations must be kept in mind not only by R.E. officers but by officers of the General Staff when arranging training programmes.

Establishment and Organization.

The distribution and organization of the R.E. fortress service when it was rearranged in 1905, were specially adjusted to comply with the above considerations, as will be seen if we consider the details.

Establishments.—The number of officers, W.O., N.C.O. and men allotted to any fortress is now based almost entirely on the minimum required in war, after making allowance for all possible assistance from reservists, territorial or local forces who would join a fortress on mobilization. The effect is, that in our home defences the peace establishment of R.E. (permanent forces) is comparatively small and in fact provides for little more than a skeleton round which the engineer organization for war can be built up. But at most foreign stations the local forces are either small in numbers or deficient in quality, so that the number of permanent R.E. approximates to the total of the war garrison.

This difference between home and foreign establishments has very considerable effect on the system of training to be followed.

Although all the N.C.O. and men in the fortress service are on one roster for promotion and drafting, they comprise two distinct classes, those specially trained in "coast defence" duties and others not so trained who are called the *personnel* for "works." The first class, who are the successors of the old Submarine Mining Service, are specially trained in working the electric lights and telephones and include a large number of men with high qualifications as tradesmen. The others are men of general trades, identical in training and qualifications with the *personnel* of the R.E. field companies except that they have no experience of mounted duties.

The works *personnel* comprise men of general trades in a proportion which is fairly uniform for all stations with a margin of about 10 per cent. of "unallotted" trades to allow of the provision of any special trades which may be required to suit the needs of any particular station; trades which come under this heading are printers, surveyors, sawyers, extra masons in a stone country and so on. The numbers of the works *personnel* vary with the size and importance of the fortress, but generally they should bear a definite proportion to the infantry garrison. Our present proportion abroad is between three and four R.E. to every 100 infantry.

The coast defence *personnel* in addition to the specialists—electricians, engine drivers, telephonists and instrument repairers—includes a number of men of general trades with a margin of "unallotted." All are, however, trained in "coast defence" duties, that is the simpler duties connected with lights and telephones, and those of general trades are employed in war in the less important duties. The establishment of coast defence *personnel* depends on the actual number of lights and telephones in each fortress.

Organization of Military Units.—At the same time as the establishments were brought into line with war requirements, certain new principles of the organization of R.E. work were introduced. Taking the military organization first, the changes consisted in

1. Forming the R.E. in a command into a few "large companies."
2. Posting as far as possible all R.E. officers under the rank of lieut.-colonel to companies.

Under the previous organization the R.E. for mines and lights had been very completely localized, but the R.E. works service was still organized in small companies, generally of a strength of 93 N.C.O. and men,* commanded by a captain with two subalterns. Any other R.E. officers in a fortress, including all majors, were not posted to a company and took only a small part in the military training of the command.

Under the new organization there is in a typical fortress of moderate size only one R.E. unit to which all officers and men belong. But when the numbers exceed a total of about 200, one unit would be too clumsy and then two units are formed, one for the N.C.O. and men trained in coast defence duties and one for the remainder. This latter form of organization exists at Malta and Hong Kong abroad, and Portsmouth and Plymouth at home. Gibraltar is an exception as it retains its old organization into four small companies, two for coast defence duties and two for works *personnel*. This exception was made mainly for sentimental reasons. In some commands at home, the R.E. at several small fortresses in the same command are grouped to form one unit.

The advantages of this organization into large companies may be stated as :—

1. Better training for all officers, especially of the rank of major.
2. Reduction of company staffs, fewer clothing accounts, etc.
3. Facility of transferring men within a command from one duty to another.
4. More equal appointment to lance rank and promotion of N.C.O. This is often unsatisfactory when units are very small.

It must be observed that this organization involves one peculiarity

* I have never found out how this figure of 93 was arrived at. It was most probably a subdivision of some older organization.

in that the " unit " is an administrative entity only and *not* a fighting organism. In war the R.E. in a fortress necessarily work in a number of detachments of various size, while even in peace it is seldom possible to keep all the R.E. in one barracks, as detachments must be placed in the outlying portions of a fortress for the care of electric lights or for works.

It follows from this that there is seldom any advantage in assembling the whole of one company for training in its war duties, as such duties can be equally well practised by portions of a unit such as a half-company, section, or group of detachments, subject to certain conditions as regards numbers which I have discussed later on.

Command of Companies.—One of the objections urged against the system of large companies is that the major commanding will be so overwhelmed with the details of the company that he will have no time for other work. The answer to this lies in a proper devolution of responsibility as to which I have found some doubt to exist.

Speaking generally the whole military organization depends on a devolution of responsibility from the C.-in-C. downwards, and each link in the chain acts under the authority deputed to him by his immediate superior. Some of the duties to be thus deputed are laid down in regulations, but others are left to the discretion of individuals. There is then no reason why the major should personally superintend all details, thus, he can allot the charge of clothing to one officer, that of the pay accounts to another and so on, retaining only general supervision and such a devolution would be entirely in accord with military principles.

The application of the principle depends on local conditions ; it will be best illustrated by a description of the actual distribution of responsibility as it was worked out at Malta. At this station there are two large companies each commanded by a major. The conditions of work and the size of the available barracks made it necessary to make large detachments from both companies, and to station these detachments in three outlying divisions. The headquarters and about half of each company were stationed together in a central position. These half-companies at headquarters and the three detachments were each placed under the command of a captain and all five captains were given full responsibility for the command and local administration of their half-company or detachment. In addition the captains at headquarters were placed in charge of the pay accounts, clothing and equipment of their respective companies. The two majors had each important works duties and retained under their immediate control such general questions as the distribution of N.C.O. and men between headquarters and detachments, confidential reports, training and reports on training, and any question affecting their companies which had to be referred

to higher authority. They also shared the barrack duties performed by the senior major of an infantry battalion.

It will be seen that under this system the captain's command was the local unit for all purposes and was treated as the unit in arranging training programmes and on ceremonial parades.

Malta is of course an exceptionally large station, but I commend to the notice of all officers serving in a unit, either in peace or war, which is large enough to have a major and a captain, the principle that the major should carry out what I may call the "General Staff" side of the duties such as training and technical work, delegating to his captain the "administrative" duties, such as pay, food, clothing, etc.

Establishment for Engineer Services.—So far I have not referred to the military portion of the Establishment for Engineer Services. This consists of a group of W.O. and senior N.C.O. selected for special technical duty and subdivided into four main classes (1) clerks and draughtsmen, (2) storekeepers, (3) mechanists, (4) foremen of works.

The first two classes require no comment; they will be fully employed in time of war on the same duties as in peace. The position of mechanists also is fairly well defined, they have definite duties in peace and war and they take part in all the technical work and training of the R.E. according to their qualifications in charge of groups of lights, engines or telephones.

A change of organization was made about 1905 in the amalgamation of various separate groups of mechanists, so as to form one single group for all electrical duties and another group for all machinery duties. Thus an electrician mechanist should be able to supervise any electrical work whether connected with defence lights, barrack lighting, electric power, or telephones, while a machinery mechanist should be able to erect and look after any class of machinery which is likely to be met with in R.E. charge. For instance, it should no longer be necessary, as was done in the past, to erect defence engines by a special machinery branch and then hand them over to be worked by the officers and mechanists in charge of the defence electric lights. This change makes it easier to detail mechanists to divisions.

But while the position of mechanists in war is thus clearly defined, the position of foremen of works is not. Most officers, I find, consider these as essentially a part of the peace organization only and look on a foreman of works as an individual with an extraordinary knowledge of the schedule, whose primary duty is to engage in a perennial battle with the triennial and other contractors. They therefore assume that the foremen will continue in war their special peace duties. Foremen of works thus receive no military form of training and are hardly taken into account in defence schemes. Possibly one reason for this is that they are as a class decidedly

overworked, so that any idea of employing them on military duties has dropped.

But on the other hand, foremen of works do perform considerable military work in peace time in the construction of fortifications, military roads, and semi-permanent defences on the land fronts. Also they have very considerable technical knowledge of the strength of materials and experience of the supervision of labour. It seems obviously desirable to use this knowledge both in the supervision of work in war and in teaching junior ranks how to make the best use of material.

I am certain also that with the field army there will be a great demand for the services of this valuable class, on the line of communications, at sieges and whenever large works, such as hutting, the preparation of a defensive position, or the repair of a large bridge, have to be undertaken for the field army.

I suggest therefore that all foremen of works should be given some form of military training, such as by attaching them every second or third year to a company while going through a course of fieldworks, but this is only possible if some relaxation can be made in their works duties.

The command of this establishment is often a difficult point and in many places it is still customary to put them under the command of a special officer and to keep separate pay lists, clothing accounts, etc., for this staff. Not only do these little accounts give an amount of trouble quite out of proportion to the numbers involved, but this arrangement establishes a line of demarcation between this staff and the units which it is very desirable to avoid. The best solution in my opinion, and one which I have carried into practice at two foreign stations, is to attach the members of this staff to the company with which they generally work and live. They are then looked after as an integral part of the unit, separate accounts are saved and their position as a definite part of the military organization is emphasized.

Organization for Works.—The organization for works is a very large question, and I only propose to deal with it here so far as it bears on the military organization and training of the R.E.

The principal change introduced into the works organization in 1905 was in the formation of what I may call "Large Divisions." Prior to this date the custom had been to make as many divisions as there were officers, and I believe there were at one time in Malta as many as twelve divisions. It was of course impossible under such an organization to allot a proper office staff to each division, and I have known cases under the old system where three division officers shared one clerk, while I had personal experience of an instance where three division officers shared the services of one foreman of works. Under the old system there was also the

absurdity that majors and subalterns were often treated as interchangeable for division purposes.

Under the system of "Large Divisions," each division is in charge of a senior officer—major or captain—with one or more subalterns as assistants, and each has a complete organization of office staff and of foremen of works, and mechanists for the work of the division. This organization also fits in with the military organization outlined above, as to each division there can be allotted a detachment (or local unit) which will be commanded by the division officer.

Further, the principle should be enforced that, in addition to the military command and building work, the division officer should be held responsible for all the regular engineer work in his division such as charge of lights and engines, pumping plant, workshops, power stations or command telephone lines. But this work can only be done if there is a proper devolution of duties, both military and technical, to subalterns and subordinate staff.

In making up detachments, it is obviously best to allot men trained in coast defence work to divisions which include sea defences and lights, and to allot the works personal to divisions which include the land fronts of a fortress.

It is sometimes urged that the coast defence *personnel* are so fully employed in their special duties that they have no time to spend on works. This may be the case in some stations at home, but at all stations abroad the peace establishment is nearly the same as the war establishment, and it should be possible to employ a good number of men on works in the fortifications and barracks in the neighbourhood of their lights. In war time the numbers are sufficient to provide two reliefs, each relief being on duty for half the night. While night work involves a considerable strain when continued for some time, it does not preclude some work during the day, in fact such work gives useful occupation. I think therefore that the electric *personnel* can fairly be required to superintend all the special works, such as extra obstacles, preparation of parapets and similar services which have to be undertaken on the sea fronts of our fortresses in war time, and can also with civilian assistance carry out the minor maintenance of the forts and the buildings in or near the forts in which their lights are situated. They cannot however undertake the execution of works on land fronts at a distance from their lights.

A mistake is often made as regards the work of officers in electric light units in war. It is no part of the duties of such officers to themselves work directing handles, open or close switches or attend to telephones. Unless specially detailed in charge of a look-out post or acting as the senior R.E. officer of a fire command, the duties are those of a superintendent. They are responsible that their lights and everything connected with them are in thorough working order and that the arrangements for the supply of fuel and stores

are complete, and also for the distribution to work, discipline and interior economy of the detachments under them. They should be present when lights are first started, and see that everyone is at their post and that all communications are in working order. If everything is correct it is then best to " leave well alone." The executive orders to the directors of moving lights are given by the officer or N.C.O. in charge of the look-out station, in the case of observation lights, and by the artillery officer in charge, in the case of fighting lights. Under this general procedure there should be no difficulty in electric light officers supervising works services in the neighbourhood of their lights.

Workshops.—The question of workshops deserves a short notice as it affects considerably the individual training and the peace and war distribution of the R.E.

Speaking strictly, a workshop is any building where stores and tools are brought together and manual work is done. Shops of this nature —which may be called hand workshops—are required by each group of workmen. Thus a small workshop is usually provided in each engine room for carrying out minor repairs and several groups of shops for carpenters, smiths and painters, etc., are required in any large division. Some of these may be supplied with one or more mechanical tools such as a power lathe, but it is generally more economical to arrange one set of shops in a central position fitted with machine tools, as this simplifies the provision of power, and the supervision of work. Such shops are called " central workshops."

At most coast fortresses the nucleus of such a shop already exists for the repair of electric light plant and electrical instruments. Some extension of this shop, such as the provision of a moulding plant and a heavy hammer, will make it an efficient central shop able to carry out any machinery repairs throughout the fortress. To this should be added a wood-working shop with sawyer's bench and machine tools, and the whole will then form a group of central shops.

In deciding what shops should be provided for the R.E. it is necessary to consider what other shops exist in charge of the Artillery, A.S.C. or A.O.C. It is desirable to avoid overlapping so as to ensure economical use of tools; on the other hand over-centralization involves loss of time and expense for transport of materials and articles to or from the central shops. Much of the work also is of a special nature. This applies to all the shops dealing with ordnance, and to such special work as the repair of barrack furniture or the wheelers' shop in fortresses which is concerned mainly with transport vehicles. Such special shops must of course be left in charge of their special corps.

The best general distribution of workshop duties is for the R.E. shops to be equipped to carry out all the heavier work of the fortress, such as castings, forgings, large repairs or renewals of machinery,

leaving special work to be done by the corps concerned. The R.E. shops will also do all the work required in connection with engineer services and all repairs to electrical instruments.

The organization of the workshops should be on a military basis, the men of the R.E. employed in the shop forming a section or sections of a company and working under their own N.C.O.; but in addition there should be sufficient permanently employed civilians to ensure continuous work in the shops when the R.E. are withdrawn for training or military duties. All issues of tools should be treated as shop equipment, and issues should only be made to individuals from the shops. The practice of issuing tools direct from store to individual tradesmen is a fruitful source of loss, courts of enquiry and store troubles of all kinds.

In war time the R.E. shops will be very fully employed in preparing material for the fieldworks to be constructed on mobilization, such as shelters or obstacles. Most of the R.E. must, however, be withdrawn from the shops for work on lights or in the field. It is thus necessary to arrange to engage extra civilian labour on mobilization to ensure this work is not delayed. The electrical instrument repairing shop will be especially busy during war on account of the increased wear and tear on all the electrical plant. The staff of this shop cannot be reduced on mobilization and it is not easy to obtain qualified civilian labour.

O.C.E.L. and I.R.E.M.—A few words must be said for the position in our organization of the officers who are called "Officer in Charge Electric Lights and Telephones" or O.C.E.L. and the "Inspector of R.E. Machinery" or I.R.E.M. The latter is now purely an inspecting officer and has ordinarily no responsibility for the erection or working of machinery. His duties are to carry out certain tests of machinery on first erection and at periodical intervals, and to assist C.R.E. and D.O. with advice on machinery questions. He is assisted in carrying out his inspections by one or more mechanists. Except in some of the larger stations the duties of inspection do not take all his time, and the I.R.E.M. is then available to be employed as any other R.E. officer on duties such as charge of a division and in military duty with a company. The staff of the I.R.E.M. can also be employed in such duties as charge of a group of defence engines.

The O.C.E.L. combines the duties of an inspecting officer with that of an executive officer for certain electrical services. His inspection duties include the inspection of all defence lights and telephone services whether directly under him or under division officers. He is usually the commanding officer of the electric light company, in which case he is also responsible for the general distribution of men for light and telephone duties. His executive duties are mainly in connection with telephones as the administrative telephone service of a fortress cannot be subdivided and must be dealt with as a whole.

It is advisable, however, that all telephone work involving alterations to buildings or fortifications should be done by division officers, and personally I think the best distribution of telephone duties is to make the D.O. responsible for all command lines in his area, leaving the administrative telephone system and main trunk lines under the O.C.E.L.

The O.C.E.L. used to be responsible for the stores for E.L. and telephone services, but since the formation of the central store system this responsibility devolves on the O.C. Stores. D.O.'s should correspond direct with O.C. Stores on all store questions, including stores required for electric lights and telephones on their charge.

In addition to his telephone work the O.C.E.L. may have direct charge of any movable or reserve lights. At a small station he may be a division officer.

Employment of Junior Officers.—Under the above system of organization it is contemplated that all officers below the rank of captain will be employed as assistants either to a D.O. or to the O.C.E.L. They should be given a definite charge such as the supervision of a portion of a division, or the execution of special services. Their work should be mainly executive as distinct from office work, but they must of course learn the office duties, and they will have opportunities of acting in charge of a division during the leave season.

