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Authors alone are responsible for the statements made and the opinions expressed in their papers.

THE DUAL RÔLE OF R.E. OFFICERS.

By Major A. F. Sargeaunt, R.E.

By the dual rôle of R.E. officers, or the two branches into which most of R.E. work is divided, is meant on the one hand all that appertains to the construction and maintenance of buildings, structures, and fortifications, and on the other hand those duties which are enumerated in Field Service and kindred regulations.

There is a tendency amongst some officers to belittle the importance of the work of the branch to which they do not for the time being belong, and to magnify their own particular branch; yet the two branches are interchangeable and an officer who is constructing barracks or fortifications to-day may be commanding an unit in the field to-morrow. It is no doubt difficult for the man who is in his element in working out calculations for a steel roof or designing a ferro-concrete building to sympathize with one whose time is chiefly occupied in training his own men and those of other arms in all that pertains to the art of war in camp and in the field; whilst the keen soldier, who is anxious to show what his own arm can do to assist and co-operate with others in the field is unable to bear with a life which entails much time at an office table and in which there is no soldiering.

It thus comes about that opinions are expressed in which the dual rôle is not recognized; but the fact remains that R.E. officers must be prepared to perform the dual rôle and unless they are so prepared they cannot be considered as thoroughly efficient. Of course there are exceptions to every rule, and some officers may specialize in one particular branch, and may be fortunate enough to be continuously employed in that in which they have specialized; but for the majority it is more a question of being generally useful and efficient than of being a specialist.

As in most cases where there are two well-supported divergent opinions, so in this case the happy mean will be found to lie between the two. If we think for a moment, we shall recollect that nearly every officer looks forward to some day filling the post of C.R.E., and the greater part of a C.R.E.'s work consists in arranging for and superintending building operations. It is therefore of the utmost

importance that when he reaches the C.R.E.'s chair, an officer should be *au fait* with the latest ideas in connection with building, *e.g.* the use of new materials and how they affect W.D. work, or the advantages and disadvantages of vulcanite and ruberoid as roof coverings; and further, a C.R.E. with an Army or a Division has in all probability a great deal to do in the matter of constructing bridges, building huts, draining areas, etc., which necessitate a knowledge of the art of the Civil Engineer. We see then the need of all officers keeping in touch with the works or building branch of the Corps.

On the other hand in addition to possessing this knowledge of building a C.R.E. also requires to represent the R.E. in the field with the other arms, and he must be prepared to give advice and instruction in everything which concerns the work of R.E. in the field, and he is the adviser to the G.O.C. as to how the R.E. can be most usefully employed. So, for this reason, R.E. officers must keep in touch with other troops during training and on manœuvres and must be up to date in the latest regulations and ideas on these subjects. These requirements are not peculiar to a C.R.E. who is the C.R.E. of a division as well as the C.R.E. of a district, because all officers are liable to be asked to act as umpires at any time, and opportunities may occur of commanding a mixed force in the field or at a war game, so that R.E. officers ought at all times to be ready to exemplify that they are capable of carrying out these duties as efficiently as an officer of any other branch of the Service.

The question arises how can this double rôle be best filled, that is to say how can a R.E. officer keep abreast of the times as regards field operations and at the same time not get rusty in the matter of bricks and mortar and kindred materials. It is not possible to legislate for officers engaged on special work such as the Ordnance Survey, and staff billets, and these appointments are only of a passing nature and limited to a certain number of years; it therefore follows that the officers to be dealt with fall into two main categories, viz. those employed with field units and those employed with fortress companies or as division officers.

The aim now is to make suggestions by which the individuals in one category may be brought into contact with the individuals in the other category.

The officers with field units will be considered first.

From the beginning of April or May to the end of September the time of officers with field units is occupied with training in one form or another, and there is no time to carry on the work of a division in addition; if the training of a troop or company and the oversight of a division run concurrently, both must suffer and justice cannot be done to either. But at the same time there is ample opportunity

during these summer months to train N.C.O.'s in such subjects as road reconnaissance, map reading, small defence, attack, or other schemes, which usually come under the head of winter training; so that those subjects which are comprised in winter training can be carried out during the summer training instead. If this is done, then from the beginning of October to March or April the N.C.O.'s and men can be employed at their trades for at least five days a week either under their own officers or under the D.O., and the drivers and horses can be utilized in carrying materials for repairing roads and parades, etc. Saturday should be reserved for the unit commander to have the whole of the *personnel* of the unit at his disposal for drill or any other purpose that he may think fit. It is not practicable to hand over all the available labour to be used in the division, because in the unit itself there will be considerable work for several tradesmen; wagons have to be painted, carts repaired, pontoons and other technical equipment overhauled, and sufficient men should be put onto this work to get it done as expeditiously as possible.

It is only right that the sapper should have every opportunity of working at his trade through the winter; he enlisted with the idea that he would be employed at his trade, and he becomes a more efficient sapper the more practice he can have; he is also fitting himself for employment when he returns to civil life, and incidentally allows the fulfilment of the Corps Memo. where it is laid down that a man must be employed six months at one trade rate before he can be tested for a higher rate.

No doubt the ideal arrangement is for the men to be employed under their own officers, and this is often feasible, for there are usually certain items awaiting execution and requiring a variety of trades which the C.R.E. can hand over to the unit to carry out, or on a less ambitious plane the O.C. unit may take over the quarterly requisition for one or more barracks and arrange for all the items to be carried out; such work requires organization and forethought if the best use is to be made of men and time. If these suggestions are for some local reasons not practicable, then the *personnel* of the unit must be transferred to the D.O. for him to detail and supervise.

Again, the D.O. will, unless he is unhuman, require leave, and during the period that he is away his place can be taken by an officer from a field unit, who will thus have an excellent opportunity of unearthing buried knowledge and bringing that knowledge more up to date.

Thirdly, there are always questions of enlarging, re-adapting, or building *de novo* in every C.R.E.'s jurisdiction, and although there may be no funds in hand for any particular item yet it is a sound policy to have a cut-and-dried scheme ready to hand. For instance, there may be a proposition to convert a certain building into an

Officers' Mess, the alternative being a wholly new building. The D.O. is always a busy man, so here the latent talent in the field units may be advantageously utilized by the C.R.E.; the selected officer can go thoroughly into the alternate schemes, and make his proposals in the form of a report with explanatory sketches. Even though, as already mentioned, there may be no immediate prospect of the work being carried out, yet having a clear and concise report will enhance such a prospect, especially if the question happens to be brought forward for instance during a G.O.C.'s inspection or at a visit by a member of the Army Council.