Summary.—From the above it will be seen that the system of organization I recommend may be applied as follows :—

1. Work out the war distribution both as regards duties and numbers and allot officers, mechanists, foremen and other ranks according to the work to be done.

2. Subdivide the works services into a few large divisions following as closely as possible the war organization of the fortress.

3. Allot officers and men for special duties in the C.E. or C.R.E. Offices, under O.C.E.L., or in central workshops. Then allot the remainder to divisions following as closely as possible the probable distribution for war.

4. Arrange the interior economy of the company or companies, so that the officers and men allotted to a division form a distinct half-company, section or sub-section. Each divisional group will then constitute a local unit. It is not necessary that the sections shall be uniform in size or that each division shall have an equal number. A division with a small military section will make more use of civil labour and *vice versâ*.

Of course in applying the above rules, due account must be taken of local conditions. The organization recommended is not likely to be exactly applicable at any one fortress, but by establishing what may be an ideal organization we get an outline into which local conditions can be applied.

TRAINING.

The training of the R.E. may be considered under the following heads, but it must not be supposed that the table is arranged in order of importance.

Engineer Training.—That is training special to R.E.

1. Technical training for electric light and telephone duties.
2. Training in "Works."
3. Training in "Fieldworks."

Military Training.—That is training which the R.E. share with other arms. *Engineer Training*, Sect. 15 (i.).

4. Drill and field training as an infantry company.
5. Musketry, visual training and ranging.
6. Signalling.
7. Engineer reconnaissance and map reading.

Standard to be Reached.—Before making some remarks on the details of the above, it is desirable to say a few words as to the standard required in any subject, as it is obvious that this standard cannot be the same for all arms or for all branches of a technical arm like the R.E. An example of this occurs in the *Musketry Regulations* where the training and classification of the R.E. and infantry is identical for the individual range practices up to 600 yards. But the training of the R.E. in the application of fire is limited to a small number of field practices all at comparatively short ranges.

In the same way, though engineer fortress companies are trained in drill and field training as an infantry company, it is not to be expected that they will reach the same standard. Indeed this is not necessary as an infantry company is being trained to take its place in a larger unit—the battalion—while an engineer fortress company will rarely fight even as a single unit, but more often as several separate sections or detachments. Similarly, I think it is unreasonable to expect from a company trained to coast defence duties, the same standard of efficiency in fieldworks and field duties as a works company.

When it is necessary to restrict a course or reduce the standard in any way, the safe rule is to make the reduction in the more difficult collective training. A man who has a thorough grounding in details can always be usefully employed but is of little use without that grounding.

General Arrangement of Training.—Training should be continuous throughout the whole twelve months of the year, but the actual dates for the different portions vary at stations abroad. The year is divided by regulation into two main portions for individual and collective training respectively—*Engineer Training*, Sect. 2 (i.), and

the latter is divided into three portions—*Engineer Training*, Sect. 10 (i.), for (1) military training such as drill and musketry; (2) special technical instruction, such as fieldworks, or electric light running; (3) combined operations with other arms, and all these stages have to be considered for each of the seven subheads into which I have divided training above. It is, however, laid down in several places in regulations that there is no hard-and-fast line between the stages, and that individual training and the simple forms of collective training can be carried on throughout the year as may be convenient, in the intervals of other work. All forms of training must be practised by night as well as by day.

The number of subjects to be taught and this subdivision of the year may make the preparation of a programme seem a very complicated proceeding, but it must be remembered that in every system of education it is customary to include several subjects in any curriculum, to take several subjects in one day and to fix the time to be given to any subject by a detailed programme, or time table, prepared for some weeks in advance.

We may now consider the different forms of training in more detail.

Electric Light Duties.—The electric light training is divided into three portions, (1) an individual training spread over the whole year referred to in the footnote to Sect. 15, *Engineer Training;* (2) collective training at weekly practices; (3) combined training with other arms during an annual training of 12 days. The weekly running is largely used for night practice by the artillery, and their convenience must be considered in arranging dates. Some running is also required for practising the R.E., testing engines, etc., and on such occasions no attempt should be made to combine with other corps or instruction will suffer.

The annual 12 days running must be carried out when the full war manning is available, that is when any local forces are up for training, and must also if possible include the annual mobilization of the fortress. It is intended to act as a test of the efficiency of the machinery, and also accustom all ranks to the conditions which will prevail in war. All observing posts and artillery fighting posts should be manned during this training.

Some representation of fighting vessels is essential for a useful practice with electric lights, as the effect of the lighting cannot be properly observed by the illumination of the water only.

Telephone Duties.—Training in telephone duties is carried out by the necessary work in connection with the administrative telephone system. Command telephones are manned at the weekly practices and annual manning. It must be remembered that all men trained in coast defence duties should be practised both with lights and telephones. This can be arranged by an interchange of duties during

the first part of the collective training. R.E. officers not trained for electrical duties should be given an opportunity of learning the general principles of working both lights and telephones.

Works.—The method of training in works is by employment on actual work in connection with forts, barracks, etc. This has been already dealt with at some length. The only training question to be kept in mind is that the junior officers should be given an opportunity of getting experience of all the different branches of work. This can be best effected by some rearrangement of duties annually, after the leave season.

Fieldworks.—It is laid down in *Engineer Training* that instruction in this subject shall be by an annual course lasting six weeks at which the whole unit should if possible be present. During this six weeks the whole of the *Manual of Military Engineering* has to be practised and at the end a special report has to be rendered to the War Office. I venture to think that this form of training is rather out of date and certainly not well adapted to the conditions of work of a fortress company.

In the first place, the concentration of any form of training into a continuous course is a departure from the principle, now adopted in all other subjects, of a progressive training commencing with the individual and culminating with combined practice with other arms. A "course" is apt to degenerate into a form of cramming, and the course once over the knowledge gained is quickly forgotten. In the second place, as I have shown above, the company in a fortress is rarely the fighting unit, and it is very inconvenient to stop all other work so that a whole company may go through the course simultaneously.

I suggest therefore that the training in this branch of work would benefit if it were spread over the year in the same way as drill is now taught. Instead of a cram, the practice of fieldworks would then become a habit just as drill is at present. There are many parts of the course of fieldworks, such as field geometry, knots, gabions and brushwood work, which are preliminary to combined work and can be taught to individuals or small squads in the neighbourhood of the barracks. Other portions as mining, hasty field defences, demolitions, railways or simple forms of work with spars, can also be practised by small parties, while the amount of special stores available in a fortress for bridging is insufficient to practise more than about 80 to 100 men at one time.

The usual difficulties urged against a distribution of this instruction over the year are the difficulty of getting tools and materials and of obtaining ground for practice. In most of our fortresses, however, there are old forts, whose ditches give excellent opportunities for practising bridging and whose glacis provide excellent digging ground for elementary instruction. As regards tools and materials,—under

the system which has now been in force for some years, consumable stores including explosives are issued on an annual allowance which can be drawn at any time, and in any portions convenient for work; ordinary digging tools can be drawn at any time and in any quantity required; special tools such as saws can be drawn from the R.E. workshops, timber for bridging or fieldworks can be drawn from the special stock held in R.E. custody; in fact the only stores on which there is any restriction are cordage for bridging and the railway stores.

The arrangement I suggest for this training is to divide the course into three parts, (1) individual training carried out in one or two hours each week during the first part of the training year and in the intervals of other training—the exercises described in *Engineer Training*, Sect. 8 (3), can be combined with this training—(2) a course of about a fortnight devoted to bridging, partly over water and partly over land, carried out by half-companies or portions of a unit not exceeding 100 men at a time; (3) a fieldworks camp of two or three weeks during which actual work is performed as part of a tactical scheme; unless the digging ground is extensive it is not desirable to put more than about 100 men in one camp. Some transport for tools should be provided, and during this period subalterns can be sent out in charge of a section to carry out some scheme at a distance from headquarters.

The training should culminate in some form of combined manœuvres with other arms, in which actual work should be done by the R.E. in combination with infantry. Such schemes might deal with siege operations, or seizure and fortification of a position, or passing a force of all arms across a stream or arm of the harbour. Such schemes want considerable preparation in the collection of stores and hiring of ground and must of course be worked out with the General Staff of the fortress.

With the permission of the War Office we have actually tried a subdivision of the course at Malta for the last three years, and I am satisfied that better results were obtained than with the old system of a concentrated course.

There is one further point connected with this course which deserves comment and that is the combination of useful work with training. This means that certain works services in connection with the fortifications or the preparation of positions on the land fronts are set aside for execution during the annual course of fieldworks.

The advantages claimed for this are :—

1. Men take more interest in the execution of something of a useful nature and the time and labour required for demolition is saved.

2. More materials are available for actual work than can possibly be obtained for purely training purposes.

3. There is an economy in utilizing the labour which is otherwise wasted during the training period.

On the other hand there are serious objections to attempting to combine training and practical work in this way, which in my opinion more than balance the advantages.

1. In order to assemble even a part of a company for training, arrangements have to be made to take men engaged in special employments, as clerks, draughtsmen, surveyors, photographers or trades special to electric light or telephone work. During their absence their special work remains in abeyance. It is desirable therefore not to extend the course unnecessarily.

2. A considerable number of different subjects have to be practised during the time allotted for training. Appendix I., *Engineer Training*, details 39 subheads of instruction which have to be disposed of in about six weeks of six working days a week. The time for each subject is thus short.

3. Any work of a practical nature usually includes the repetition many times over of the same operation, and also includes a good deal of purely fatigue labour for the handling of stores or large earth movements. It thus takes a considerable time to complete, and this time can seldom be spared during the period allotted for training without adversely affecting instruction on other subjects.

On the whole, I suggest as the result of experience that the time set apart for training is best expended in studying those parts of the *Manual of Military Engineering* which do *not* form part of the ordinary work of the Engineers in a fortress, and that actual work should only be done during training to a very limited extent. For instance, I have known a half-company giving up two out of the three weeks of the annual camp to the construction of a length of military road, to the exclusion of other branches of work, or spending a week or ten days in mixing and laying concrete for a gun position. Such work may quite properly be done by military labour but it could equally well be done during any other time of the year.

To illustrate my proposal I may take the case of a military road involving the selection of a track, two or three culverts over small water courses, some blasting, and the formation of the surface for (say) half a mile. The following might be done during the training,—the line of road could be laid out, a small portion including one culvert and a little blasting could be prepared up to formation level, and a part of this again completed with road material. This would be ample for instructional purposes. The road would then be completed after the training by any of the usual works methods. Or again a length of wire entanglement of 200 or 300 yards is required round the gorge of a fort, with holdfasts partly in rock. This is too big a job to be carried out as a whole, but a small portion may usefully be left for execution by parties under training.

Drill and Field Training.—This is adequately carried out at present by allotting a certain amount of time each week throughout the year, and calls for no special comment.

Musketry, Visual Training and Ranging.—This is provided for in two ways, first by the allotment of certain days throughout the year for practice in judging distance and firing on the miniature and 30-yard ranges, and secondly by courses of firing on the full size ranges. The arrangement for these latter depend on the position of the ranges with reference to barracks, and the extent to which they are required for other corps. There is, however, no necessity to assemble a whole company for this training at one time, provided that all shoot at about the same time of the year, so as to equalize the conditions for the coveted marksmen's badges. A half-company is a convenient unit for this course. As ammunition is limited, musketry training should always be carried out very carefully and deliberately.

The habit of fire use and control can be acquired by always including some fire practice in every military exercise. Thus a route march becomes interesting if it has for its object the seizure and occupation of some defile or railway crossing, or parties at fieldworks can be attacked by a few men while at work, or a company drill on the barrack square can end by a manning of the boundary wall.

Signalling.—Engineer Reconnaissance and Map Reading.—These subjects though shown under collective training require mainly individual instruction and are best taught by weekly or monthly practices throughout the year.

As regards signalling I would express my regret that a knowledge of the Morse Alphabet should be entirely dropped. It has some advantages over semaphore as it can be used from a moving boat and under other circumstances where semaphore is unsuitable. It can also be used at night, with lamps, should telephone communication not be available, as for instance in directing mobile lights from a distance. Also simple telegraphic messages can be sent on a telephone by the Morse Alphabet when speaking is difficult. Both Morse and semaphore can be taught without flags or special appliances.

Arrangement of Training Programme.—The training year usually commences at the beginning of the leave or furlough season, which is fixed at the time of year least suitable for military work. Thus at home the training year begins on 1st November and ends on 31st October,—*Engineer Training*, Sects. 10 (1) and 8 (1)—the four winter months constituting the leave season for R.E. Abroad, the training year is fixed by the general officer commanding to suit local conditions, and in tropical and semi-tropical stations the leave season is in the summer or hottest time of the year. In arranging the training programme in such places climate must be considered, as this affects not only the time of year any particular training can be carried out but the amount of work which can be done in a day.

At some stations a system prevails during the hot season of restricting parades and work to the early morning or late evening, but the standing order that Engineers should average eight hours' work a day throughout the year, usually requires longer working hours. My experience at three hot stations—Mauritius, Hong Kong, and Malta—has convinced me that the important factors for health are (1) adequate cover for the head and body when exposed to the sun ; (2) regular meals and sufficient time to eat them ; (3) sufficient time for ablutions, etc., especially on first rising ; (4) regular work or employment without overstrain. If these conditions are complied with, a good day's work can be done in the hottest weather. In fact, the early parades are rather harmful than otherwise, as they interfere with the breakfast meal. Whenever I have been able to apply my principle of a moderate working day, I have found the health report of the R.E. compared very favourably with that of the rest of the garrison.

In addition to climate there are other points to be considered. There are first of all the fixed dates of holidays and festivals, such as Xmas, Easter, King's Birthday and others. It is obviously undesirable for instance for Easter to come in the middle of the musketry course.

Next there is the trooping season with the arrival and departure of drafts. This always throws much extra work on the company staff for two or three weeks before the departure or after the arrival of a draft. At foreign stations where drafts are received at one or two fixed times of the year it is not desirable to put men through courses for the last few months of their tour, while newly arrived men should be instructed in local conditions as soon after arrival as possible.

The principal difficulties to be met are, however, those connected with the programme of works, which I have already referred to and which are due to the limitations of the financial year which runs from 1st April to 31st March at all stations. Under our system of financial control by Parliament the expenditure of each year is supposed to be complete in itself, so that in theory any " works " service should be begun and ended within the limits of one financial year.

Before work can be begun it is necessary to prepare detailed plans and to obtain the stores required, and at foreign stations many of such stores must be obtained from England. Plans and lists of stores can be prepared in anticipation in the previous financial year and the lists sent home, but the orders for the stores cannot be placed in England till funds are actually allotted at the beginning of a financial year, and the stores have then to be manufactured, inspected and shipped out to the station. The result of this is that most of the works services at foreign stations cannot be begun till about October or even later, so that during the last half of the year there

is much greater demand for officers and men for works than in the first half. Further, the bills for work done are necessarily deferred till the end of the year, and this causes a very heavy strain on officers and office staff during the last few weeks, that is from the middle of February to the third week in March.

At home stations there is also this accumulation of work but not to the same extent. At home stations, the dates of the training and working year fit in very conveniently, as the period of greatest work falls in the leave season, which is also the trooping season. It is thus comparatively easy to assemble men for training during the summer months.

But abroad in the north hemisphere the leave season falls in the first part of the financial year, while the winter which is the best time for training, is also the busiest time for works and is the trooping season. It is advisable therefore in making out the works programme for the year, to arrange that work to be executed by R.E. labour should be begun early in the year. It is also desirable that the regular courses should be begun early and be carried out by half-companies or even smaller units so as to disturb the works organization as little as possible. I have already shown that such a subdivision of units for training purposes will give a better training than the system of collecting the whole of a company for a course, but it spreads the period of training over a larger part of the year.

The arrangement of the weekly drills and practices requires a little consideration. Some time every week should be devoted to steady parade drill, and this is usually given the first hour of one morning in the week. In addition we allotted the whole of Saturday up to 1 p.m. as the time for the weekly training. This time should be divided up in a regular time table prepared monthly by the company officers and so arranged as to include some of all the different subjects each month. If my suggestion to spread the field-work course over the year is adopted, it might be desirable to allot the first hour on another morning in the week to military subjects, such as knotting or signalling.

I may illustrate my proposals by an actual distribution of a training programme as it was carried out at Malta.

15th June to 15th October.—Individual Training.—Leave season for officers in two portions, furlough season for N.C.O. and men. Weekly drills and practices and electric light running. Detachments in camp for minor military works. The principal drafts from England usually arrive in September.

15th October to 15th December.—Bridging Courses.—A fortnight each carried out by one half-company at a time. Four courses in all, the coast defence company first.

15th November to 31st March.—Electric Light.—Practice in conjunction with artillery training, E.L. running on one or more nights

each week, the annual 12 days manning taking place in February or March to coincide with the battle practice of the artillery. The local E.L. militia begin recruit training about 15th December and the whole corps come up for training from 15th February to 15th April.