Much more might be done than is done in officers visiting engineering works in progress. Borough or county surveyors or engineers can name many interesting and instructive works over which they have control. Young officers on a construction tour from Chatham will visit engineering works in the vicinity of garrisons, of which the R.E. officers in those garrisons know nothing; so that here we have an easy and pleasant way for R.E. officers to acquire knowledge of civil engineering, and the cost of the journeys might be borne by the Training Grant or Transport Vote.

There is still one more suggestion, and that is that papers on engineering and building subjects be disseminated much more liberally than they are at present; much may be learnt from the perusal of such papers as *The Building News*, *Engineering Record*, and *Concrete*, and one copy of each could cover a wide area.

If these suggestions, which have been put forward, can be put into practice, the officer with a field unit can no longer complain that he is out of touch with engineering work; and with his own leave, attendance at courses, staff tours, regimental rides, writing essays, etc., he will find that the winter months are profitably and fully occupied.

But how about the Division Officer? How is he to learn to co-operate with infantry, artillery, and cavalry, and to assist them in their particular work? How can he become cognisant of their methods of training, how learn the method of developing an attack? How is he to become acquainted with the organization of his own arm, and to know what it is capable of doing in the field? As with all knowledge, so with this, there is no royal road; it can only be acquired by practice.

Although it is easier to carry out periodical services and other barrack items when the barracks are comparatively empty, yet by pre-arrangement and forethought at the commencement of the financial year it should be possible to have one month, say August or September, when there is a minimum of work in hand, and when the D.O. can be spared. During this pre-arranged month the D.O. should be attached to a field unit during training. He will then

learn what technical equipment is carried in the field, what first and second line transport consists of, how camping grounds are prepared for occupation, he will see how the feeding of men and horses is arranged for, he will march and bivouac—in short, many an officer, who is accustomed to the rhythmical routine of a Division Office, and who was under the impression that to belong to a field unit meant to be continually hustled, will learn to delight in the open-air life of the soldier with its concomitant advantages of a healthy appetite and sound sleep.

Officers of fortress companies have to put their men through fieldworks and musketry courses, but they do not as a rule come into contact with other arms during these times. If therefore officers are to be attached to field units it should be at a time when the unit is engaged in brigade, or divisional training, or army manœuvres; a fortnight's training under these conditions is worth several months of training when these conditions are absent. Under these conditions too an unit can usefully employ more than its peace establishment of officers, thus approximating to its war establishment, and such work as reconnaissance for attack or defence can be the better carried out.

Division officers could also be employed as umpires during training and manœuvres, thus relieving regimental officers who could remain with their units. Many officers are taken to act as umpires, who have had no previous experience of such work and their duties are very fully explained in the regulations, so that there is no need to be afraid of courting failure, and as an umpire one gets a wider vision of the trend of events and of the actors than if one is tied to one particular unit, and one hears discussions and criticisms on various points of interest which have arisen during the manœuvre.

Staff tours and War Games, although not to be compared with field training from an instructional standpoint, give an insight into army organizations, road spaces, etc., and give practice in writing orders and in appreciating situations. Tours and war games could be participated in without seriously interfering with the work of a Division Office.

If these suggestions are to be given life it entails co-operation amongst C.R.E.'s. The Training Programmes are published early in the summer, and if the C.R.E.'s in a divisional area could come together when the programme has been published they could formulate a scheme for interchange or attachment of officers as has been suggested, knowing their own requirements and the requirements of the Divisional Headquarters Staff.

Although it may not be possible to intermingle all officers as has been outlined yet it should be possible to do so in the case of the majority of majors and captains, and if it entails putting a junior

subaltern in charge of a division whilst the D.O. is training, or of a field unit whilst the O.C. is in charge of a division, then it will be a good experience for these young officers.

These notes do not profess to be exhaustive, nor is it imagined that a cut-and-dried scheme would be applicable to all parts of the country; but the object has rather been to draw attention to the subject so that it may be more generally recognized, that so far as the general work of the R.E. for the Army is concerned, that work is of two kinds, and that a closer association is needed between the officers engaged on these two kinds of work.

ECHOES FROM THE ENGINE ROOM.

(*Concluded*).

By "INSPECTOR."

ECHO NO. 18.

PUMP SPEEDS.

Some general observations upon choice of plant are made later on, it will therefore suffice to remark here that although it may be possible to get the desired output from a small pump driven unduly fast, such a pump is less likely to give reliable service than one more appropriately proportioned to the work to be done. The deduction from this is that, in selecting a pump, it is insufficient to consider only the head concerned and the gallons per minute, especially so in the case of competitive tenders. It is desirable therefore, in the case of reciprocating pumps, to decide upon some limiting speed for the pump plunger, ram, or piston. Manufacturers' lists are apt to be somewhat misleading in this respect as some makers adopt a far more liberal rating than others. Although therefore this point can best be decided by experience, some general remarks may be of assistance. To avoid misunderstanding, by "pump speed," or simply "speed," is here meant the mean speed in feet per minute of the pump plunger, ram, piston, or bucket.

In the case of steam pumps or pumping engines it is the pump end that limits the permissible speed. The longer the stroke of the pump the higher may the speed be. The higher the head worked against the slower must the pump be run. The more uniform the flow of water from the pump the faster may the pump be worked without causing undue "hammer" or other discomforts. For instance a 3-throw pump can work satisfactorily at a higher speed than a single ram pump. Again, the permissible speed will depend somewhat upon the design of the pump valves; their size and lift and number. The speed is moreover governed more or less by the general design of the pump. For example it is permissible to run a direct acting pump faster than one of the same size operated by long rods *e.g.* a well pump. And finally the speed is influenced by the air vessels on the pump.

If one considers the results of actual practice and summarizes the deductions that can legitimately be made from the published catalogues of leading manufacturers, it will be found, in spite of all these varying factors, that some fairly definite figures for speed can be arrived at.

It is not desirable to run boiler feed pumps of the "donkey" type too slowly if advantage is to be derived from the flywheel; but for continuous working it may be preferable to sacrifice the flywheel effect to some extent in order to avoid excessive wear and secure reliability. Having regard to these considerations the following limits of speeds appear to be appropriate for this class of pump:—

For a stroke of	2"	...	...	...	40 f.p.m.
,,	4"	...	...	...	70 ,,
,,	6"	...	...	...	80 ,,

For flywheel pumps of the "Manchester," "Cameron" and "Colchester" types and for direct acting flywheel pumps generally the limits given above may be taken as a guide for the smaller sizes. For the larger sizes the corresponding limits would be

For a stroke of	9"	...	...	...	100 f.p.m.
,,	12"	...	...	...	120 ,,
,,	18"	...	...	...	180 ,,

These figures may be compared with the speeds for flywheel pumping engines given in Table IV.