During this period all R.E. officers can be trained in regimental exercises and schemes. The works company are also available for combined exercises and manœuvres with infantry on the land fronts.

1st to 30th April.—Musketry Courses.—By half-companies, one half of each company firing simultaneously. The Militia fire a course during the first fortnight.

1st May to 15th June.—Garrison Manning and Manœuvres and Fieldwork Camp.—The actual details depend on the command arrangements for manœuvres, which are again dependent on naval movements. During this period employment on works should be reduced to a minimum. Fieldwork camps can be formed by companies or half-companies as may be most convenient.

All the above dates are approximate, they vary a few days from year to year to suit the incidence of Easter and other holidays, and according to the days of the month on which Sunday falls. I do not suggest that the above is an ideal programme but it was at least a practicable one. But such a course of training is only possible if all ranks are sufficiently zealous to make full use of their opportunities. In conclusion I would add one word of warning which I have often given to individuals, both officers and N.C.O.'s, and that is "You cannot teach anything until you have first learnt it." All officers and N.C.O.'s should therefore carefully study their text books and regulations before trying to teach their juniors, and if necessary preliminary lectures should be arranged before the commencement of the practical work.

THE RÔLE OF HEAVY ARTILLERY ON THE MODERN BATTLEFIELD.

A Lecture delivered at the School of Military Engineering by MAJOR R. O. MARTON, D.S.O., R.G.A.

I THINK that it would perhaps be well to commence the review of this subject with a consideration of what is meant exactly by heavy artillery. It may appear strange that such a consideration should be at all necessary, but even amongst artillery officers the term "heavy artillery" has been employed somewhat loosely to signify anything from a 4-in. gun to an 11-in. mortar, and thus frequently has caused a certain confusion of thought. I will ask you therefore to bear always in mind the official nomenclature as given in war establishments. Firstly, "A heavy battery and ammunition column" is an integral part of a division; it is armed with 60-pr. guns of 5-in. calibre, and is the only kind of "heavy artillery" which normally belongs to the field army. In addition to the normal establishment there are "units which may be required with, but do not normally form part of, the field army," and amongst these are given the establishments of

(2). A siege artillery brigade (medium).
(3). A siege artillery brigade (heavy).

When quoting from British official works, we must remember therefore that heavy artillery is confined to the 60-pr. batteries.

As the *rôle* that any weapon has to play in the field must necessarily depend on its capabilities, which in turn are designed to fulfil certain requirements, it cannot fail to be of interest to study the reasons which have influenced our choice of weapon or nature of weapon, and whether other nations have been influenced by the same reasons to a similar choice; or, if any divergence of opinion exists, the arguments in support of either side. The choice I have just mentioned refers of course to the necessity of coming to a decision as to what change or extension of artillery weapons should be made to keep level with the altered conditions of modern warfare. A variety of scientific and other causes have contributed to modify the tactics of arms other than artillery, and as artillery is the servant of the other arms, modification became necessary to keep an efficient artillery. Now power and mobility are both essential to an efficient artillery, but each is directly antagonistic to the other. One of the

chief problems is to determine the proper mixture of power and mobility most suitable to the normal condition of warfare. It is obvious, and the point was brought home to us very earnestly in the South African War, that the greater the power the better, provided that a certain standard of mobility was maintained. So far there has been no divergence of opinion, and all civilized nations have added to their establishments weapons that are described as "heavy artillery," or weapons heavier than their field artillery which were weapons combining as great a power as was then imagined possible with the standard of mobility that was considered necessary for them.

With the choice of nature of weapon, however, the divergence of opinion commences, and, to put the matter briefly, we have decided on possessing a gun whereas all other countries have decided in favour of a howitzer. This divergence of opinion does not only exist between ourselves and other nations, but is to be found amongst ourselves without reference to other people, and has formed the theme of much discussion in the last few years. Three schools of thought may be said to exist viz. :—

Those who favour the gun.
Those who favour the howitzer.
Those who favour the possession of both.
(This latter to perhaps a minor degree).

The arguments in favour of each are many and strong, and I should not have the time to attempt to examine them all, or nearly all. Just to mention some of the main arguments may not be out of place, nor without interest in considering this subject. The chief argument in favour of the gun lies in its undoubted superiority as a shrapnel weapon as compared with a howitzer, and our existing 60-pr. can produce thoroughly effective fire of this nature up to 9,500 yards.

In this connection, however, it must be noted that the nations who have adopted the heavy howitzer in preference to the heavy gun, do not attempt to fire shrapnel from their howitzers, but only high explosive shell which they claim will destroy any nature of target. Against the introduction of a heavy howitzer it is also claimed that we already possess a howitzer, our present field howitzer, which will do all that is required from this nature of fire. It certainly is a powerful Q.F. howitzer firing shrapnel and H.E. shell of between 35 and 40 lbs. weight up to a range of over 7,000 yards. As regards weight of equipment and weight behind the team if horse transport is used, the gun is at a disadvantage compared with the howitzer. Comparing our 60-pr. gun with the German howitzer (5·9 in.) we have 108 cwt. as against their 59 cwt. behind the team of eight horses. Indeed the French claim that 11 cwt. per horse is the maximum weight that should be considered for continuous work on a campaign. This makes our 13½ cwt. per horse excessive, if judged by that standard.

I have heard it stated, and it certainly is a very strong form of indirect argument, that one reason why we should include a heavy howitzer in our equipment, either in place of, or extra to, our present gun, is that we should then be armed in a similar manner to any possible foe we might be at war with. It does not follow that we should be at a disadvantage because we were differently armed, but judging by history it does frequently appear that one side will imagine itself to be at a disadvantage if the other side possesses some weapon of a different nature or strength. There is then a disposition on the part of the other to try and copy its opponent's weapon, which at the best results only in some sort of makeshift, and experience in its use has to be gained during the progress of the operations. As an instance of this, the South African War produced two examples. Firstly, we found our enemy in the possession of heavy guns to be used in the field, and we introduced our 5-in. gun on a very makeshift mounting to cope with them. The second example was the case of the 1-pr. Q.F. Maxim or pompom which we found being used against us. This was a weapon which I believe we had actually tried before the war and decided against its adoption into the Service. We considered, however, that we were at a disadvantage in not possessing it when our foe had it, and therefore introduced it during the war.

The first view was apparently the correct one, as our opinion of its value was so small that it has now been discarded again after letting our cavalry play with it for a time. As regards the introduction of a heavy howitzer in addition to our present heavy gun, there is doubtless much to be said against the further addition of complications to our equipment and ammunition columns and wheels accompanying a division unless some very well-defined object is going to be obtained by so doing. In some quarters it is maintained, however, that there is a *rôle* for both the heavy gun and heavy howitzer in addition to the field gun and field howitzer. It certainly is very possible to imagine the great effect that might be produced by heavy howitzer H.E. shell on strong field fortifications such as may well be found on modern battlefields; on defended villages such as were the case at the Battle of Mukden and which withstood the Japanese bombardments and assaults for four days successfully; on shielded batteries whose *personnel* might well be destroyed by the all-round devastating effect of the splinters of large H.E. shell detonating in a complete manner. I say that it is not only very possible to imagine these results being produced by the heavy howitzer firing H.E. shell, but also very possible to imagine that these results could not be produced as quickly or as satisfactorily, if at all, by any other form of heavy field artillery of our present equipment.

It is impossible to leave this question of gun *versus* howitzer or

both without referring to a form of heavy artillery which I mentioned at the beginning of these remarks as having a status in war establishments, but not recognized as normally forming part of the field army although it may be required to act with it. I refer to the mobile siege artillery brigade of medium howitzers. On mobilization this brigade would consist of four batteries of 6-in. B.L. howitzers with an ammunition column to each two batteries. These howitzers fire a 100-lb. H.E. shell of great power and shrapnel as well, but their maximum range is a short one.

Also, it is probably recognized universally that our 6-in. howitzer, whatever may or may not be its merits as a siege howitzer, is not the most suitable weapon to take into the modern battlefield. Its range is short, and its mounting deficient of several elements which are now regarded as essential for service in the field. In regard to this discussion on the best nature of heavy artillery for us to possess, I hope that I have put the *pros* and *cons* of the question so impartially that I have left you in complete ignorance as to what are my own personal and unimportant views on this question.

I think it will be convenient at this period to refer to what is given in our official text book (*F.A. Training*, Sec. 144) on the characteristics of "heavy artillery," which is as follows :—

"The special characteristics of heavy artillery are accurate long-range fire and great shell power, but these advantages are to a certain extent discounted by a limited mobility. The long-range fire of guns of this nature should be utilized to bring enfilade and cross fire to bear on the enemy's positions. The sites chosen for them should be such as to facilitate fire being brought to bear on as much of the ground occupied by the enemy as possible. In normal circumstances these conditions are most likely to be obtained by dispersion.

The fire of guns of this nature is of special value against shielded guns, fortified localities and buildings.

Owing to the limited mobility of these guns and the fact that they are unprovided with shields, considerable risk may be incurred without adequate compensation, if they are placed too far forward or exposed to a flank. Occasions may however occur, when to gain decisive results it will be necessary to use them in line with those of lighter calibre.

If well protected and placed on the flanks of a defensive position in an open country, their long-range fire may compel a turning movement to be made on so wide an arc, that time, valuable to the defenders, may be gained."

Thus laid down we have the principles to guide us as to the *rôle* the heavy artilleries will have to assume on the modern battlefield, and we may now proceed to examine them in detail, and, where profitable, to compare them with those of our neighbours.

(May I again just remind you that we are dealing only with the official 60-pr. batteries).

Accurate Long-Range Fire and Great Shell Power.—The 60-pr. is an extremely good shooting gun and its long range and shell power as compared with the field gun scarcely require comment, covering as it does with effective shrapnel fire with deep zones all ranges up to 9,500 yards and common H.E. shell up to 10,000 yards. A great asset to a good long-range gun which must not be overlooked, is the great accuracy and the tremendous power at the shorter ranges such as we might well be limited to in many European countries.

The loss of mobility referred to as a disadvantage to be set off against this increase of range and power is not, except for tactical reasons, as acute as might at first be imagined. Under modern conditions with the more prolonged battles, the longer intervals between them, the improved means of communications in most theatres of war, the presence of heavy artillery at the right time and place is facilitated and its comparative lack of mobility can then be eased by its tactical employment.

The long-range fire is expected to enable an enfilade or cross-fire to be brought to bear on the enemy's positions, and we see it laid down that, from any site chosen, as much as possible of the enemy's ground should be capable of being brought under fire. Dispersion of guns is suggested under normal conditions. Furthermore *Combined Training* in assigning the *rôle* to heavy artillery of supporting the firing line in the final stage of the attack, explains that the fact of "its great shell power and long range, enabling it tc bring a concentrated fire on all points selected for assault" makes this *rôle* peculiarly applicable. Now the enormous advantages of enfilade fire or even oblique fire are self-evident, but it is very open to question whether the attainment of this much-desired end will be so easy in the large majority of instances. Undoubtedly the long range does facilitate this aim, but there is a danger in too much stress being laid on this point. As General May once said in a discussion on this subject "it might result in zealous officers wasting a great deal of time in looking for positions whence they could obtain enfilade fire, when very possibly such an ideal position is not discoverable owing to lack of existence." Enfilade fire means fire from a point on, or close to, the prolongation of the enemy's line. Unless it be parallel to the enemy's line, it will not be true enfilade fire. It may be oblique fire, but it is not always easy to get even oblique fire. You no doubt can obtain enfilade fire against certain portions of the enemy's position where his line is indented or turned back, but except from a flank you cannot enfilade his position as a whole.

Now there are certain objections to placing guns of this nature too far on the flanks, at any rate in offensive operations. There is the sound principle of covering as much of the enemy's ground as possible

from the site chosen, remembering that the movement of guns once committed will not always be an easy operation, and also the limited mobility of these particular ones. Concurrence with this principle involves a much more central position and a very carefully chosen one too. In discussions on this subject, there has been disclosed a reluctance to consider the employment of such guns on the flanks where counter attacks by a vigorous enemy may be expected and where guns of greater mobility are therefore desirable. Also, for the protection of guns so placed, your line may have to be extended beyond them to such an extent as to materially upset your calculations.

So practically it boils itself down to the conclusion that for good working principles an officer seeking for a position for heavy artillery should choose one in a more or less central and well-protected position, as near in as he can get with safety, and then let him get as much enfilade, oblique or cross fire out of it afterwards as he can.

I think dispersion of guns is a natural corollary to the large extent of modern battlefields and also to the fact that we only possess one heavy battery to a division. From the conclusions arrived at as regards the position of our heavy artillery, we shall see that no special line can be taken in its *rôle* of "supporting the firing line in the final phase of the attack." The cross fire advocated in *F.A. Training*, and the enfilade fire so admirable in theory for rendering such support, will have to depend on circumstances, and perhaps as often as not this support will have to be rendered with frontal fire over the heads of our own troops. This operation which has naturally been frequently termed the most delicate one that artillery of any nature can be called upon to perform, may very often be one of peculiar difficulty for heavy artillery. It may have to be attempted at long ranges when the difficulty of keeping touch with the attacking infantry becomes greater than ever. The communication and co-operation between the infantry and artillery under such circumstances is a gigantic question. For effective observation of fire and also to watch the situation or keep in touch with the director of the operation when firing at long ranges, a battery commander or his observation officer will generally be at some considerable distance from his guns with which he will be in telephonic communication. It is open to question whether such communication, however admirably carried out, will be quick enough, and whether it would not be better for heavy artillery at this stage to cover the advance of other artillery moving up to the close support of the attack.

As an instance of the infantry point of view on this matter, a criticism made at a powwow at one of the tactical days of practice with live shell which now forms part of the training of field artillery, was rather interesting. The battery on this occasion was supporting an attack on a certain position, and to represent the final phase a row

of dummy targets was suddenly raised to show our infantry making the final assault. The battery was at some distance from the position where both the infantry and artillery officers were stationed and communication to the battery was by telephone. The battery was to be ordered to cease fire, and certainly the order to that effect was not passed as quickly as perhaps it might have been, but one could not say that there was any undue delay. The point in the criticism was that even the telephone was too slow and that instant verbal orders to stop firing would be preferable. I would mention that this was a howitzer battery firing from a covered position, and that the battery commander was necessarily therefore prevented from both observing the progress of the attack and commanding his battery by voice. To conform to the wishes of the infantry as expressed on that occasion it would have been necessary for the battery or batteries supporting the attack to have been pushed forward to very much closer ranges, or even to close behind the firing line in which task they could be covered by the fire of other batteries. Whether they could get there, or whether the 18-pr. batteries with their flat trajectories would be much use if they got there would depend upon the circumstances of the particular case. In furtherance of this idea and to meet both these difficulties, light pack howitzers have been suggested as standing both a better chance of getting forward and being of use when they get there. In fact in *F.S. Regulations* such a course is laid down to be acted upon by mountain artillery. From the nature of our heavy artillery weapon it is essentially one that will produce greater effects against *personnel* than against material targets. In this respect there is perhaps a fundamental difference between our heavy and the corresponding artillery of the German and French Armies. Their primary *rôle* may be said to be the attack of material such as permanent or semi-permanent fortifications, and the attack of *personnel* a secondary *rôle* though they claim equal success in regard to the latter. No doubt a reason for their choice of the howitzer, and the organization of their howitzer battalions, lies in the fact that they expect them to be used early against the strong places and barrier forts to be found on their land frontiers, on the speedy overcoming of which much of the freedom of movement for their field armies may depend.

To refer again to *F.S. Regulations* we find it laid down that the principal duty of our heavy artillery is (1) to silence at distant ranges (over 6,000 yards) hostile guns that may command lines of advance. A good example of this is given in the attack by General Buller on Allemans Nek in S. Africa, where the Boers reserved the fire of their artillery which commanded the line of advance of our infantry, until the latter were well committed. Our 5-in. guns both silenced the enemy's gun and covered a change of position of two field batteries who then enfiladed the Boer position on the S.E. of the Nek and this proved the turning point of the action. Numerous

instances also occurred where the Japanese, without heavy artillery, were unable to silence Russian batteries which swept important lines of advance, and prolonged combats and great sacrifices were the result of this deficiency.

(2). To search and enfilade points which the lighter guns can only reach with frontal fire. We have referred before to the difficulty of attaining this admirable end. Again it is easy to point to many cases where the Japanese would have saved much time and great losses if possessed of a heavy artillery to perform the above duty. It must of course be remembered that the Russians in selecting their positions knew that their foe was deficient of this arm.

(3). Destroy villages and houses. This involves the use of H.E. shell. Villages may be occupied as temporary shelters to collect in prior to a further advance, or occupied as tactical points when probably powerful earthworks may have been constructed. The reduction of the latter case is a much more suitable task for heavy howitzers.

(4). Again refers to support of final attack which we have discussed.

(5). Refers to long range fire between 6,000 to 4,000 yards and gives as its chief object during the general action "to sweep as large an area as possible within the enemy's position." A good example of this is found in the forcing of Botha's Pass by General Buller. Two 5-in. guns were man-handled into a very carefully reconnoitred and prepared position whence they were able to sweep the Boer position from end to end, and the latter never manned their trenches properly in consequence.

This result cannot be effected if the guns are placed too far from the front of the position to be attacked, and 4,000 yards is given as a distance nearer than which heavy artillery with its lack of mobility should rarely approach. It must be remembered that these guns are not provided with shields. At one time it was recommended that they should be but it was never carried out, owing I presume to the fear of still further increasing the weight of the equipment. For this reason, amongst others, such guns would generally be placed in concealed positions and entrenched. We saw it laid down that to gain decisive results, occasions may occur when it is necessary to bring heavy guns forward into line with those of lighter calibre. This can only be looked upon as an exceptional use of heavy artillery. Such action was not unknown in S. Africa, but only when there was no effective artillery opposition on the part of the Boers. No doubt it would only be wise or possible under this condition.

In the defence, it is suggested that heavy artillery be placed on the flanks to fulfil certain objects. The conditions in the defence are simpler than in the attack and do not make the same demands on mobility or on a high degree of field training with other arms. Such positions may compel any turning movements to be executed

on a wide arc and so gain valuable time for the defence ; will support counter-attacks made from either flank and tend to prevent the attacking artillery from taking up positions from whence it might obtain enfilade fire—will enable cross fire to be brought to bear on the front of the position, thus compelling early deployment of the attacker's infantry and preventing his batteries from coming into action at short ranges. Given first-rate conditions fulfilling these points, a large amount of the defender's artillery would be left free to deal with the attacking infantry, to the great advantage of the defence.

Both in the attack and the defence it can be said with a great deal of truth that the success of the operations of any one day will largely depend on the initial distribution of the batteries with respect to the tasks allotted to them, and it is a platitude perhaps to refer to the careful and thorough reconnaissance which should be a prelude to the selection and taking up of positions. In the absence of knowledge on essential points or until the situation had cleared up, the divisional commander would generally retain his heavy artillery under his own hand, ready to throw it in when and where required. It might be ordered into a "position of observation" ready to cover the advance of other batteries, and this covering power is a very valuable asset in heavy artillery.

There are certain *rôles* that one can imagine being assumed by heavy artillery that are not mentioned in our training manuals, viz. in pursuit and acting on rear guards.

It may seem a strange idea suggesting the least mobile form of artillery taking part in a pursuit. Certainly a great deal would depend on the nature of the country being traversed, and its communications and the strength and *morale* of the opposing forces. But such a long range gun in pursuit might oblige a rear guard to maintain itself at least 5 miles from the tail of the main body it is protecting. Such a distance would increase the already difficult task of a rear guard in avoiding being cut off from its main body. In open country long range guns pushed to the front for this purpose should ignore the rear guard and make the hostile main body their objective. Similarly in open country or a country suitable for the employment of heavy artillery great value may be obtained by placing such guns with the rear guard thus causing the pursuers to deploy at considerable distances and retarding them.

These considerations rather lead us to examine the best position for such guns on the line of march. Naturally, depending upon the nature of the country and the situation, the position may be anywhere from one end of the column to the other.

However, some might well be placed at the head of the main body, or even with the advanced guard if no stubborn resistance was likely to be met with, and if it was important that the march

should not be delayed by small bodies of troops in advantageous positions.

We have just mentioned the value such guns might have acting with the rear guard, but if roads were bad it might be unwise to risk them in such a position. Again in close country, wooded or flat or against an enemy well provided with mounted troops, a position somewhere near the centre of the column would be advisable.

I think that very little use could have been made of any form of heavy artillery, for instance, in most of the country in Norfolk and Cambridgeshire where this year's manœuvres were held.

CONSTRUCTION OF A REINFORCED CONCRETE FLOOR, DALHOUSIE BAKERY.

By COLONEL H. C. NANTON, R.E., AND LIEUT. H. S. TREVOR, R.E.

IN a Bakery being constructed at Dalhousie, baking and storing will be done on the ground floor, for which a room of 66½ ft. by 40½ ft. is required. This will be subdivided by railings to provide spaces for an entrance vestibule, office, bread store, issue vestibule, etc.

Above it the first floor is constructed to carry a load of 400 lbs. per square foot, on which will be placed the main and expense flour stores, as well as the heavy kneading machine and oil engine to work it. In the main flour store one year's supply for the whole garrison of Dalhousie will be collected.

The first floor consists of a 10-in. reinforced concrete slab 66½ ft. by 40½ ft. resting on the side and end walls of the building, and supported down its centre by three reinforced concrete pillars 14 ft. high and 2 ft. in diameter. The slab is quite smooth and level top and bottom; it is complete in itself without either beams or rafters, except where large openings for stairs or lifts are required. In this case one reinforced beam from a pillar to a side wall is given on account of a stair opening. The pillars and floor slab were cast *en bloc*, and the edges of the slab extend well into the side and end walls on which they rest.

The temporary work required for construction was simple, and consisted of a plain false floor of two layers of ¾-in. sawn planking upon which the concrete slab was cast. The uprights which supported the false floor will ultimately be roof rafters and the planking roof covering under galvanized iron sheeting. The false floor was brought to an accurate level by reverse wedges placed below the feet of the uprights, and the joints between the planks were either covered by oiled paper, or pointed with mortar or mud to prevent the matrix passing through.

On the false floor, boxes were set up, so that, when the floor slab was cast, the openings for the ventilator, dough shoot, and stairs, were formed. Up the centre line of the false floor three holes, 4 ft. in diameter (the dimensions of the fluted pillar heads) were cut, and the upright rods of the pillars passed through them. After the pillar uprights and spirals were placed, the pillars and caps were enclosed by light sheet iron casings.

The reinforcing rods of the floor slab were then laid, and a wet

mix of Portland cement concrete was poured in, firstly, filling the pillars, and then extending 10 in. thick across the whole floor. This operation was done as quickly as possible.

One month after pouring the concrete, the pillar casings were removed and the false floor struck by knocking away the reverse wedges under the uprights. The false floor and uprights then became available for constructing a second reinforced concrete floor to carry assorted S. & T. Stores.

The reinforcing used was the "mushroom system" of reinforced concrete, in which the vertical rods of the pillars are bent outwards to form a mushroom head rising towards the top of the floor slab. A mesh of rods reinforcing the slab is thus raised to the top of it where it passes over the mushroom, so placing the steel suitably to take the *shearing* strains.

The pillars are designed to carry a working load of 250 tons each in case a second floor is constructed, and are 14 ft. high and 2 ft. in diameter over all. To distribute this pressure, the foundations consist of two footings of Portland cement concrete reinforced at their bottom faces by a four-way grill of round steel rods. The foundations pressure is thus reduced to about $3\frac{1}{2}$ tons per square foot.

The pillar footings were formed by rough wooden boxes open top and bottom. In these boxes the reinforcing grills were placed and a wet mix of concrete poured. After a few inches of concrete were placed, the grills were lifted to admit of the mix flowing under to a depth of about 1 in. below the bottom bars. The remainder of the mix was then poured and pushed into place by foot.

The reinforcement of each pillar consisted of eight upright $1\frac{1}{8}$-in. diameter rods on the circumference of a 21-in. circle, surrounded by a $\frac{7}{16}$-in. spiral opened to a pitch of $2\frac{1}{4}$ in. The uprights were spliced to vertical stub rods cast in the upper footing of the pillar. At the top, centre, and bottom of each pillar, punched bar hoops surrounded the uprights. The punched projection of these hoops formed distance pieces to hold the temporary sheet-iron casings in position. When casting the pillars a skin was thus formed outside the spiral. The cores were clear and there was nothing to retard the flow of the concrete or to cause voids in the cores.

The eight steel uprights of the pillars were brought well towards the top of the floor slab, and then were bent backwards and outwards until their ends came within $\frac{1}{2}$ in. of the bottom of the slab. Overlying these were placed two $\frac{7}{8}$*th* diameter rings, the outer being 8 ft. 9 in. in diameter, and the inner 5 ft. in diameter. The mushroom heads of the pillars thus formed had the appearance of dished cart wheels.

The floor slab reinforcement consisted of a four-way mesh of $\frac{7}{16}$-in. diameter rods arranged in bands, lengthways, cross-ways, and

diagonally in each direction. With the exception of the side and end bands, they all cross the mushroom heads of the pillars. The mesh is thus densest where it passed over the mushroom heads, and where it rests on the walls, *i.e.*, at the places where the slab is subjected to shearing strains. Where the mesh falls to the centre of the slab panels its density is less, as here so much steel is not required.

When the reinforcing rods of the pillars and the floor slab were laid, the sheet-iron casings of the pillars-caps and pillars were well greased and placed in position, the former being joined up to the false floor as neatly as possible with small sheets of tin tacked to the floor. The false floor joints were closed roughly by tacking oiled paper along the most open seams and by pointing others.

A wet mix of 1—2—4 P.C. concrete was then brought by wheelbarrows on to the false floor; the pillars were first poured full and afterwards the 10-in. floor slab was cast. The mix was sufficiently liquid to flow readily, yet not so thin as to allow the matrix to part from the aggregate. No ramming was done, and all that was necessary was to lift the reinforcing mesh slightly at the centres of the panels to allow about $\frac{3}{4}$ in. of concrete to flow under it.

In practice it was found impossible to cast the whole slab and the pillars in one operation, and the work was extended over three days. The slab was divided into three sections by boards on edge across the building, a pillar being under the centre of each section. Each section was completed to its full thickness and the joint for the next day's work was across the centre of the panels.

Note on the "Mushroom" System of Ferro-Concrete.—The system of ferro-concrete construction used in the Dalhousie Bakery is known as the "Mushroom" System of Ferro-Concrete Construction, is the invention of Mr. C. A. P. Turner, of Minneapolis, U.S.A., and is a patent. The name used for the system is derived from the shape of the reinforcement over the heads of the columns, and also from the rapidity with which buildings can be constructed. As the system is a patent, and the formulæ used for calculation dependent upon practical experiments, supported by the very large experience of the inventor in ferro-concrete construction on a large scale, floors should not be designed and put up on this system without reference to him.

The system consists of continuous flat slab floors, of uniform thickness throughout, supported by columns or construction walls, as required. The floor slab is divided for purposes of calculation into panels, with a column at each corner, or with walls on two sides according to circumstances. The formula used for computing does not consider the slab as "continuous," and so will serve for any panel of the floor, whether supported on walls or columns. The arrangement of the reinforcement in the floor slab is such that loads placed anywhere on it are transferred *direct* to the supporting

columns or walls, instead of through a system of beams at right angles. The steel is arranged in a network of rods of uniform size, so that the floor is most strongly reinforced where the stress is greatest, while the crossing of the rods serves to distribute concentrated loads over as large an area as possible. The whole floor slab, and also the supports, are thus tied together into one monolithic mass.

The strength developed by any panel of the floor under test loads is very great, and as the result of a number of experiments under varying conditions, the inventor has adopted the value $\frac{WL}{50}$ for the maximum bending moment in a uniformly loaded slab, W being the total load in 1,000-lb. units, and L the span in feet. This value allows a factor of safety of 4 (reckoned against the ultimate strength of the slab). The working stress of the steel is about 13,000 lbs. per sq. inch.

The reason for the low co-efficient of bending moment occurring in the loaded slab is probably due to the "flat plate" action of the portion of the slab enclosed within the lines of maximum stress. This line, shown dotted in *Fig.* 1, can readily be determined by

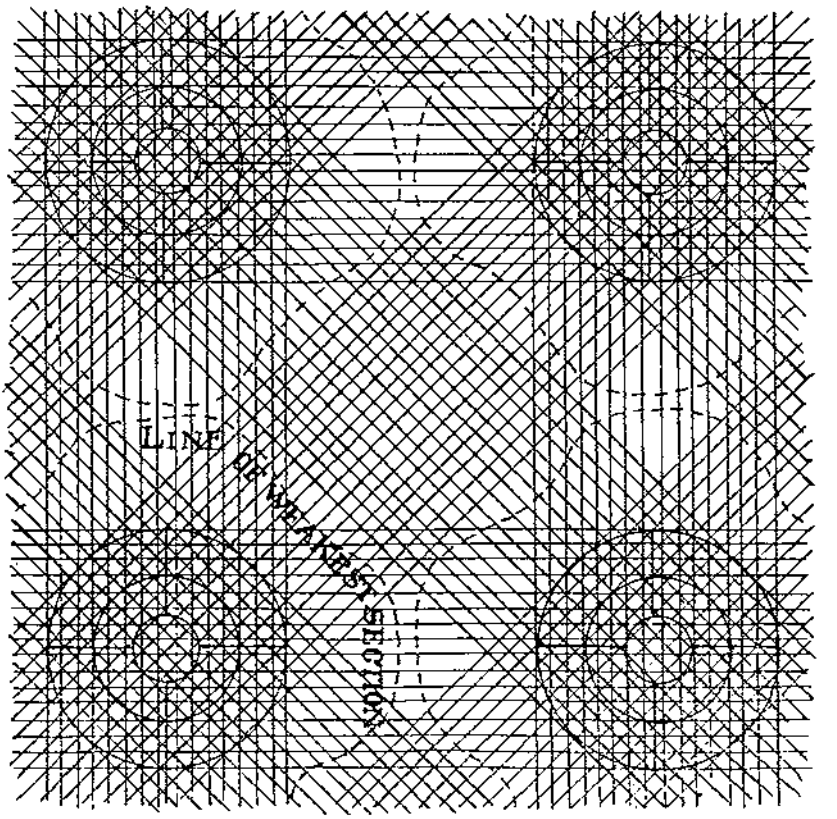


FIG. 1.

loading a panel until it fails, when the lines of rupture are found to run approximately as shown. It will be seen that the central portion of the space enclosed by these lines of maximum stress is roughly circular in shape, and is in the middle of the panel. It has been proved mathematically (by Professor Orashoff and others) that the bending moment at the centre of a circular flat plate of homogeneous material and uniform thickness, uniformly loaded and supported at its outer edge, is *zero*. It therefore appears reasonable to suppose that a similar state of affairs exists in the central portion of the Turner panel when uniformly loaded, and that the two-way reinforcement in this region serves mainly to distribute the tensile stresses occurring along the lines of maximum stress to other portions of the panel. The compressive bending stresses in a panel supported on all sides are as shown in *Fig. 2, i.e.*, in two directions at right angles. These stresses can be held in equilibrium diagonally as shown in *Fig.* 3, thus relieving the portion enclosed in these diagonals of the stress. Since the reinforcement in the centre

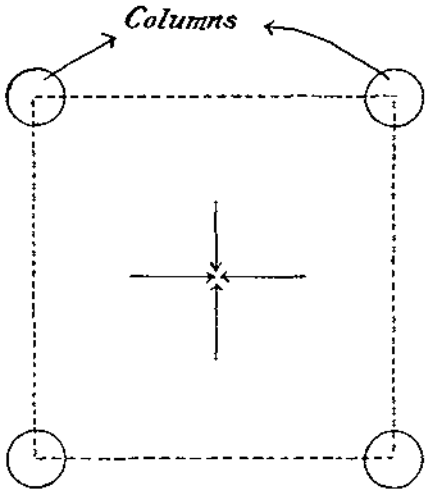


FIG. 2.

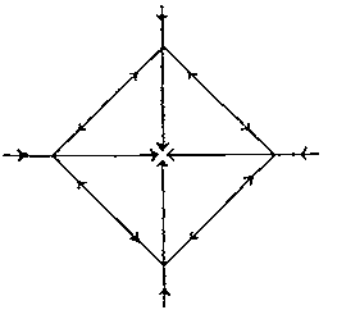


FIG. 3.

of the Turner panel is diagonal, it is probable that the compressive stresses are forced to act diagonally, opposing the tension in the steel, and thus relieving the centre of the panel of the major portion of the stress, which would otherwise accumulate there. Thus the " flat plate " action of the slab, and the effect of the diagonal reinforcement distributing the stresses laterally, both tend to strengthen and stiffen the panel and probably account for the low co-efficient of bending found by practical experiment. The theoretical investigation of the stresses in the panel is too complex to be of value, when the safe loads can be determined far more accurately and reliably

by testing actual panels. The great success of the system in America conclusively proves that the formula evolved by Mr. Turner from actual experience is thoroughly reliable when the work is properly done.

Though the reinforcing network is carried up to the top of the slab over the mushroom heads of the columns, the slab is not regarded as "fixed." The raising of the network brings the steel well into the concrete round the pillar, and also places it nearly at right angles to the planes of shear, which are not quite vertical. The network runs in four directions, over the mushroom heads, so as to provide the greatest amount of reinforcement where the shearing stress is greatest. The mushroom head of the column serves to prevent the tendency of the latter to punch through the floor slab.