For power pumps attention is directed to Table I. The speeds there given are deduced from a catalogue referring to pumps for mining and general purposes, they are considerably lower than the speeds deducible from some other makers' lists for corresponding pumps, but are not unduly low for permanent requirements entailing long hours of work. The details are given partly to illustrate the reduction of speed as the head is increased. Table II. gives the speeds deduced from another maker's list, and these form a useful guide for all ordinary purposes.

TABLE I.

Pump Speeds. Three Throw Power Pumps.

Stroke of Pump. (Inches).	Head. (Feet).	Speed (F.P.M.).	
		Standard.	Max.
6	1800	—	45
6	1200	—	50
6	600	60	80
6	200	70	85
12	1800	—	60
12	1200	—	70
12	600	70	100
12	200	80	100
15	1800	—	62·5
15	1200	—	75
15	600	75	100
15	200	75	100

TABLE II.

Pump Speeds. Three Throw Power Pumps.

Stroke of Pump. (Inches).	Head.	Speed (F.P.M.). Standard.
6	Up to 225 lb.	50
8	,,	60
10	,,	70
12	,,	80
15	,,	100
18	,,	105
4	Up to 100 lb.	67
6	,,	75
8	,,	80
12	,,	100
15	,,	105

For well pumps the speeds given in Table II. may be divided by 2 if the pump rods do not exceed 100′ in length. With longer rods the speed should be still further reduced.

The leading makes of single cylinder, or "Simplex," straight line pumps for boiler feeding usually have a stroke which is long in comparison to the diameter of the water piston, and in these pumps the speed is low relatively to that of pumps generally. The following figures are deduced from the catalogue of one of the leading makers of this type of pump :—

Stroke	6″	...	...	...	...	22 f.p.m.
,,	12″	...	...	...	...	30 ,,
,,	18″	...	...	...	...	36 ,,
,,	24″	...	...	..	...	48 ,,

These figures are also applicable to tandem compound pumps of this type, and represent the maximum speeds at which these pumps should be run for continuous working for boiler feeding.

Double cylinder, or "duplex," straight line pumps may be run faster than those of the "simplex" type because of the more regular flow of water from them. Some makers give the list rating of such pumps upon a basis of 75, or even 100, feet p.m. but a consideration of the factors governing the speed of a pump suggests that such a basis is wrong. Table III. gives results deduced from the catalogue of one of the leading makers of duplex pumps; these figures may be compared with the speeds given in Table IV. and may be relied upon as representing good practice for continuous work.

TABLE III.

Speed of Straight Line, Duplex Pumps.

Stroke of Pump. (Inches).	Head.	Speed (F.P.M.).		Remarks.
		Standard.	Max.	
3	Up to 160 lb.	25	62·5	Suitable for piston and plunger pumps. For ram pumps working at higher heads lower speeds are preferable.
6	,,	50	75	
10	,,	62·5	104	
15		62·5	125	
4	Above 300 lb.	16·75	33·5	Externally packed ram pumps.
6	,,	37·5	62·5	Boiler pumps.
10	,,	41·5	75	Externally packed ram pumps.
15	,,	50	100	Mining type.
18	,,	60	110	
4	Up to 8000 lb.	20	33	Hydraulic pressure pumps of the externally packed ram type.
6	,,	25	45	
10	,,	33	62·5	
15	,,	37·5	80	

Table IV. gives results from actual practice or from data received in connection with offers to meet definitely specified conditions. To save trouble in reproducing this table, figures for steam consumption are also included therein—these are referred to again further on.

TABLE IV.—PART I.

Speeds, P.H.P., and Steam Consumption of Flywheel Pumping Engines.

Reference.	Pumping Engine (Inches).	Boiler Pressure (lb.).	Head (Ft.).	P.H.P.	Speed (F.P.M.).		Steam Feed Coal per P.H.P. Hr. (lb.).	Remarks.
					Normal.	Max.		
A	$\frac{7\frac{1}{2} \times 13}{7\frac{1}{2}} \times 12$ ...	110 S.	145	7·5	90	120	29 S.	Plunger. Tandem Comp. C.
B	$\frac{8\frac{1}{4} \times 13}{3\frac{5}{8}} \times 12$ ...	120	1450	13·5	90	150	32 S.	Ram. Side by Side Comp. N.C.
C								
D	$\frac{9 \times 14\frac{1}{2}}{2\frac{5}{16} \times 3\frac{1}{8}} \times 20$ ...	140	1540	22·1	127	150	35·2 S. 6·22 C.	Differential Ram. Cross Comp. N.C.
E	$\frac{10 \times 22}{6} \times 18$ ...	120 S.	400	42·2	145	175	22 S.	Piston. Cross Comp. C.
F	$\frac{12 \times 26}{7\frac{1}{2}} \times 24$ ...	120 S.	400	84·4	180	220	20 S.	Piston. Cross Comp. C.
G	$\frac{10 \times 15 \times 26}{3\frac{1}{2} \times 5} \times 24$	125 S.	1142	46·6	150	180	18·5 S. 21·0 F. 3·29 C.	Differential Ram. Side by Side Triple. C.
H	$\frac{15 \times 25 \times 40}{13\frac{1}{2}} \times 36$	140	287	167	—	287	13·05 S.	Ram. Marine Type Triple. C.
I	$\frac{23 \times 43 \times 64}{12} \times 36$	200 S.	930	410	198	240	11·42 S.	Ram. Marine Type Triple. C.

TABLE IV.—Part II.

Speeds, P.H.P., and Steam Consumptions of Duplex Straight Line Pumping Engines.