The columns are of the Considere type, but the vertical reinforcing rods are bent out at the top to form the mushroom head, like the frame of a flat umbrella, and the network rests on this. The bent ends are held in place by two ring rods (*Fig.* 4). Detail of the

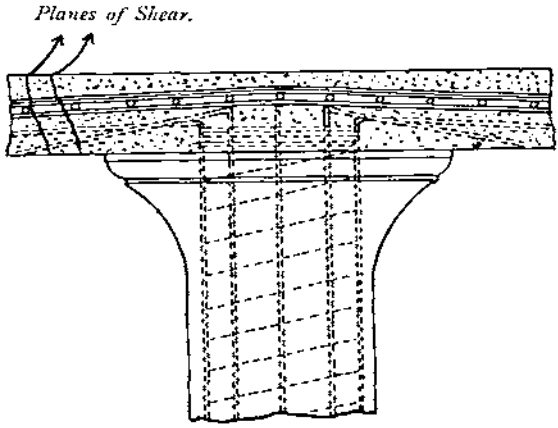


FIG. 4.

columns are given in the *Plate*. When the column rests on the ground, the footing is of slabs, reinforced at the bottom face in four directions, and the vertical rods of the column are splayed out over the network in the footing slab. When there are several floors in a building, the vertical rods of the lower pillars are not carried up into the pillars above, nor those of the upper pillars into those below, but the upper column rods merely rest on the top of the mushroom head below. The reason for this is that the tendency for the pillars to punch through the floor appears to be increased by making the vertical reinforcement continuous up the columns from top to bottom of the building.

Among the advantages claimed by the inventor for this system over other forms of ferro-concrete construction are :--

(i.). Great strength and reliability owing to monolithic construction and consequent resistance against fire, and disintegration by earthquake, or vibration from machinery.

(ii.). Low cost and simplicity of construction, as compared with other systems requiring complicated joinery in the false work.

(iii.). Rapidity of erection. Large buildings have been erected at the rate of one floor per fortnight, in America.

(iv.). Economy in height, owing to absence of deep beams: better appearance and lighting.

(v.). Elimination of dust, owing to absence of corners and angles.

(vi.). Ease in alteration of the internal partition walls, if required, without interfering with the floors.

(vii.). No skilled men required, and dangers from slipshod work largely eliminated.

The joint was freely grouted with neat cement and was carefully kept vertical, for on this line the effective compressive strength of the concrete comes into play.

The concrete mixers (twelve in number) consisted of semi-circular sheet-iron troughs held in trunnioned wooden cradles, one-third of the cradle projecting over a dwarf wall at the foot of which wheelbarrows passed. As each mix was ready the end of the cradle was lifted, and the liquid mass poured into the barrows. Each mixer took 2 c. ft. of aggregate, 1 c. ft. of sand and $\frac{1}{2}$ c. ft. of cement. Two men per mixer turned over the ingredients and the fluidity was carefully maintained by measured water added to each mix. The complete floor slab and pillars were cast in three days, about 1,000 c. ft. of concrete being mixed and poured per day of six hours.

The mushroom system for reinforced concrete floors is much in vogue in Canada and the United States, and it results in a continuous smooth floor slab of equal thickness throughout, without projections or beams of any kind, except about large openings for stairs or lifts.

Floor slabs of any area can be constructed and it is found that the rows of pillars supporting them should not as a rule be more than 25 ft. apart where very heavy weights are to be carried.

The outer edge of the slab may rest on construction walls or be supported by pillars spanned by reinforced beams and the fronts of the buildings can be of any style designed by the architect.

Owing to the fact that the strength of the slab is evenly distributed, and that internal walls form no essential part of the construction, such walls may be light and may be placed where desired without reference to those on the floors above or below.

The ease with which internal alterations can be made is a great advantage and renders this construction ideal for barracks, hospitals and public offices.

REPORT ON LOADING TEST CARRIED OUT ON 9TH AND 10TH MARCH, 1913, ON THE REINFORCED CONCRETE FLOOR OF DALHOUSIE BAKERY.

(1). *Portion Tested.*—It was possible to subject only one panel of the floor to a test load, and the largest panel, measuring 20¼ ft. × 16⅝ ft. = 341 square feet, was accordingly selected. It is supported along one of its long sides by the bakery wall and at each corner of the opposite side by a pillar.

(2). *Load.*—The load consisted of full grain bags weighing 81 lbs. each and full flour bags of 84 lbs. each. These were laid flat in layers covering the whole panel. Each of the first 15 layers contained 99 bags = 1,485 bags, and a further 183 bags were heaped on top, making a total weight of 136,410 lbs. After adding the weight of tarpaulins and stones for holding them down, the total test load amounted to 138,500 lbs. = 61·8 tons, or 406·4 lbs. per square foot. The average height of the load was 11½ ft. or 1½ above the eventual height of the room.

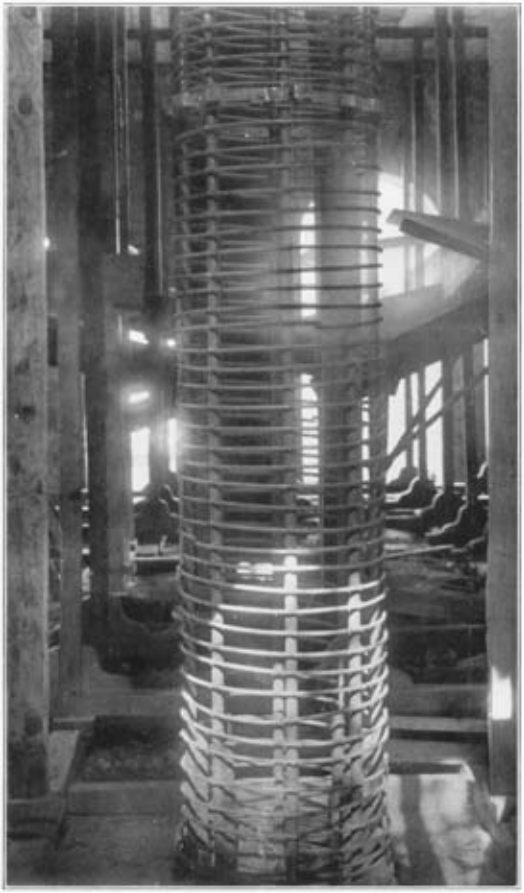
No count was taken of the additional weight of men.

(3). *Results of Test.*—A levelling staff was suspended from the centre point of the panel and frequent observations were taken with a level.

Twenty-four hours after loading began, the deflection observed was ·48 of an inch and appeared to have reached its limit. Twenty-four hours after unloading began, the recovery observed was ·264 of an inch. It is not known whether any further recovery took place, but a discrepancy between deflection and recovery is in accordance with tests carried out in America.

(4). *General Remarks.*—Ever since construction, in October, 1912, the floor has been exposed to rain and snow, and has never had a chance of properly drying out. Moreover its finishing coats of cement grout and plaster have not been applied. This process, according to American experience, very considerably strengthens the floor and future tests will be carried out after completing it.

CONSTRUCTION OF A REINFORCED CONCRETE FLOOR, DALHOUSIE BAKERY.



A Pillar Reinforcement.

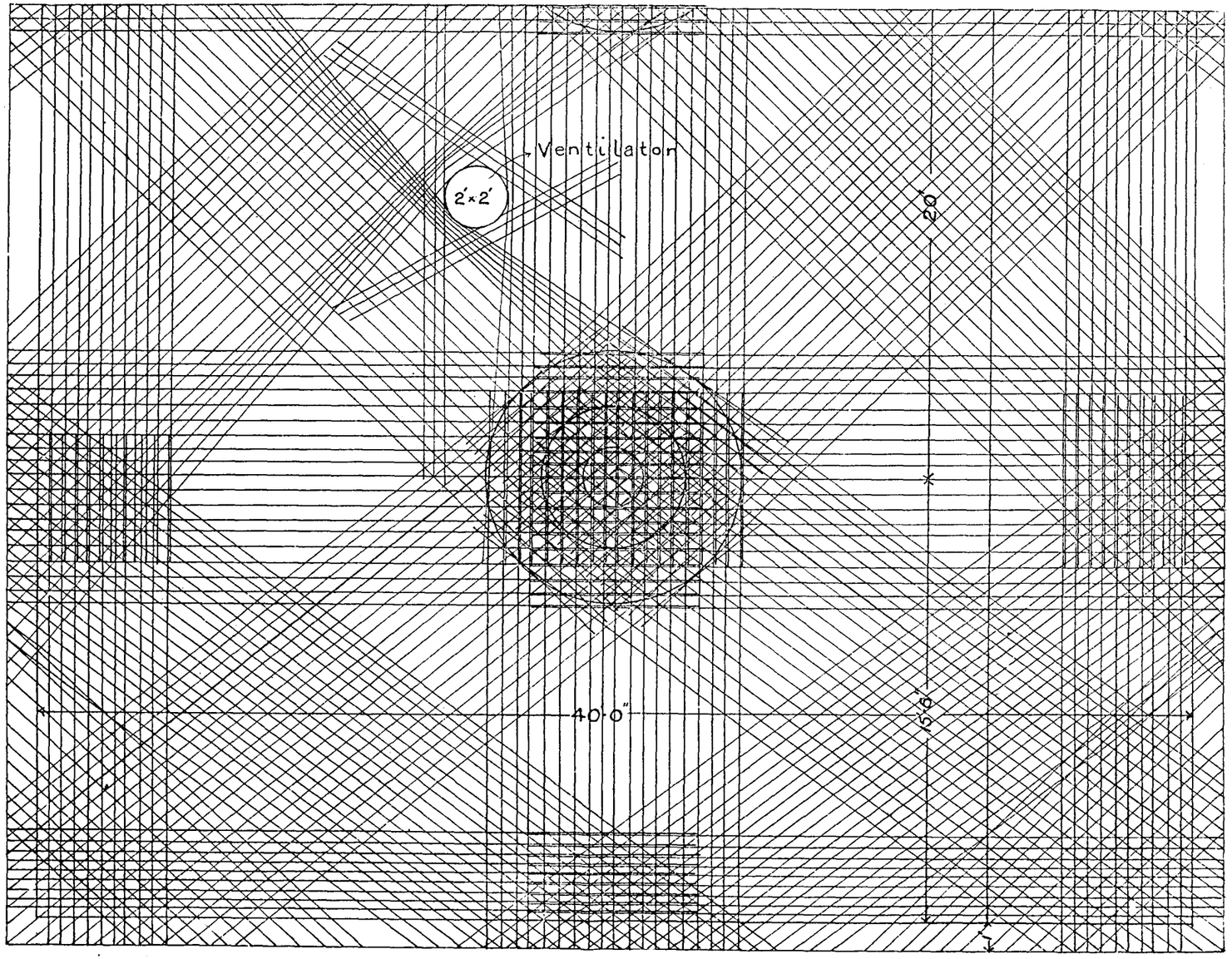
DALHOUSIE BAKERY

CONSTRUCTION OF A REINFORCED CONCRETE FLOOR, DALHOUSIE BAKERY.

Fourway Mesh reinforcing the Floor Slab, showing the Rise over the Mushroom.

DALHOUSIE BAKERY

CONSTRUCTION OF A REINFORCED CONCRETE FLOOR, DALHOUSIE BAKERY.



FOURWAY REINFORCEMENT OF THE FLOOR SLAB.

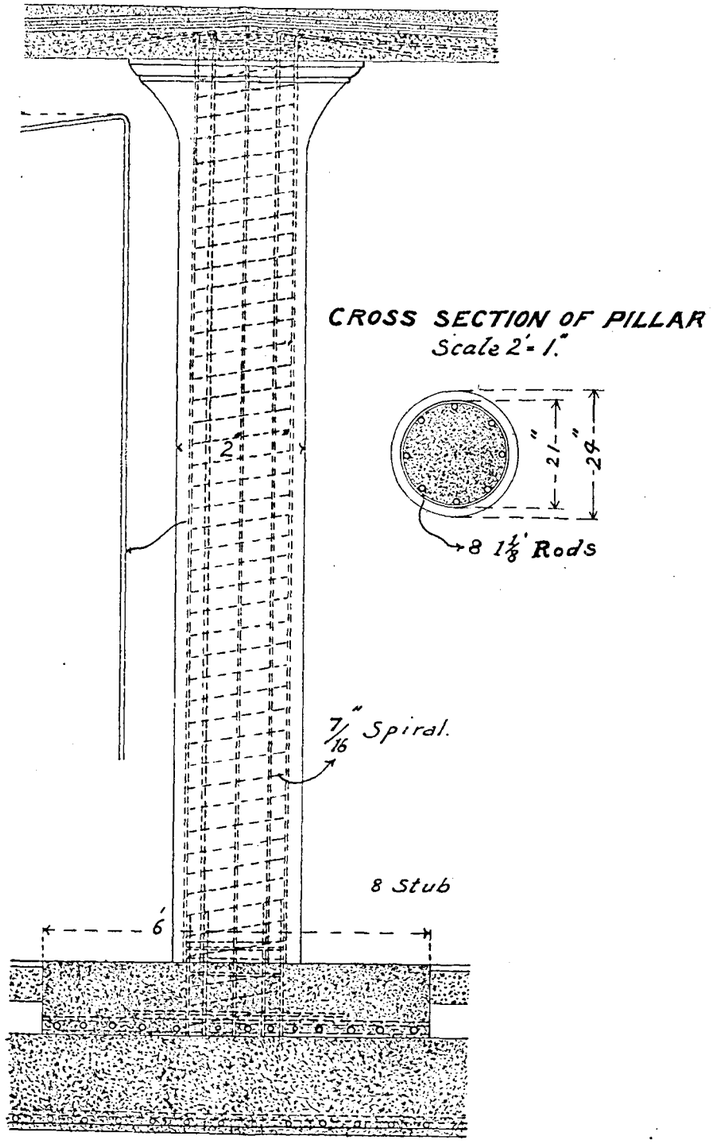


PLATE I.

EARLY INDIAN CAMPAIGNS AND THE DECORATIONS
AWARDED FOR THEM.

SERINGAPATAM. 1799

Indian and Campaigne Medals

EARLY INDIAN CAMPAIGNS AND THE DECORATIONS AWARDED FOR THEM.

By Major H. Biddulph, R.E.

The following notes on the Early Indian Campaigns and the decorations awarded for them, were compiled by the writer as so little information seems to be available on the subject. That which exists, also, is very inaccurate. This is probably due to the fact that information as to the Native Corps engaged in battles many years ago is not very accessible; while the renumbering of the Indian armies in 1824, when the regiments were broken up into single-battalion regiments, followed by the Mutiny, which swept away most of the Bengal Army, and led to another renumbering of the corps that survived, complicated the matter still further. The period covered is 50 years, viz. 1799—1849. The medals issued by the H.E.I.C.S. to its native troops only have not been dealt with in detail. To have included the Indian Mutiny would have doubled the article; it is estimated that some 300,000 medals in all were issued for that campaign, the vast majority being without a clasp, or issued to native troops and local and irregular corps of every sort and description. It is not generally known, however, that at least 49 Europeans and 79 Natives earned the Mutiny medal with four clasps—the late Dr. Buick had two of these medals in his collection.

Mysore, 1780–99.

No less than three wars were waged by the H.E.I.C.S. against Hyder Ali and his son Tippoo Sahib, successive rulers of Mysore. The first war, 1780–4, is notable for the defeat of Colonel Baillie, the defence of Wandewash (commemorated on the colours of the Dublin Fusiliers) and the Siege of Cuddalore, when the original 24th Bengal Native Infantry defeated the French European troops at the bayonet's point, taking prisoner the Chevalier de Damas and Sergeant Bernadotte, better known in later years as the King of Sweden.

The second war 1790–2 was undertaken by Lord Cornwallis in person, as the opening phase of the campaign was mismanaged by the local commander-in-chief. Bangalore was stormed and taken on the night of 21st March, 1791, and the army advanced on Seringapatam, defeating Tippoo at Arikera, a few miles from his capital. At the end of May just before the arrival of the force co-operating from the Bombay side under Major-General Robert Abercromby, Lord Cornwallis ordered a retreat on account of the abnormal rains,

and the consequent loss of transport and failure of supplies. In the ensuing cold weather Cornwallis marched once more on Seringapatam and on the 6/7th February was fought the great battle on the island, which ended finally in the complete defeat of Tippoo, who lost 76 guns and some 20,000 men. Among the killed was Lieut. Patrick Stewart, Bengal Engineers. Tippoo then sued for peace, which was granted on his agreeing to cede an enormous tract of his territory and the payment of a war indemnity of 33 million rupees (about £4,000,000 stg.).

For both these wars the H.E.I.C. granted medals, but to the *native* ranks only; the native officers receiving medals in gold or silver according to their rank, while native non-commissioned officers and men received similar silver medals of smaller size.

The third Mysore war was undertaken in 1799, the chief command being vested in Lieut.-General George Harris, while a force under Lieut.-General Jas. Stuart co-operated from the Bombay side. This campaign is notable as being the first occasion on which the future Duke of Wellington, then Colonel the Hon. A. Wellesley saw service in the field. He commanded the Nizam's detachment to which his regiment, the 33rd Foot, was attached. The Madras and Bombay columns met with little opposition and concentrated beneath the walls of Seringapatam early in April, 1799.

The siege was commenced. On the 4th May the breach was stormed at midday, and Tippoo fell in the assault.

No less than 934 guns, howitzers and mortars were captured with the fortress; and the prize money amounted to £1,143,216, probably a record for British troops. A special medal was granted by the Company to *all* ranks; general officers receiving it in gold, field officers in silver-gilt, other European officers in silver, British sergeants and drummers in copper-bronzed, as also Native officers, havildars and drummers of the Madras and Bombay Armies, while inferior ranks received it in grain tin.

The die was copied in Calcutta and the Bengal Government following their usual practice, issued gold medals to the native officers, and silver medals to other native ranks of the Bengal native troops present at the siege.

A detailed list of the troops engaged is appended, together with a description of the medals issued and notes thereon. It was not until 1851 that the *Queen's* troops received official sanction to wear this medal on all occasions.

SERINGAPATAM, 1799.

(*a*). English Die; 1·9 in. diameter.
Gold, silver-gilt, silver, copper-bronzed, tin.

(*b*). Calcutta Die; 1·8 in. diameter.
Gold, silver.

Obverse.—A tiger struck down by a lion; inscription in Arabic "The conquering Lion of God." "iv. May, MDCCXCIX."

Reverse.—The storming of the breach at midday.

Persian inscription in exergue "The God-granted Fortress of Seringapatam, 4th May, 1799."

Ribbon.—Watered yellow, or crimson with blue edges, 1¾ in. wide.

N.B.—The inscriptions on the medal have a double meaning: "The conquering Tiger (Lion) of God" was one of Tippoo's attributes; but in this instance is applied to the British Lion instead of to Tippoo's Tiger; while the phrase "The God-granted Fortress of Seringapatam" which here signifies the conquest of it by the British, signified previously to Tippoo's subjects that his sovereignty over Seringapatam was of Divine origin, both phrases being customary ones of Tippoo's.

The Medal for the Capture of Seringapatam, 1799, etc.

Much difference of opinion has prevailed as to the ribbon actually worn with the Seringapatam medal. That it was intended to be orange-coloured admits of no doubt, the statement on this point of General Sir J. L. Caldwell, Madras Engineers, (who received the medal) cannot be traversed. As, however, no ribbon was issued with the medal, everybody entitled to wear it had to provide it for themselves, and it is certain that a very large number of officers wore it suspended from the broad crimson and blue ribbon worn with Peninsula gold medals, which was the "military" ribbon of Great Britain. Examination of portraits, engravings, etc., show that Lord Harris, Sir David Baird, Sir Thos. Munro, Lord Combermere and others wore it in this way, some round the neck and others at the button hole; and it has been denied that the orange ribbon was worn by anybody. This, however, can be disproved, portraits of Sir John Malcolm and of Sir Robert Sale show distinctly the orange ribbon. Sir John Malcolm, who served as a captain at the siege in command of the Nizam's contingent, died in 1833, his portrait shows him wearing the gold or silver-gilt medal with an orange ribbon. Sir R. Sale served as a subaltern in the 12th Foot at Seringapatam, and his portrait as a Major-General appears to have been taken when he was at home on leave in 1844, after the close of the Afghan War. He is depicted wearing the Seringapatam medal with orange ribbon, the Ghuznee, Cabul and 2nd Jellalabad medals. The addition by the recipient of a heavy clasp, in gold or silver, inscribed "Seringapatam," was not uncommon in the case of officers.

With regard to the issue of the medal, it is to be noted that it was given not only as a war medal to the troops engaged at the siege or in the neighbourhood, but also as a commemorative medal to various personages and officials of high rank, and also to at least one military officer who was not present, viz.:—Major-General John Braithwaite, Adjutant-General, Madras Presidency. This fact detracts consider-

ably from the interest attaching to all medals issued by the H.E.I.C. for various services ranging from 1778—1826, as one can very rarely be certain that any individual medal was actually worn by a soldier, and still less often as to who (if any) the wearer was. Re-strikes also, of all these medals, except that for Ava, are not uncommon. The dies of the Ava medal are at the Royal Mint, and re-strikes do not exist except the few issued as specimens with representative sets of medals; but original silver proofs perhaps exist. The dies of the Seringapatam medal, English die, are in private hands, and those of other medals at the Calcutta Mint; as it is only within the last few years that the Calcutta Mint has been prohibited from issuing re-strikes, they are by no means uncommon.

The Egypt (1801), Java and Nepaul dies are now cracked, and specimens showing these flaws are sometimes seen.

The dies of the 1784 Carnatic medal (commonly but erroneously called the Deccan medal), and of the Mysore medal, 1791–2, are not in existence; but castings are met with.

Medals from the Calcutta-made Seringapatam dies were struck in gold and silver for the Natives of the Bengal troops that served at the siege, Native officers receiving the gold medal, and other ranks the medal in silver. The Bengal troops present consisted of four companies of Bengal Foot Artillery and eight companies of Lascars, the 1st and 2nd Battalions of the 10th Bengal Infantry, and the 1st, 2nd and 3rd Volunteer Battalions from Bengal; after the war the 18th and 19th Regiments of Bengal N. Infantry (each of two battalions) were formed from these three Volunteer battalions.

The Seringapatam medal was the only one of this series that was issued to Europeans, with the exception of one gold medal presented to Sir Archibald Campbell, Commander-in-Chief of the expedition to Ava, 1824–26, and for this reason it has been discussed somewhat fully.

Troops engaged at

(1). *Siege and Capture of Seringapatam*, 1799.

Commander-in-Chief:—Lieut.-General G. Harris.

Madras Troops.

Cavalry:—Major-General J. Floyd, 19th Light Dragoons.

1st Brigade:—*Colonel J. Stevenson, 4th Madras Cavalry.
H.M. 19th Light Dragoons (430 men).
1st and 4th Madras Cavalry.

2nd Brigade:—*Colonel J. Pater, 2nd Madras Cavalry.
H.M. 25th Light Dragoons (454 men).
2nd and 3rd Madras Cavalry.

* Both these officers entered the H.E.I.C.S. from that of the Nawab of Arcot as Captains in 1784. They both attained General Officer's rank. Stevenson served with Wellesley in 1803–4.

Guides :—Major J. Campbell.

Artillery :—Major-General D. Smith, Madras Artillery.
1st and 2nd Battns. Madras Artillery.
1 Co. Coast Artillery (serving with Nizam's detachment).
*3-1st, †5-2nd, 1-3rd and 2-3rd Battns. Bengal Artillery, and 8 Companies Lascars.

Engineers :—Colonel W. Gent, Madras Engineers.
Corps of Pioneers.

Infantry :—Right Wing :—Major-General T. Bridges, 1st Madras N.I.

1st Brigade :—Major-General D. Baird.
H.M. 12th Foot (693 men).
„ 74th Foot (789 „).
„ Scotch Brigade (559).

3rd Brigade :—Colonel F. Gowdie, Madras N.I.
1-6th, 1-12th and 1-1st Madras N.I.

5th Brigade :—Colonel G. Roberts, Madras N.I.
2-3rd, 1-8th and 2-12th Madras N.I.

Left Wing :—Major-General W. Popham, 7th Bengal N.I.

2nd Brigade :—Colonel J. C. Sherbrooke, 33rd Foot.
H.M. 73rd Foot (746 men).
‡Swiss Regiment de Meuron (715 men).

4th Brigade :—Lieut.-Colonel J. Gardiner, 1-4th Bengal N.I.
§1st, 2nd and 3rd Volunteer Battalions from Bengal.

6th Brigade :—Lieut.-Colonel T. Scott, Scotch Brigade.
2-5th and 2-9th Madras N.I.

Nizam's Detachment :—

¶Colonel the Hon. A. Wellesley, 33rd Foot.
H.M. 33rd Foot (879 men).

1st and 2nd Brigades :—Lieut.-Colonel J. Dalrymple, Madras N.I.

1st Brigade :—Lieut.-Colonel L. Grant, 10th Bengal N.I.
1-10th and 2-10th Bengal N.I.
2-11th Madras N.I.

2nd Brigade :—Lieut.-Colonel T. Bowser, Madras N.I.
2-2nd, 2-7th and 1-11th Madras N.I.

* The 3-1st Bengal Artillery served with the Nizam's detachment.

† The 5-2nd Bengal Artillery served with Colonel A. Brown's force; having recently come from Ceylon.

‡ The Regiment de Meuron was originally in Ceylon in the pay of the Dutch. On the capture of that island by the British it accepted service under the Crown, and was removed to India.

§ The three Volunteer Battalions from Bengal were formed of volunteers from every regiment in Bengal except the 10th Regiment, Bengal N.I.

¶ Later 1st Duke of Wellington.

Artillery :—Major R. Howley, Madras Artillery.
3-1st Bengal Artillery.
1 Company Coast Artillery.
Lascars.
Nizam's Infantry (with guns) :—*Capt. J. Malcolm, Madras N.I.
4 Battalions of Infantry (the old French contingent, 3,600 strong, to which two troops of disciplined cavalry were attached).
Nizam's Cavalry :—Mir Alam. 6,000 strong.

Bombay Troops.

Commander-in-Chief :—Lieut.-General Jas. Stuart.
Artillery :—Lieut.-Colonel G. A. Lawman, Bombay Artillery.
3rd, 4th and 5th Companies.
Engineers and Pioneers :—Colonel J. C. Sartorius, Bombay Engineers.
Infantry :—†Major-General J. Hartley, 75th Foot.
Right Brigade :—Lieut.-Colonel J. Montresor, 77th Foot.
1-2nd, 1-4th and 1-3rd Bombay N.I.
Centre Brigade :—Lieut.-Colonel J. Dunlop, 77th Foot.
H.M. 75th Foot (223 men).
The Bombay European Regiment (528 men).
H.M. 77th Foot (693 men).
Left Brigade :—Lieut.-Colonel J. Wiseman, Bombay European Regiment.
2-3rd, 1-5th and 2-2nd Bombay N.I.

(N.B.—The 2-3rd Bombay N.I. had detachments from other regiments).

On the 1st April, 1779, Major-General Floyd was detached with all the regular Cavalry and the 3rd Infantry Brigade (Gowdie) to meet a convoy under Colonel A. Read. Read met Floyd at Cowdahully at the end of April, was joined by Colonel Brown's detachment on the 6th May, and the whole force returned to Seringapatam with the convoy on the 11th May.

Colonel A. Read, 2-4th Madras N.I.

Capt. M. Cosby's Troop.
6 Troops Nizam's Horse.
Madras Artillery (36 men).
Nizam's do.
1st Madras European Regiment (69 men).
Convalescents H.M. Foot (40 men).

* Afterwards Sir J. Malcolm, G.C.B.

† Hartley was transferred as a Lieut.-Colonel from the Bombay Army to the Lieut.-Colonelcy of H.M. 75th Foot, when that regiment was raised for service in India in 1787.

Flankers 1-4th Madras N.I.
do. 1-5th Madras N.I.
Battn. Companies 2-4th Madras N.I.
Nizam's Infantry.
Pioneers.
In all 5,280 men.

Lieut.-Colonel A. Brown, Madras Infantry.

5-2nd Bengal Artillery (44 men).
Madras Artillery (55 men).
5 Companies H.M. 19th Foot (386 men).
Madras European Regiment (617 men).
Bengal Lascars.
Madras do.
New Troops N. Cavalry.
3 Companies 2-1st M.N.I.
Battn. Companies 1-2nd M.N.I.
„ „ 1-3rd M.N.I.
Flankers 2nd and 3rd Regiments, M.N.I.
Flankers 13th Regiment, M.N.I.
Pioneers.
In all 4,300 men.

Both these detachments shared in the prize money, the estimated total value of which was £1,143,216; and although not actually present at the siege it is probable that they were granted the medal also.

(2). *Assault of Seringapatam, 4th May, 1799.*

Major-General D. Baird in command of the assaulting column.

Right Column :—Colonel J. C. Sherbrooke.
Flankers, Scotch Brigade.
do. Regiment de Meuron.
H.M. 73rd and 74th Regiments.
Flankers, 2-2nd, 2-3rd, 1-11th and 2-12th Madras N.I.
do. 1-2nd, 2-2nd, 1-3rd, 2-3rd, 1-4th, 1-5th Bombay N.I.
50 Gunners and Lascars.

Forlorn Hope :—*Lieut. V. Hill, 74th Regiment, with 1 sergeant and 12 men, supported by 25 men.

Left Column :—Lieut.-Colonel J. Dunlop.
Flankers, H.M. 75th, 77th and Bombay European Regiment.
H.M. 12th and 33rd Regiments.
Flankers, 1-10th, 2-10th Bengal N.I., and the 3 Volunteer Battalions, Bengal N.I.
50 Gunners and Lascars.

* Killed in the assault.

Forlorn Hope :—*Lieut. A. Lawrence, 77th Regiment, with 1 sergeant and 12 men, supported by 25 men.

Half the corps of Pioneers accompanied each column.

The casualties during the siege were :—

Officers	...	22 killed.	45 wounded.	
Europeans	...	181 „	624 „	22 missing.
Natives	...	119 „	420 „	100 „

934 guns, howitzers and mortars were captured with the fortress.

ENGINEER OFFICERS WHO SERVED IN THE MYSORE WARS.

1ST MYSORE WAR, 1780–4.

Only Madras Engineers employed.

1780.—*With Colonel Baillie's Force.*

Capt. Jno. Theobald, killed at Perambankum, 10. 9. 80.
Ensign — Brunton, taken prisoner, and died in Seringapatam.

1781–2.—*With Sir Eyre Coote's Army.*

Capt. Alex. Dugood, killed at Chittoor, 10. 11. 81.
„ Jas. Johnston, at Negapatam in 1782.
„ Wm. Gent.
Lieut. Jno. Wickens, to Negapatam 24. 9. 81, with Coote in 1782.
Ensign Rd. Baker.
„ Chas. Parsons Ogg.
„ Geo. Bong, sent to destroy Fort Pulicat, December, 1781.

1781–2.—*With the Southern Army.*

†Major Thos. Geils, Chief Engineer; at Siege of Negapatam and Trincomalee.
Lieut. Jno. Wickens, at Siege of Negapatam.
„ Chas. Salmon, A.D.C. to Colonel Jno. Braithwaite, 13. 2. 82.

Capitulation of Trincomalee, 30. 8. 82.

- Capt. Geo. Banks, to Trincomalee from Trichinopoli, 30. 7. 82.
- Ensign Rob. Watson, „ „ Negapatam, 30. 7. 82.
- „ Crawford Lennox, „ 30. 7. 82.

Ensign Wm. Collins Tyson, to Negapatam vice Watson, 30. 7. 82.

* Father of Sir H. M. Lawrence.

† [Lieut. Thos. Geils, Madras Artillery, served with the Engineers from 1768–87, when he returned to the Artillery as Lieut.-Colonel and Commandant. A MS. *Army List* of 1787 shows him as Major of Engineers and Lieut.-Colonel Commandant of Artillery, his name being entered in the lists of both corps.]

1783.—*With Major-General Jas. Stuart's Army.*

*Lieut.-Colonel Pat. Ross, Chief Engineer.
Capt. Jas. Johnston.
„ Geo. Banks.
Lieut. Jno. Wickens, A.D.C. to Chief Engineer.
Ensign C. P. Ogg.
„ Jacob Hemming.
„ Dan. Jennings.
„ Jno. Norris.
„ Sam. Saunter.

1783.—*With the Southern Army.*

Capt. Jno. Byres or Bryres, from July, 1783, as Chief Engineer.
Lieut. Chas. Salmon.

2ND MYSORE WAR, 1790–2.

Bengal Engineers.

S. Capt. Alex. Kyd, A.D.C. to Lord Cornwallis.
S. Lieut. Pat. Stewart, killed 6. 2. 92 at Seringapatam.
S. Ensign Jos. Stokoe, commanding Pioneers.
S. „ Jas. Tillyer Blunt.
S. Two other officers, names unknown.

Madras Engineers.