Reference.	Pumping Engine (Inches).	Boiler Pressure (lb.).	Head (Ft.).	P.H.P.	Speed (F.P.M.). Normal.	Speed (F.P.M.). Max.	Steam Feed Coal per P.H.P. Hr. (lb.).	Remarks.
P	$\frac{6}{5\frac{3}{4}} \times 6$	80	97	3·18	50	55	97 F. 19·7 C.	Piston. N.C.
Q	$\frac{5\frac{1}{4} \times 7\frac{1}{2}}{2\frac{3}{4}} \times 6$ ...	80	375	2·9	50	55	19·9 C.	Ram. N.C.
R	$\frac{6 \times 10}{3} \times 10$... ...	90	770	13·39	85	100	40·75 S. 56·1 F. 7·43 C.	Ram. C.
S	$\frac{5\frac{1}{4} \times 8 \times 14}{7\frac{3}{8}} \times 10$ ..	110 S.	140 105	15·25 8·66	67	100	42 S. 55 S.	Plunger. C.
T	$\frac{5\frac{1}{4} \times 8 \times 14}{3\frac{1}{8}} \times 10$ ..	140 S.	890 1490	16·1 21·45	83 67	92 75	30·8 S. 31·25 S.	Ram. C.
U	$\frac{5 \times 8 \times 13}{7} \times 15$ ..	110	182	25·5	125	150	18·35 S. 28·3 F. 5·21 C.	Plunger. C.
V	$\frac{6 \times 9 \times 16}{9\frac{1}{4}} \times 15$ ...	110 S.	60	9·41	100	125	44·4 S. 90·6 F. 12·7 C.	Plunger. C.
W	$\frac{10 \times 16}{12} \times 12$ ...	90	120	28·2	80	100	56·4 F. 8·05 C.	Plunger. N.C.
X	$\frac{8\frac{1}{2} \times 13 \times 21\frac{1}{2}}{9} \times 18$	110	388	84·6	150	165	19·68 S. 26·6 F. 3·75 W.	Plunger. C

It is not intended to suggest that the maximum speeds given above never are and cannot be exceeded. For purely temporary work those speeds should certainly be increased in order to save the cost of a needlessly durable outfit. On the other hand the governing conditions for a permanent job may render it necessary to run the pump concerned appreciably below the maximum speed given in the tables. In short, although the tables are undoubtedly useful as a general guide, they should not be blindly followed.

ECHO NO. 19.

RELATIVE DIMENSIONS OF STEAM END AND WATER END.

In the pumps herein discussed the steam end is always double acting, but the water end may be either single acting or double acting.

If the push and pull of the steam end is called "Effort," and the opposition offered by the water end "Resistance," then the "Fraction" $\frac{\text{Effort}}{\text{Resistance}}$ will always be greater than unity.

If the steam pressure available and the total head are known then it might be reasonable to expect that the above fraction would have some fairly definite value. If the steam end is compound the situation becomes somewhat more complicated.

There is always the friction in the pump to be allowed for, and in the case of a pump used for feeding the boiler from which it is supplied with steam, allowances may also have to be made for (i.) loss of steam pressure between boiler and pump, (ii.) resistance offered by feed check valve, feed heater, water meter, economizer, etc.

Effort and Resistance will depend upon the area of the steam end and water end respectively, and the value of the "Fraction" will therefore be deduced generally from the square of the diameters of the two ends. In the case of compound pumps each cylinder may be assumed to give half the total effort and the "fraction" will refer to the relationship between the H.P. cylinder and the water end.

The question as to the horse-power of a pump with given dimensions, supplied with steam of a definite pressure, and run at a certain piston speed, is discussed at some length in Echo No. 20. For present purposes it is assumed that Effort = pressure at stop valve $\times$ (diam.)^2 of steam end, and Resistance = head $\times$ (diam.)^2 of water end. If the relative dimensions of standard sizes of steam pumps are compared on this basis it is found that the "fraction" has the valves shown in Table V. for different classes of pumps.

The meaning of the "fraction" can best be illustrated by quoting a few examples from which the general results have been deduced.

Example 1.—Straight line. Both ends D.A. Single cylinder. Duplex. For boiler feeding. Size, 9″ steam, 5″ water.

$$\text{Fraction} = \frac{9 \times 9 \times \text{steam pressure}}{5 \times 5 \times \text{steam pressure}} = 3{\cdot}24.$$

Example 2.—As for Example 1 but for water supply. Steam pressure 50 lb.; head 300′. Size, 10″ steam, 5″ water.

$$\text{Fraction} = \frac{10 \times 10 \times 50 \times 2{\cdot}31}{5 \times 5 \times 300} = 1{\cdot}54.$$

Were this pump used for boiler feeding the corresponding fraction would be "4".

TABLE V.

Relative Dimensions of Steam and Water Ends.

Type of Pump.	Value of "Fraction."				Remarks.
	Boiler Feeding.		Water Supply.		
	Limits.	Average.	Limits.	Average.	
Straight Line.					
Boths ends D.A.—					
Single Cylinder ...					
"Duplex"	2 to 6	2·75	—	1·5	Notes (*a*) and (*b*).
"Simplex"	1·75 to 2·5	2	—	1·5	
Tandem Compound—					
"Duplex"	1 to 1·75	1·25	1 to 1·125	1·1	Note (*c*).
"Simplex"	1·25 to 1·5	1·35	—	—	
Flywheel.					
Steam D.A. Water S.A.—					
Single cylinder ...	2 to 4	2·5	—	1·0	Note (*d*).
Two cylinders, side by side.	1·5 to 4	2·0	—	1·0	Note (*e*).
Compound, side by side	1 to 2·25	1·5	1 to 1·3	1·125	Note (*f*).
Both ends D.A.—					
Single cylinder ...	2·5 to 4	2·5	—	1·5	Notes (*d*) and (*e*).
Two cylinder ...	2·5 to 4	2·5	—	1·5	Note (*g*).
Compound	No	data	available.		

All above pumps are non-condensing.

NOTES ON TABLE V.

(*a*). The smaller the pump the higher the value of the fraction. This applies in every case.

(*b*). If the steam end directly operates the water end through rods, as may be necessary when the pump end is placed some way down a well, the fraction 1·5 becomes 1·7.

(*c*). In the case of tandem, and other compound pumps each cylinder does about half the work.

(*d*). The fraction has a high value for boiler feeding as it may be necessary to run the pump so slowly that the flywheel effect is negligible. For this reason the fraction has the same value even when the water end is double acting.

(*e*). This type of pump is nearly equivalent to a single-cylinder pump with both ends double acting, hence the fractions have the same values as in that case. Somewhat smaller values would, however, seem to be permissible, especially so in comparison with the figures for compound pumps.

(*f*). Although the flywheel effect may be small, one cylinder nevertheless assists the other. The same applies in the case of twin-cylinder pumps.

(*g*). This case is more strictly similar to a single-cylinder pump with both ends double acting.