S. Lieut.-Colonel Pat. Ross, Chief Engineer.
B. Major Geo. Maule, Chief Engineer.
Capt. Elisha Trapand, to Tanjore, G.O., 11. 5. 91.
„ J. A. Kissellbeck, to Vizagapatam, G.O., 31. 8. 91; died 24. 5. 92.
B. „ C. P. Ogg, to Ganjam, G.O., 31. 8. 91. To Trichinopoli, G.O., 15. 2. 92.
Lieut. Wm. Wynn Ryland; sick 6. 11. 90; died 12. 6. 91.
„ Geo. Bong.
S. „ Jacob Hemming; wounded 6/7th February, 1792.
S. „ Mich. Russell, Adjutant, vice Cree, killed.
B.S. „ Jno. Norris.
B.S. „ Walter C. Lennon, commanding Pioneers.
B.S. „ Colin Mackenzie, A.D.C. to Lieut.-Colonel P. Ross.
B. Ensign Alex. Cree, Adjutant, killed at Ryacottah, July, 1791.
„ David Barclay, died at Trichinopoli, 9. 7. 90.
B. „ Geo. Johnston, to Coimbatore, end of 1791.
B.S. „ Thos. Wood, from September, 1790.

* N.B.—When the Corps of Madras Engineers was put on a purely military basis, and reorganized, 15th September, 1770, Capt.-Lieut. Pat. Ross of the Royal Engineers was brought out from England as Chief Engineer, with the rank of Lieut.-Colonel.

B.S. Ensign Jas. L. Caldwell, twice wounded.
B.S. „ Jno. W. Pyefinch.
S. „ G. C. G. Pittman.
S. „ Wm. Farquhar.

Bombay Engineers.

S. Major J. C. Sartorius, Chief Engineer with Major-General Robt. Abercromby.
S. Capt. Wm. H. Blackford, wounded.
Lieut. Fras. Stuart, killed at Dharwar, 14. 1. 91.
S. Ensign Jno. Johnson, with Little's detachment.
Three other officers, names unknown.

B. *Signifies engaged in the Bangalore Campaign.*
S. „ „ *Seringapatam Campaign.*

3RD MYSORE WAR, 1799.

Madras Engineers.

Colonel Wm. Gent, Chief Engineer.
Major Elisha Trapaud.
Capt. Jno. Norris, A.D.C. to Chief Engineer.
„ Colin Mackenzie, Chief Engineer, Nizam's detachment.
„ Geo. Johnston.
Capt.-Lieut. Jas. L. Caldwell, twice wounded.
„ Jno. Blair.
Lieut. Wm. Castle.
„ Thos. Fiott d'Havilland, with Brown's detachment.
„ Jno. Cotgrave.
„ Ben. Sydenham.
„ Jno. Ross Cleghorn.
Ensign Thos. Fraser, adjutant, wounded at Malavelly, 27. 3. 99, later with Read's detachment.
Thos. Arthur.
Wm. Gerrard.
Geo. Rowley.
Ensign Edw. Malton.
„ Chas. W. Bell.*
„ Jno. Smith.

Bombay Engineers.

Lieut.-Colonel J. C. Sartorius.
Ensign Jno. Johnson.

* [N.B.—Ensign C. W. Bell was transferred to the cavalry permanently on 28. 6. 01 and served with the 6th Madras Light Cavalry at Asseerghur, Argaum and Gawilghur in 1803.]

REVIEWS.

LES AÉROPLANES DANS LA GUERRE D'AUJOURD'HUI.

By LIEUT. DE BOISRICHEUX.

Paris, 1913: *Librarie Chapelot.*

THE writer sets out to answer the following questions; what advantages the commander will obtain from these new auxiliaries, and what strategical and tactical consequences will result from their employment.

He divides aeroplanes into four classes, for reconnaissance, for communication, for combat and for observation, especially in connection with artillery.

The question of transport is discussed, also means of transmitting information, security against rifle and gun fire, the employment of aeroplanes with cavalry, and their uses as means of communication.

In the combat they can be used to drop bombs, or can be fitted with automatic rifles or small-bore guns. They can be used to frighten the enemy's cavalry and so interrupt his charges.

Excellent results have been obtained by siege guns directed from aeroplanes, and their observations should save field artillery the waste of many rounds. Several methods of communicating with the batteries are described.

A few remarks are made on organization for the various functions mentioned above.

The conclusions are that aeroplanes will be most annoying to the enemy, of invaluable assistance to the reconnoitring cavalry, and will have great influence on the moral and leading of the troops. The C.-in-C. and his staff must realize that the least mistake or hesitation may be noticed and put to profit by the enemy. The soldier must be imbued with greater courage and indifference to death, for he will find his weapons of little use in protecting him against his new antagonist.

A.R.R.

FEUILLES DE ROUTE BULGARES.

By ALAIN DE PENENNRAU.

Paris, 1913: *Librarie Chapelot.*

THE author gives an interesting description of his journey from Paris to Sofia, and thence through Thrace in rear of the Bulgarian Army in October and November, 1912. He first tried to join the 2nd Army before Adrianople, but finding the censorship too strict moved off to

join the 3rd Army. With the latter he had slightly better success and describes from hearsay the Battle of Kirk Kilisseh (Bulg. Lozengrad). The Turkish repulse here seems to have degenerated into a demoralized rout, and the stores of all descriptions abandoned were estimated at 10 millions of francs in value. The Bunar Hissar road as far as Jana was littered with military stores. The battle on the line Bunar Hissar—Lule Burgas is described from hearsay. It was only in front of the Chatalja lines that the author saw any fighting. Here the excitement and dash that had carried the Bulgarians to victory was exhausted, dysentery was decimating their ranks, possibly diplomacy was calling for a halt, or the capture of Adrianople was assuming a more important aspect.

Whatever the cause, insufficient weight was put into the attacks on the Lines, the Turks behind earthworks and nearer their sources of supply had regained heart, and the Bulgarian advance was checked.

The conduct of all ranks and arms in the Bulgarian Army must have been most praiseworthy to have so far triumphed over difficult country, the almost entire absence of roads, and the bad weather. Sanitation in camp however was practically *nil*, though the hospitals were well organized.

The author paid another short visit to the investment of Adrianople on returning. For a study of the strategy and tactics of the campaign the book is of no value, as no details of that nature could be obtained.

A.R.R.

LA GUERRE EVENTUELLE.

By LIEUT.-COLONEL A. GROUARD.

Paris, 1913: Chapelot.

THIS is a very careful study of the strategy which the author considers France should employ prior to, and during the commencement of, the war with Germany which he looks upon as inevitable.

The first chapter is devoted to a general description of the military frontiers between the two nations, and of the part to be played by the various fortified positions on either side, whether in attack or defence.

The conclusion arrived at, in the case of a war between France and Germany alone, is, that the latter will at first be the attacking party, and that France may have to give way for a time. In any case the author does not recommend that France should be in a hurry to attack. If she did so and were victorious her further advance should be very deliberate, and each zone of captured territory would have to be carefully occupied.

The author criticizes some recently published works on the same theme, *La France victorieuse dans la guerre contre Allemagne* and *L'Offensive contre Allemagne*, by Colonel Boucher, also *La doctrine de defense nationelle*, by Capt. Sorb. He considers these to be much too sanguine, and the conclusions arrived at to be deduced from false data. He argues that France has the advantage of starting from

interior lines, points out how this advantage should be utilized if the fullest benefit is to be derived from it, and how the German attack could best be met and checked.

Some trenchant remarks are made in regard to the higher command of the French Army, and to the necessity for the Commander-in-Chief to be freed from civil control.

An appendix is added, written since the commencement of the Balkan War, pointing out how the situation might be modified in the event of a general European conflict. Even if Germany were engaged in war on one of her other frontiers, an advance into German territory would be attended with risk. A vigorous offensive is advocated on a portion of the line, and the necessity for making good all conquest is again drawn attention to.

The book is exceedingly interesting and well worth study, but is not too flattering to our neighbours! "Amour propre."

A.R.R.

LA GUERRE TURCO-BALKANIQUE, 1912.

By LIEUT.-COLONEL BOUCABEILLE.

Paris, 1913: Chapelot.

AN interesting and useful account of the principal events of the war. The work opens with a short geographical and political sketch of the countries concerned. The normal composition, organization, and mobilization arrangements of each of the armies is briefly stated. Part II. comprises the operations of the Greek Armies, Part III. those of the Montenegrins, Part IV. the Servian and Parts V. and VI. the Bulgarian. A separate chapter is devoted to the maritime operations. Some remarks are then made on the probable causes of the Turkish defeat, and the book ends with a comparative statement, in chronological order, of the operations of the allies. There are 11 maps, and 10 sketches in the text, illustrative of the country and the most serious engagements.

A.R.R.

NOTICES OF MAGAZINES.

REVUE D'ARTILLERIE.

January, 1913.

THE MILITARY VALUE OF AVIATION.

A lecture given by Colonel J. E. Estienne, of the Artillery. His conclusions are that light, easily transported, single-seated aeroplanes, built to rise quickly rather than to travel far, will always be of great use to officers of all arms, especially to the cavalry, as they meet the tactical need of enabling one to rise to see better. Heavier machines as weapons of offence, unless they can be armed and armoured and provided with engines of great horse power, will not have great influence on the results of battles. Incendiary grenades might be useful, especially against airships.

CONTRIBUTION TOWARDS THE HISTORY OF THE ARTILLERY (*continued*).

Treats of the introduction of time and percussion fuzes, and of the difficulties encountered and met by degrees. Also of the opposition to rifled guns, one of the chief being that the shells would not roll, and their effect was too local. Case shot could not be used with them. Of considerable historical interest.

THE LIGHT HOWITZER.

Major Challéat, of the Artillery, discusses the question whether the French *corps d'armée* have need of these weapons, and in what proportion. He compares the French and German 75-m.m. and 77-m.m. guns, their numbers and employment and the effect of their shrapnel and high-explosive shell. He is against the proposal to use reduced charges and curved fire with the French gun. He then describes the characteristics and employment of the German 105-m.m. light howitzer firing the universal shell. This shell is used with time fuze as shrapnel, and as common shell with a percussion fuze, with or without delaying action. As he does not know the details of the German shell, he describes one patented in France by Messrs. Krupp.

His conclusions are that France also ought to have a light howitzer, and makes suggestions as to the number required, the most suitable size of bore, and how the need could be met.

METHODS OF TESTING METALS, CONGRESS OF NEW YORK, 1912 (*continued*).

Section D. Various.—These extracts are not capable of much further condensation. The following are briefly the heads of the matters discussed:—

(1). Proposed uniform definitions for iron and steel of different qualities.

(2). General principles to be observed in selecting copper for mechanical and electrical constructions.

(3). Comparison of the magnetic and electrical properties of metals in relation to their behaviour during mechanical tests.

(4). Application to cast iron of the methods of mechanical test adopted for other metals.

(5). Note on the resistance of cylindrical tubes up to the point of rupture.

The compiler of the extracts then proceeds to suggest the tests that would be of useful application in artillery laboratories.

Various Information.

The results of recent military aviation meetings in England and Russia are published in tabular form.

A description is given of the German Polte cartridge. Part of the charge is made in the form of a sausage with constrictions at intervals. The portions between the constrictions are numbered. Normally the full charge is inserted, and if a reduced charge is required one section or more is withdrawn through the hole for the cap in the base of the cartridge, and cut off at the required constriction. The inverse method is possible however, and extra sections can be inserted.

February, 1913.

Some Lessons from the Balkan War on the Tactical and Scientific Employment of Artillery.

An article by General Herr, who visited the Servian lines at Uskub and Kumanovo, and the Turkish position at Chatalja, and who is thus able to compare the sometimes contradictory accounts of the two opposing sides on actual occurrences of the war. This is the first occasion on which the opposing troops have both been armed with the most recent guns, the Turks possessing German weapons and having been trained on the German model, the Allied Powers being French trained, and with weapons similar to those of the French artillery.

At Komanovo the Servian guns at once opened fire on the Turkish guns, which had been placed in the open to fire on the Servian infantry. The latter were soon reduced to silence and the Servian guns could attack the Turkish infantry without being molested themselves. Three batteries of Turkish guns later opened fire on the Servian flank attack. Two in the open were at once annihilated, the third battery, masked even to its flashes, escaped injury and decimated the Servian infantry by oblique fire, until the Servians brought an overwhelming cross fire to bear on it.

Conclusions.—1. (*a*). In spite of shields and of being in a covered position, a battery can be destroyed and not only neutralized.

(*b*). Wounds caused by shrapnel balls take longer to heal than those caused by the rifle. The artillery fire disabled more men than the rifle.

2. The artillery duel is still necessary.

3. Oblique fire is very deadly, the one covered Turkish battery checked the whole Servian flank attack.

4. The Servians only fired 120 rounds per gun, but as the Turkish guns were in the open this gives no idea of what the expenditure of ammunition would have been had the Turkish guns been masked.

(*a*). The Servians ranged on a large number of points and were able to seize fleeting opportunities for inflicting loss.

(*b*). The Servian officers consider that, in spite of knowing these

ranges, the expenditure of ammunition would have been much greater had they not had observing ladders close to their batteries. No time was thus lost in observing the results of fire, and correcting the fire thereby.

At the Battle of Monastir the following particulars were gleaned:—

1. The Servian heavy artillery was most effective at 8 kilometres (5 miles) and the Turks could not reply to it.

2. A Servian division was caught on a bridge between the cross fire of two groups of Turkish guns, and could only be freed by the Servian heavy guns which opened oblique fire at 10 k.m. on the two Turkish groups.

3. After the duel against the Turkish artillery marked by such incidents as above described, the Servian artillery acquired a definite superiority and their infantry attacks could be pushed home.

4. The Servians used their mountain artillery to accompany their infantry advance.

Conclusions.—1. The artillery duel is still necessary.

The adversary who has heavy artillery can by degrees reduce his opponents' field guns to silence, while the latter cannot reply and are hindered in their attack on the adversary's field artillery. Mountain artillery owing to the facility with which it is transported can accompany infantry, its use in broken country is clearly indicated, and it can take cover and fire from behind steep slopes.

The Bulgarian artillery was very ineffective against the lines of Chatalja. The Turks attribute this to the fact that the shells were burst too high. Fuzes picked up were set to 5,600 and 5,800 metres. At such ranges field artillery fire can only be effective if burst with great accuracy. Owing to the small effect of the Bulgarian shells the Turks had virtually the superiority in artillery and could use two arms against one.

An attack in front over open ground is assured of success if a definite superiority is first acquired over the enemy's artillery. The Bulgarian field artillery could not advance under cover to within effective range. Heavy guns are necessary in such cases. High-explosive shell are required to silence guns in pits.

At 1,500 metres, owing to their flat trajectory, the Turkish guns had no effect on the *personnel* in trenches straight in front of them. Oblique and flank fire is necessary.

From the above General Herr deduces that the French *corps d'armée* should have long range guns of a calibre of about 100 m.m. He advocates the "universal" shell adopted by the Germans for their 105-m.m. howitzer. Aeroplanes should be detailed for the exclusive use of the artillery. Observing ladders and range finders are most necessary. Teams cannot be hooked in under fire, some arrangement is required to enable the positions of guns to be changed easily by hand.

The regulations direct that artillery fire should at first be divided between the enemy's artillery and his infantry. This is wrong, and should be altered, fire must first be concentrated on the artillery. Scientific methods of fire against infantry require to be explained in more detail in the Regulations. The necessity for oblique fire should be more strongly insisted upon. The principles laid down as to the use of aeroplanes by artillery apply to individual batteries only. They must be extended to embrace their employment by larger units.

Note on Firing from Well-Concealed Positions.

Many officers are led away by the advantages concealment seems to offer. Major H. Cédié argues that positions offering very considerable concealment will seldom be obtainable in war, or if obtainable will not be used owing to the delay caused in ranging. This particularly applies in a combat of encounter, good concealment will be more used in defensive actions than in any other.

The Firing Manual of the Russian Field Artillery.

This manual appeared in 1911 together with instructions on the application of the rules of fire. The changes introduced since the 1904 edition of the manual are commented upon. It is remarkable that ranging is to be carried out by the whole battery (eight guns). The rules for obtaining the direction seem complicated. Rules are given for laying on dirigibles.

Generally speaking the manual is based on the lessons of the Russo-Japanese War. The advantages of concealment and well-organized intercommunication are insisted upon. Only two rounds per gun rapid fire is allowed. Indirect laying is to be the normal method, and mere initiative is left to the battery commander.

A.R.R.

Rivista di Artiglieria e Genio.

January, 1913.

French Military Aeronautics.

Aerial navigation, under whatever form it may have assumed, but especially that of aviation, has developed greatly in these last years and is still on the increase. Under the title of "military aeronautics" an arm, formed with *personnel* of all the other arms, has arisen. Military aeronautics is concerned with the study of the acquisition and construction, and the placing in working order of all the means of aerial navigation for military purposes—balloons, dirigibles, aeroplanes, etc. To the War Minister is allotted a special section which, partly under the direction of the engineers, is called the aeronautical section, and which centralizes and studies all questions relating to military aeronautics, *personnel*, material, and mobilization.