General Note.—S.A., and D.A., signify "single acting" and "double acting" respectively.

Boiler feeding figures refer to cases where a pump supplies with water the boiler by which it is supplied with steam. It is assumed that the pressure per square inch on the steam end is the same as that upon the water end.

Water supply figures are based upon assumed conditions of a definite effective steam pressure in the steam end and a definite head against the pump end.

Example 3.—Flywheel. Steam end S.A.; water end D.A. Compound. Two rams. Boiler feeding. Size, 6" and 10" steam, 5" water.

$$\text{Fraction} = \frac{6 \times 6}{5 \times 5} = 1{\cdot}44.$$

Example 4.—As for Example 3 but for water supply. Steam 60 lb.; head 160'. Size, 12" and 16" steam, 10" water.

$$\text{Fraction} = \frac{12 \times 12 \times 60 \times 2{\cdot}31}{10 \times 10 \times 160} = 1{\cdot}25.$$

Were this pump used for boiler feeding the fraction would be 1·44 as in Example 3.

ECHO NO. 20.

SELECTION OF PUMP FOR GIVEN DUTY.

For temporary purposes it is not worth going to the expense of complications if a simple pump can be obtained to do the necessary work. Economy in first cost is more important than economical operation, and hence, provided reliability is not unduly sacrificed, a single or double cylinder non-condensing pump, to be run at its maximum speed, is to be preferred for such work. The requirements to be met may however be so little known beforehand that it may be necessary to allow a considerable margin in the size of pump selected.

Similar arguments apply generally to cases where the pump is only required occasionally, or if the pump is only run for two or three hours a day. Under such conditions although it may be gratifying to have a small steam consumption, such as would be obtainable with a high class pumping engine, from a business point of view the capital cost must not be overlooked. Exceptions may however arise which will call for some modification of this *e.g.* fuel may be very costly.

The more permanent the requirement, the higher the cost of fuel, and the longer the hours of daily pumping, the more justifiable is it to employ two stage or three stage expansion, and surface condensing; but it should be remembered that it is necessary to engage more highly paid labour for relatively complicated pumping plant in order to insure that the plant is worked to the best advantage.

In the case of a permanent military water supply scheme the requirements are probably known fairly definitely when the plant is installed, and although some allowance should be made for unforeseen contingencies it is not economical to put in plant that is needlessly big for the job. Recent water supply schemes for Indian cantonments have been based upon the assumption that the daily supply should be pumped in 8 hours; this allows an ample margin to meet possible increases in the daily consumption of water, always supposing that there is a liberal supply of water to be pumped. It may not be feasible to greatly accelerate the speed of the pump, as the correspondingly greater output might increase the "head" beyond that for

which the pump is suitable; moreover, by assumption, the pump should not be so much too big for the original requirements as to permit of any very large increase in its power in this way. The pump can however be run for longer hours daily, the pump house staff being added to if necessary to meet this. In what follows permanent requirements will alone be considered.

In the case of deep-well pumps the engine generally drives the crankshaft of the well gear by belt or through gearing or by a combination of belt and gearing and the engine is thus fairly comparable with any other engine used for driving ordinary machinery, as its speed is but indirectly governed by the requirements of the pump. The same remark applies to power pumps. But as regards direct-acting pumps, with which this Echo is more intimately concerned, the conditions are somewhat different in that the permissible speed of the pumping engine is limited by the water end.

Although single cylinder non-condensing pumps are made in sizes up to 50 pump horse-power (P.H.P.), and more, for 50 lb. steam, such a pump would be quite unsuitable for a permanent scheme. Per contra, a duplex, triple expansion, condensing pumping engine does not accord with "Inspector's" view as to what is suitable for an output of 10 P.H.P. or less. Doubtless the personal opinion of the "consulting engineer" is a big factor in the selection of a pump for a given duty, and therefore the remarks that follow can at best only be taken as suggestions.

For pumping plant (for water supply purposes—not boiler feeding) there is always ample water available for condensing, if, as is commonly the case the pumped water is used for that purpose, hence for 10 P.H.P. and upwards the engine may advantageously be made surface condensing; below this size condensing is hardly justifiable as a general rule, especially if the conditions permit of utilizing the exhaust steam in a feed water heater or water softening plant.

Compound pumps are made in quite small sizes, for one P.H.P. or less, but unless fuel is expensive a compound pump seems scarcely permissible for anything less than 5 P.H.P.

A triple expansion pump may be used for 25 P.H.P. and upwards, but for smaller sizes a compound pump is more appropriate, indeed, having regard to first cost, simplicity of operation, and all the other factors applicable to normal conditions it is doubtful if this limit should not be doubled unless fuel is very costly or the hours of pumping almost continuous.

For single stage expansion a steam pressure of from 50 to 80 lb. per square inch by gauge at the engine stop valve should be aimed at. For two-stage expansion the pressure may be 80 to 120 lb., and for three-stage expansion the pressure may be 100 lb. and upwards.

These are the general suggestions, but there are several modifying

factors. For instance the plant, although permanent, may be only worked occasionally, or intermittently, and therefore the above limits for compound or triple expansion plant may require extending. Or, for the same reasons, in order to reduce the capital cost it may be preferable to get the requisite effort by leaving out the condenser and working at a higher initial pressure.

These suggestions for permanent requirements may be conveniently put in a tabular form :—

Single Cylinder.—Up to a maximum of 10 P.H.P. Boiler pressures up to 100 lb. Always non-condensing.

Compound.—From 5 P.H.P. up to 25 P.H.P. generally, but from 2·5 to 50 P.H.P. to meet special conditions. Boiler pressures from 80 lb. upwards. Condensing above 10 P.H.P. always, never below 5 P.H.P.

Triple Expansion.—From 25 P.H.P. upwards. Boiler pressures from 100 lb. upwards. Always condensing.

These are the suggested limits for flywheel pumps. Since a straight line pump is less able to use the steam expansively it would be justifiable to instal a triple expansion pump of that type for sizes below 25 P.H.P.

Echo No. 10 may be referred to as to choice of type in the case of Power Pumps, and Echo No. 18 for a guide as to piston speeds.

As regards the type of pump end, the relative merits of piston, plunger, and ram have been already discussed.

Although hydraulic pressure pumps are made to work against what is equivalent to very high heads, it seems usual, when considerable quantities of water have to be dealt with, not to exceed 2,000′ in a single lift.

Even though the type of pump may have been decided upon, there is still an important point to be settled, namely, the number of pumps to be installed to deal with the supply required. On the grounds that reliability of service is supremely important, it is sometimes contended that it is better to provide three pumps than two, even though with three pumps two would normally work simultaneously, whereas with two (larger) pumps each would be able to give the necessary output alone. While it may be admitted that this view deserves consideration when the size of the plant is based upon eight hours' pumping daily, it is contended that two pumps, *i.e.* one in work and one spare, is the preferable arrangement in nearly every case. Two sets of plant, each of a size which, for purposes of comparison may be called "unity," will cost less than three similar sets each of "half" size. One "unity" set will be more economical in working than two "half" size sets, and unless the conditions are very abnormal the two sets give a reasonably sufficient margin of spare plant.

Although the reader of these notes may have to specify the boiler pressure intended, or available, and also the "speed" permissible, type of steam end and of pump end, it will scarcely be necessary for him to lay down the sizes of cylinders and length of stroke. On the other hand it would often be useful for him to know approximately whether the plant offered is of economical size for the work proposed.

It is not difficult to work out the indicated horse-power (I.H.P.) of a steam engine from indicator diagrams taken from it, and, from a study of the diagrams a fairly good idea can be obtained as to whether the engine is working up to its maximum output or not. It is less easy to say beforehand what the maximum output of an engine would be at a definite speed and with a certain initial pressure.

The formula applicable to the indicator diagram is

$$\frac{P \times L \times A \times N}{33{,}000} = \text{I.H.P.}$$

In this formula the only variables, for a particular engine, are "P" and "N" *i.e.* the M.E.P. (mean effective pressure) and the number of strokes per minute. Applying this formula in a different way the M.E.P. can be deduced for an observed brake horse-power (B.H.P.) at a particular speed *i.e.*

$$P = \frac{33{,}000 \times \text{B.H.P.}}{L \times A \times N},$$

and for purposes of comparison the piston speed, in feet per minute, can be substituted for L × N. If "B.H.P." is taken as the maximum output at which it is desirable to work the engine in practice, it is found that the value of "P" depends upon (i.) the initial pressure (ii.) whether the engine is worked condensing or non-condensing and (iii.) whether the engine is single cylinder, compound, or triple expansion; but for any given set of conditions "P" is practically constant. If in addition to this the piston speed is constant, the only variable in the above formula is "A," *i.e.* the area of the piston, and since "A" depends upon the square of the diameter of the cylinder, we may write

$$\frac{P \times L \times A \times N}{33{,}000} = \text{B.H.P.} = d^2 \times F,$$

where "F" is a factor depending, for a particular piston speed, upon the three conditions enumerated above, and "d" is the diameter of the cylinder in inches. (The L.P. cylinder in compound and triple expansion engines).

In a compound engine it may be assumed that each cylinder does half the work. This is true if the valves are properly set and if the engine is fairly well loaded. Similarly in a triple expansion engine each cylinder does one-third of the work. To apply the above deductions as to M.E.P. and the factor "F" to compound and triple expansion engines the L.P. cylinder is alone considered in each case.

In order to arrive at a suitable value for "F" as regards the pumping engines dealt with in this Echo a piston speed of 120 f.p.m. is assumed. For any other piston speed of "X" f.p.m. divide by 120 and multiply by "X" to arrive at the maximum B.H.P. The results arrived at by using the formula $d^2 \times F$ may, in the case of direct acting pumping engines, be taken to represent the maximum pump horse-power (P.H.P.) of the engine concerned. By "maximum" is meant the highest output which should be continuously demanded from the pumping engine at the speed concerned; not the highest possible output attainable. It may be permissible to exceed the maximum arrived at by use of the formula given here, with the stated value of "F" for any particular set of conditions, either by increase of speed up to the limit for which the engine is suitable, or by increasing the initial pressure (and therefore) the M.E.P.; but for *economical* working it is preferable to work the engine somewhat below the power given by the formula. This economical power is lower, relatively, for condensing engines than for non-condensing, but leaving this refinement out of consideration the economical power may be taken as 70 per cent. of the maximum power deduced from the use of the values of "F" given below.

Tabulating average values for M.E.P. and "F" deduced from various sources the following figures are obtained.

Non-Condensing.

Pressure at engine stop valve. Lb.	50	60	80	100	120	140
Single cylinder.						
M.E.P.	25	30	40	51	—	—
F.	·07	·085	·115	·145	—	—
Compound.						
M.E.P.	—	16	21	27	32	37
F.	—	·045	·06	·075	·09	·105

Condensing.

Pressure at engine stop valve. Lb.	60	80	100	120	140	160	180
Single cylinder.							
M.E.P.	42	47	60	—	—	—	—
F.	·12	·135	·17	—	—	—	—
Compound.							
M.E.P.	—	27	32	40	46		
F.	—	·075	·09	·115	·13	·145	·165
Triple Expansion.							
M.E.P.	—	—	24·5	26·5	28	30	31·5
F.	—	—	·07	·075	·08	·085	·09

The figures given above are applicable for ordinary ratios between the areas of H.P.; I.P.; and L.P. cylinders. Normally the relative areas of the cylinders lie between the following limits, viz.:—For compound, non-condensing, H.P.:L.P.::1:2 or 1:3. For compound condensing, H.P.:L.P.::1:3 or 1:4. For triple expansion, condensing, H.P.:I.P.:L.P.::1:2·5:5 or 1:3·5:9.

The values for "F" are deduced almost directly from the corresponding values for M.E.P. It will be noted that in every case the M.E.P. is considerably below the initial pressure and although in practice cut-off would not occur so early in the stroke as the low value of the M.E.P. would suggest nevertheless it must take place considerably before the end of the stroke in order that the given values for M.E.P. shall result.

These figures may be taken as reasonably accurate for single cylinder and compound engines; they may be less reliable for triple expansion engines as the data available to "Inspector" for deducing average results have been somewhat scanty. To avoid misunderstanding it must be remembered that the values for M.E.P. apply in any case, but the values for "F" only refer to a piston speed of 120 f.p.m.; in both cases the figures only apply to the L.P. cylinder in compound and triple expansion engines.

The tabulated figures refer more correctly to those pumping engines in which a comparatively early cut-off can be advantageously used, *e.g.* flywheel engines. The figures are less appropriate to straight line engines, since this type, as has been already pointed out, is less able to use the steam expansively, especially so as regards single cylinder and compound engines; hence for these engines the P.H.P. resulting from the use of the figures in question represents the economical rather than the maximum horse-power.