Military aeronautics is placed under the authority of a general officer directly under the War Minister, who has the title of "permanent inspector of military aeronautics." It comprises: (*a*) personal navigation; (*b*) aeronautical troops; (*c*) establishments. These elements are distributed in aeronautical centres.

(*a*). Personal navigation is formed from officers and men of the troops recruited from the whole army and who are placed outside the lists. The numbers are variable and are determined by decree according to the funds available and the requirements for instruction. They are allotted to the several aeronautical centres, and divided into sections for aviation and the crews for dirigibles.

(*b*). Aeronautic troops comprise 7 aeronautical companies (4 for aerostation, and 3 for aviation) and 10 aeronautical sections, but this number may be increased as aviation progresses.

1. *Transport Companies.*—These are divided into three groups each under the orders of a Lieut.-Colonel or Colonel. Each group contains companies and sections, either for aerostation or aviation or in various localities for both.

The following table shows the disposition of the aeronautical troops:—

Groups and Localities.	Troops.	
	Central Units.	Detached Sections.
1st Group, Versailles.	1st Aeronautical Company (aerostation). 2nd Aeronautical Company (aerostation). 3rd Aeronautical Company (aviation). 8th Transport Company.	11th Aeronautical Section (Chalais Meudon). 12th Aeronautical Section (Douai). 13th Aeronautical Section (Etampes).
2nd Group, Reims.	4th Aeronautical Company (aerostation). 5th Aeronautical Company (aerostation). 6th Aeronautical Company (aviation).	21st Aeronautical Section (Chalons Camp). 22nd Aeronautical Section (Verdun). 23rd Aeronautical Section (Toul). 24th Aeronautical Section (Epinal). 25th Aeronautical Section (Belfort).
3rd Group, Lyons.	7th Aeronautical Company (aviation).	31st Aeronautical Section (Campo d'Avon). 32nd Aeronautical Section (Pau).

One of the sections of the 1st group is at the disposal of the War Minister.

Aeronautical Centres.—The name of "Aeronautical Centre" is given to the locality where aeronautical services are collected under a central authority, who is called the "chief of the aeronautical centre." The aeronautical centres may be constituted with one unit of aerostation, with one unit of aviation, or with both. They arrange for professional instruction, and for the purchase, maintenance, and repairs of material.

Aeronautical Establishments comprise depôts for aeronautical material, offices, and special establishments.

The depôts and offices are found in all the principal and secondary centres, developed more or less according to the importance of the centre. They provide for the purchase, maintenance and repair of the material. They depend upon the chief of the centre under the direction of the Commandant of the group to which the centre belongs, thus:—Command of the 1st group—for the depôts and offices stationed in the military government of Paris, and the districts of 1st, 2nd, 3rd, 4th, 5th, 9th, 10th Army Corps, as well as the 11th Morocco, Tunis; command of the 2nd group—districts of the 6th, 7th, 20th Army Corps; command of the 3rd group, districts of the 8th, 12th, 13th, 14th, 15th, 16th, 17th Army Corps, as well as the 18th, 19th at Algiers. Each of the depôts and offices has its own specialized and administrative staff.

The special establishments depend directly upon the War Minister through the channel of the Inspector-General of Aeronautics, and comprise:—

The direction of military aeronautical material;
The central establishment of military aeronautical material; } at Chalais
The laboratory for military aeronautics; } Meudon.
The atmospherical and telephotography laboratory;
The military aviation laboratory at Vincennes.

Peace Organization of the Companies and Aeronautical Sections.

	Aeronautical Companies.	Aeronautical Section.	Transport Companies.
Captains	1	1	1
Lieutenants and sub-lieutenants	2	—	2
Total officers	3	1	3
Adjutants	1	—	1
Sergeant-majors	1	—	1
Farrier-sergeants	1	1	1
Sergeants	9	2	10
Corporals	9	4	12
Chief workmen	5	2	—
Buglers and drummers	2	1	2
Privates	80	50	100
Total troops	108	60	127
Officers' horses	3	1	3
Troop horses	—	6	130

Peace Organization of the Aeronautical Groups.

		1st Group.		2nd Group.		3rd Group.		Note.
		Officers.	Troops.	Officers.	Troops.	Officers.	Troops.	
Staff of the groups.	Commandant (colonel or lieut.-colonel).	1	—	1	—	1	—	All the officers are mounted except the treasurer and the clothing officer. The commandant has 2 horses.
	2nd Commandant (lieut.-colonel or major).	1	—	1	—	1	—	
	Relatore (major or captain)	1	—	1	—	1	—	
	Officer in charge of mobilization (captain).	1	—	1	—	1	—	
	Treasurer (captain or lieutenant).	1	—	1	—	1	—	
	Clothing officer (captain or lieutenant).	1	—	1	—	1	—	
	Under officers, corporals and soldiers.	—	31	—	31	—	31	
Aeronautical troops.	Aeronautical companies(*a*)	9	324	9	324	3	108	(*a*). 3 to 1st group, 3 to 2nd, 1 to 3rd.
	Aeronautical sections (*b*)	3	180	5	300	2	120	(*b*). 3 to 1st group, 5 to 2nd, 2 to 3rd.
	Transport companies ...	3	127	—	—	—	—	
	Total men for each group...	21	662	20	655	11	259	
	Horses...	20	130	19	30	8	12	

The numbers indicated correspond to those up to the end of 1912. The number of sections varies with successive augmentations.

Administrative and Technical Organization.—For manœuvres and mobilization the units are divided into (1) squadrilla and crews for the dirigibles; (2) formations assigned for the service of captive balloons.

The commandant of the aeronautical centre is responsible to the commandant of the groups for the military and technical instruction and

for the mobilization of all the effective aeronautical troops. He is also responsible for the depôts of aeronautical material. The effective officers of the companies and sections are charged with the administration of the units, and with their military and technical instruction.

The chief of aviation is concerned with aeroplanes, the organization of the squadrilla, and the instruction of the aviators. The chief of aerostation is concerned with the dirigibles, spherical balloons—both free and captive, kites and the instruction of the *personnel*.

AVIATION.—*Aeroplanes*.—The composition of this section is not precisely fixed and depends upon the future development of aviation. The decree of the War Minister authorizes that the normal squadrilla should consist of eight machines, divided into four sections each with two machines. The machine may be biplane, monoplane, or multiplane.

Each squadrilla is provided with automobile transport—12 autocars for each squadrilla, that is three per section, and an office wagon per squadrilla, two rapid motors for terrestrial communication. The *personnel* of a normal squadrilla consists of 7 pilots, and comprises the commandant, observers in various numbers, 1 accountant, 4 non-commissioned officers, 44 corporals and skilled privates, 2 non-commissioned officers and 14 unskilled soldiers. Provision is made for requisitioning private material in time of war and for the summoning of pilots.

At the end of 1912 it was intended that 27 squadrilla for the field, and 5 for fortresses should be mobilized, as well as 6 squadrilla for the surveillance of certain points on the coast, and 10 sections with a reserve machine for each section for the cavalry divisions. At the end of 1913 there should be 510 machines, and the ultimate programme is for a thousand or even more.

AEROSTATION.—*Dirigibles*.—These take part in manœuvres, and the commandant directs the instruction of the pilot pupils and the mechanics, under the authority of the chief of aerostation of the aeronautical centre. The *personnel* constituting the crew of a dirigible is taken from the aeronautical companies and sections stationed in the aeronautical centre. Trials are being made with a uniform type of dirigible *cruisers*, and there should be 20 of these by the end of 1915 (5 each year for 1912, 1913, 1914, 1915), which, together with 15 dirigibles now existing of divers types, will form the complete squadron according to the present programme. In war time private dirigibles will also be requisitioned to be used with the army.

Spherical Balloons.—Each aeronautical company has an aerostatic park, either for compressed or ordinary hydrogen. The park for compressed hydrogen is conveyed in 20 wagons (1 windlass car, 12 tube cars, 1 balloon car, 1 ammunition, 2 carbon, 3 provisions and baggage). The ordinary park consists of 16 wagons (1 for the manufacture of hydrogen, 1 windlass, 1 balloon car, 13 for tools, carbon and baggage). The organization for each park comprises 1 captain, 2 subalterns, 78 troops. Each park provides for 4 balloons—1 varnished spherical balloon of 540 m.c., 1 unvarnished balloon, 1 auxiliary balloon of 200 m., 1 balloon of 50 m.c. for transport of gas. There are also the necessary means for preparing 10 inflations.

The depôts of aerostatic material are at Versailles, the camp at Chalons, and at Reims.

E. T. THACKERAY.

CORRESPONDENCE.

THE WATER SUPPLY OF RISALPUR.

DEAR SIR,

The article in the April number of the *R.E. Journal* on the Risalpur water supply might perhaps have been of still greater interest if it had gone rather more fully into the actual results obtained. It leaves one perhaps with the impression that the six wells give the required supply of 263,000 gallons. For the benefit of anyone who may have to undertake a similar project I would draw attention to one or two points.

The diagram accompanying the article in question shows certain curves of recuperation. The best curve is that of No. 1 well taken in July, 1908; the other curves taken in 1912 show a very considerable falling off in the rate of recuperation as compared with No. 1 well in 1908. Now in 1908 No. 1 was the only well; in 1912 there were six wells.

It may be admitted as stated by Lieut. Wilson that the inflow of fine silt into the wells may partially account for the reduced rate of recuperation, but it is not I think enough to account for it altogether. The presence of five additional wells spaced 150 to 160 ft. apart and within a radius of 400 ft. from the original well, must I think be held partly responsible for the reduced inflow on the whole lot when all are pumped simultaneously.

It will be seen from Lieut. Wilson's diagram that in 1908 the recuperation of No. 1 was about 1 ft. 9 in. from a draught of 5 ft. in one hour; in 1912 when five more wells had been added the corresponding rate of recuperation for No. 1 well was only about 8 in. in one hour from a draught of 4 ft. 8 in. The other two wells whose curves are given by Lieut. Wilson show rates of about 11 in. and 8 in. from 5-ft. draught in one hour. Subsequent experiments this year (1913) give a rate of 10 in. to 12 in. from a 5-ft. draught after five wells have been pumped simultaneously.

A great deal of fine silt has been removed from these wells and it is doubtful whether we can look for any great improvement in this respect. We therefore have to reckon with the fact that the rate of inflow into the six adjacent wells is not much more than one-half of the rate obtained from one of these wells, when it was the only well. A rate of 12 in. being quite insufficient to give the necessary supply, the question is what is the greatest depth to which we can safely pump without disturbing the well bottoms and causing inflow of silt. Experience in the rather fine sand at Risalpur tends to show that the sand will not stand a rate of over 1·6 ft. per hour. This rate is obtained at a draught of about 8 ft., and is equivalent to about 2,000 gallons per hour, that is to say we can pump 10,000 gallons per hour from five

wells, or say 11,000 gallons on an average, as it is only occasionally that we want one well spare for cleaning.

The next question to be answered is how many hours rest must the wells be allowed daily after being pumped down to 8 ft. to avoid permanent depression of the water level. As stated by Lieut. Wilson, the original scheme proposed pumping for 16 hours, giving only 8 hours' rest.

The necessary period can be easily calculated if the true value of "C" (*vide* Lieut. Wilson's diagram) is known. It will be seen from his diagram that with C=$\frac{1}{4}$, and draught 5 ft. the water is still about 5 in. below normal after 10 hours. With daily pumping it would probably be necessary to allow another two hours for recovery, so that even with a 5-ft. draught 12 hours' pumping is about as much as can reasonably be allowed, assuming that $\frac{1}{4}$ is a fair value for C.

The true value of C at Risalpur must be rather under $\frac{1}{4}$, and in practice with draught of 8 ft. it is found that about 16 hours' rest is necessary; this allows the wells to recover to within 3 in. to 4 in. below normal. That is to say that the six wells at Risalpur will only stand about eight hours' pumping at the rate of 11,000 gallons per hour. In point of fact in order to obtain reasonable efficiency from the engines, water is pumped at the rate of 18,000 gallons per hour; when the limit of draught is reached the engines have to be stopped until the water has risen sufficiently. The supply is far below what was originally aimed at, and is inadequate for the needs of the cantonment, and the problem now is how to increase it at reasonable cost.

There are other points in Lieut. Wilson's article which call for remark. He states that in the middle of the cantonment the water was found to contain too much salt to make it suitable for permanent use. It is believed that this conclusion was based on the results of a single new well. Be that as it may subsequent experience has shown that good drinking water could have been got in cantonments. The moral seems to be that a water-bearing area should not be too hastily condemned on the evidence of a single well or boring.

The wells as now sited derived little or no benefit from the Kalapani stream. The site plan shown on page 219 of the April *R.E. Journal* is not to scale, No. 1 well being actually about 500 ft. distant from the normal channel of the Kalapani.

The Kalapani is, however, liable to contamination from various sources before it passes the well sites, and it is questionable whether it would have been sound to site the wells so as to obtain infiltration from, the actual stream. The question of filter beds must have arisen, adding appreciably to the cost of the scheme.

The suction pipes are actually 4 in. and not 5 in. as shown in the diagram. The result is that when pumping at the rate of 18,000 gallons the engine must have at least three wells to draw from, and the water in the two last wells cannot be pumped to the full draught. It would have been better if the 5-in. suction pipes as originally designed had been adhered to. As to the means of improving the supply, tube wells provide the only means of doing this at reasonable cost.

Mr. Ashford, of the Canal Department, after several years' experiments, has produced at Amritsar a tube well which successfully obviates the

infiltration of sand. A 10-in. well tube of this description has been successfully working at Amritsar during the last two years, during which period its output has averaged over half-a-million gallons a day. An equivalent supply from the ordinary masonry well would have cost at least fifty, perhaps a hundred times as much.

For a water supply like that of Risalpur the surface well of masonry with its heavy initial cost and uncertain results is out of date, and it is now proposed to put down tube wells at Risalpur. The result may be of sufficient interest to form the subject of a future article in the *R.E. Journal*.

G. LUBBOCK, *Major, R.E.*,
Garrison Engineer, Risalpur.

14th May, 1913.

WEST BEYNE BRIDGE.

SIR,

May I point out some small errors which have somehow crept into my paper on the West Beyne Bridge in the *R.E. Journal* for May, 1913? They are:—

(*a*). On page 269 in the 15th line from the bottom, the quantity of water should be 6 gallons per cubic foot of cement, instead of 12.

(*b*). On page 273 in the 13th line from the top, for "renewed" read "removed."

(*c*). On page 279 the prices of sand and stone given—viz. Rs.33/- and Rs.18/- respectively, are per *hundred* cubic feet and not per cubic foot. The same mistake also appears on page 280.

(*d*). The cost of labour for concreting with a gang of 50—60 men worked out to Rs.8.25 per *hundred* cubic feet.

Yours faithfully,
E. P. ANDERSON,
Capt., R.E.

Lahore, 19th May, 1913.

The Editor, *R.E. Journal*.

BOOKS RECEIVED.

SERVICE CHEMISTRY: Being a Short Manual of Chemistry and Metallurgy and their Application in the Naval and Military Services. By Vivian B. Lewes, F.I.C., F.C.S., and J. S. S. Brame, F.C.S. Fourth edition. Revised and illustrated. 1913. Price, 15s. Edward Arnold, 41–43, Maddox Street, London, W.

THE FIELD ENGINEER'S HANDBOOK. A Handbook of Field Engineering for Civil Engineers and Engineering Students. By G. Carveth Wells, A.C.G.I., and Arundel S. Clay, B.SC., A.C.G.I. With illustrations and tables. 1913. Price, 7s. 6d. Edward Arnold, 41–43, Maddox Street, London, W.

QUESTIONS DE CRITIQUE MILITAIRE ET D'ACTUALITÉ (5e *série*). Général H. Bonnal. Paris. 1913. Chapelot. 295 pages. Prix, 3 fr. 50.

LES ARMES AUTOMATIQUES. ÉTUDE DU FONCTIONNEMENT MÉCANIQUE. Capitaine Cordier. Paris. 1912. Imhaus et Chapelot. 140 pages. Prix, 2 fr. 50.

L'ÉVOLUTION DE LA MARINE AMÉRICAINE. Capitaine de frégate de Roquefeuil. Paris. 1913. Chapelot. Prix, 2 fr. 50.

LES AÉROPLANES DANS LA GUERRE D'AUJOURD'HUI. Lieutenant de Boisricheux. Paris. 1912. Imhaus et Chapelot. 33 pages. Prix, 0 fr. 5.

OFFICIERS MAL INSTRUITS ET MAL PAYÉS (d'après de récentes publications anglaises). S.R. Paris. 1912. Imhaus et Chapelot. 22 pages. Prix, 0 fr. 60.

LE GUIDE DE L'OFFICIER CHARGÉ DES COMPAS. Capitaine de vaisseau Louis Mottez. Paris. 1913. Chapelot. Prix, 2 fr. 50.