Finally, in the case of condensing engines, the figures apply to machinery at sea level; at considerable elevations above sea level some reduction will occur in the vacuum attainable. However for the purposes of this Echo any correction on this account may be ignored because after all the values of "F" will only give an approximate test as to the output of the pumping engine concerned.

With the above values of "F" as a basis one may consider how far the pumping engines given in Table IV. are suitable for the work for which they have been supplied. This is dealt with in Echo No. 22 but it is to be distinctly noted that so far as is known, the contractors concerned were alone responsible for all the details connected with the engines in question. Whoever acted as "consulting engineer" only enumerated the conditions to be fulfilled as to gallons per minute and head. In but few cases were the engines supplied under any guarantee as to steam consumption.

ECHO NO. 21.

STEAM CONSUMPTION.

Table IV. gives the results of a number of actual tests upon different sizes of pumping engines and contains figures for steam consumption and fuel consumption per pump-horse-power-hour which may serve as a guide for estimating the performances of engines of similar sizes and types. Of course in everyday working it is only to be expected that the results will be appreciably worse than those obtained on test, apart from the losses due to raising steam, warming up, etc.

The following figures, expressed in steam consumption per pump-horse-power-hour, may be taken as a general guide, but in the case of boiler feed pumps there are many occasions when the actual consumptions are not less than double the amount shown.

Injectors	800 lb. and upwards.
Pulsometer type pump	500 lb. and upwards.

Boiler Feed Pumps. Straight Line.	*Non-condensing.*
Single cylinder, duplex	120 lb. or more.
Compound, duplex	80 lb. or more.
Single cylinder long stroke simplex ...	100 lb. or less.
Compound, simplex	50 lb. or less.

	Pumping Engines.	*Condensing.*
Compound.	10 P.H.P.	35 to 40 lb.
„	15 P.H.P.	30 to 35 lb.
„	25 P.H.P.	25 to 30 lb.
Triple.	Above 25 P.H.P.... ...	25 lb. and less, according to size.

The steam consumption of flywheel "pumps" may be taken as the same as the corresponding figures for duplex and simplex pumps depending respectively, upon whether they are run slowly, or at a speed when the flywheel is effective.

Whereas flywheel pumping engines may be expected to give results approaching the lower limit shown the figures for corresponding straight line engines would be nearer the higher limit.

The above figures refer to ordinary steam pressures without superheat. They would be reduced from 10 to 20 per cent. in the case of pumping engines with 100° Fah. of superheat at the engine stop valve.

ECHO NO. 22.

CRITICISMS ON PUMPING ENGINES REFERRED TO IN TABLE IV.

Notes on Table.—(*a*). In the fractions under the heading "Pumping Engine" the numerator denotes the sizes of the steam cylinders, and the denominator the size of the pump end; the dimension on the right gives the nominal length of stroke. Thus $\frac{5\times 8\times 13}{7}\times 15$ signifies a triple expansion engine with cylinders 5", 8", and 13" in diameter, with a pump end 7" in diameter, the stroke of all being 15".

(*b*). The letter "S" added after the boiler pressure means that the boilers are fitted with superheaters.

(*c*). The "head" given is that recorded during a test unless otherwise stated elsewhere.

(*d*). The speeds shown are those actually worked to or are the makers' rated speeds as the case may be.

(*e*). P.H.P. is calculated from the theoretical displacement of the pump during the test and from the observed head; no allowance made for slip. In no case did the slip exceed 6 per cent. of the theoretical displacement where it was possible to check it. Head was checked by an engine indicator where possible, but generally speaking it was taken directly from the pressure gauge on the rising main.

(*f*). In the last column but one the figures given show the results obtained by "Inspector" on test, unless otherwise stated. The letters "S," "F," "C," and "W," denoting cylinder steam (*i.e.* discharge from air pump), feed, coal or wood, respectively.

(*g*). The type of pump end is given under the column of "Remarks." The letters C, and N.C., signify that the pump was condensing or non-condensing. Condensers in question were all of the surface type.

(*h*). The efficiencies given in the notes below have been deduced from indicator diagrams and represent the values of the fraction $\frac{\text{P.H.P.}}{\text{I.H.P.}}$

(*i*). The evaporations recorded are deduced from the actual figures for feed and coal corrected to the standard "from and at 212° F."

Part I. of Table IV. refers to flywheel pumping engines.

Pump A.—Compound, condensing.

Not yet erected, but supplied to deliver 170 g.p.m. against a total head of 145′ with 90 lb. stop valve pressure, at a piston speed not exceeding 100 f.p.m.

Guarantee is 29 lb. steam per p.h.p. hour, and output is based on a piston speed of 90 f.p.m.

The specified output is equivalent to $\frac{1{,}700\times 145}{33{,}000}=7{\cdot}5$ P.H.P.

H.P. by formula at 90 lb. pressure and 90 f.p.m. is

$$13^2\times{\cdot}0825\times\tfrac{90}{120}=10{\cdot}45 \text{ P.H.P.}$$

From this the economical output may be deduced as

$$10{\cdot}45 \times {\cdot}7 = 7{\cdot}32 \text{ P.H.P. nearly.}$$

Deduction.—Under the limitations as specified the pump should be suitable for the job. A piston speed of 90 f.p.m. is appropriate for normal working in this case with a 12″ stroke.

It would doubtless be possible to run the pump up to 120 f.p.m. on emergency, at which speed the output by formula would be 15 P.H.P.

Note.—Since erection a preliminary test gave less than 29 lb. steam per P.H.P. hour. Engine new and working stiff.

Pump B was offered as an alternative to Pump T in Part II. and is dealt with later.

Pump D.—Compound, non-condensing. Cylinders jacketed.

Duty for which supplied :—2,500 g.p. hour against 1,550′ head, at a normal speed of 38 r.p.m., maximum speed 45 r.p.m.

Guarantee was to deliver 1,000 gallons on a consumption of 216 lb. steam (or "feed"—doubtful which was intended). The H.P. is $\frac{25{,}000 \times 1{,}550}{60 \times 33{,}000} = 19{\cdot}6$ P.H.P. It would require $\frac{1000}{2500}$ of an hour to deliver 1,000 gallons and the corresponding p.h.p. hours is $\frac{2}{5} \times 19{\cdot}6$. The guarantee therefore corresponds to $\frac{216 \times 5}{2 \times 19{\cdot}6} = 27{\cdot}7$ lb. of steam (or feed) per p.h.p. hour. The best result obtained on test has been 35·2 lb. feed per p.h.p. hour. A good result for a N.C. pumping engine of this size.

Duty for which actually used corresponds closely to the above.

Taking a stop valve pressure of 120 lb. the maximum horse-power by formula at a piston speed of 127 f.p.m. (corresponding to 38 r.p.m.) is

$$(14{\cdot}5)^2 \times {\cdot}115 \times \tfrac{127}{120} = 25{\cdot}65 \text{ P.H.P.}$$

The corresponding economical output is nearly 18 P.H.P.

Deduction.—The pump is worked near its limit. In practice it is found that the boiler pressure must be kept up to 125 lb. or over. Under normal circumstances this size of pump should be condensing, and even though this particular pump is but little worked for the six winter months, condensing would have been preferable in this case as fuel is costly.

Pump E.—Compound, condensing. Re-heater between H.P. and L.P. cylinders; no jackets.

An offer for a pump to deliver 500,000 gallons per 24 hours against a head of 400′ upon a steam consumption of 22 lb. steam per p.h.p.h. with boiler pressure of 120 lb. and 120° Fah. superheat at boiler. Normal speed deduced from output; maximum speed, estimated.

H.P. by formula with a stop valve pressure of 100 lb. and a speed of 145 f.p.m.

$$22^2 \times {\cdot}09 \times \tfrac{145}{120} = 52{\cdot}6 \text{ P.H.P.}$$

Deduction.—Suitable.

Pump F.—Compound, condensing. Re-heater between H.P. and L.P. cylinders; no jackets.

As for Pump E but for 1,000,000 gallons per 24 hours, and 20 lb. steam per p.h.p. hour.

H.P. as above, for speed of 180 f.p.m. would be

$$26^2 \times \cdot 09 \times \tfrac{180}{120} = 91 \cdot 2 \text{ P.H.P.}$$

Deduction.—Suitable.

Pump G.—Triple, condensing. Cylinders jacketed.

Duty for which supplied, 7,500 g.p.h. against 1,142′ at 38 r.p.m. with maximum speed of 45 r.p.m. Guarantee 22 lb. steam (or feed).

Stop valve pressure is 120 lb. H.P. by formula is

$$26^2 \times \cdot 075 \times \tfrac{150}{120} = 63 \cdot 5 \text{ P.H.P.}$$

Economical loading is $63 \cdot 5 \times \cdot 7 = 44 \cdot 4$ P.H.P.

Deduction.—Appropriate to the job, and an economical engine in steam.

Pump H.—Triple, condensing, inverted marine type.

Engine supplied to Leeds, England. Data abstracted from published reports.

Pump I.—Generally similar to Pump H.

Engine supplied to Rand Water Board. Data abstracted from published reports. The engine is classed as "slow-speed."

Part II. of Table IV. refers to straight-line pumping engines, and since, in every case, water is within suction distance of the pump room floor "Inspector" considers that a flywheel pump would have been preferable in every instance. All pumps are duplex and therefore the formula becomes $\text{P.H.P.} = d^2 \times \text{F} \times 2$.

Pump P.—An ordinary "trade" pump. Double cylinder, non-condensing.

Supplied to deliver 6,500 g.p.h. against 80′.

Taking a stop valve pressure of 70 lb. and interpolating a value for "F," the H.P. at 50 f.p.m. is

$$6^2 \times \cdot 1 \times \tfrac{50}{120} \times 2 = 3 \text{ P.H.P.}$$

Deduction.—Suitable, but as will be seen the consumption of feed per p.h.p. hour is very high, as is only to be expected from a small pump of this type.

Pump Q.—Compound non-condensing. Duplex.

Duty for which used entails an output of about 3 P.H.P. at a piston speed of 50 f.p.m.

Take stop valve pressure of 70 lb. then by formula

$$(7 \cdot 5)^2 \times \cdot 75 \times \tfrac{50}{120} \times 2 = 2 \cdot 34 \text{ P.H.P.}$$

Deduction.—The pump is fully loaded when stop valve pressure is only 70 lb. Although fuel is costly it is questionable if compounding is quite justifiable for such a small pump. Allowing an evaporation of 4 lb. steam per lb. coal, a not unreasonable figure for a vertical boiler having regard to coal used, the amount of feed would be about 80 lb. per p.h.p. hour, a result that may be compared with that for Pump P working at about the same output.

Pump R.—Compound condensing.

Supplied to deliver 34 g.p.m. against 763′ at 57 f.p.m. Normally worked at about 10 P.H.P. at about 80 f.p.m.

H.P. by formula at 80 lb. steam and 80 f.p.m. is

$$10^2 \times \cdot 075 \times \tfrac{80}{120} \times 2 = 10 \text{ P.H.P.}$$

Deduction.—Fully loaded. A reasonably economical pump when worked at full stroke, but although the steam consumption of 40·75 lb. per p.h.p. hour compares favourably with that for Pump "S" it is greatly in excess of the guarantee of 29 lb. for the flywheel pump "A."

A compound condensing pump is suitable for this case.

Pump S.—Triple-expansion, condensing.

Supplied originally with 6″ plungers, to deliver 8,000 g.p.h. against 157′. This is equivalent to 6·37 P.H.P.

H.P. by formula for 100 lb. steam and 85 f.p.m., the speed at which it is worked, is

$$14^2 \times \cdot 07 \times \tfrac{85}{120} \times 2 = 16 \cdot 2 \text{ P.H.P.}$$

Deduction.—Pump very much too big for the job, even under the altered conditions with enlarged plungers ($7\frac{3}{8}$″ diam.) and a normal loading of about 10 P.H.P.

The pump is very uneconomical in steam.

Compare Pump T with exactly similar steam end, and also Pump U which is worked at 25 P.H.P.

A triple-expansion pump is not justifiable for such a small output under any circumstances.

Pump T.—Triple expansion, condensing.

Steam end similar to Pump "S," but higher boiler pressure.

Supplied to deliver 18,300 galls. in 8 hours against 1,371′ and alternatively to deliver 30,200 galls. in 8 hours against 840′. The heads actually worked against are 1,450 and 850′ normally at piston speeds of 67′ and 85′ respectively. The heavier load is when working against the higher head at the lower speed.

Although not given in the form of a guarantee the steam consumption was stated at 27 lb. per I.H.P. hour.

H.P. by formula for a pressure of 120 lb. and a speed of 67 f.p.m. is

$$14^2 \times \cdot 075 \times \tfrac{67}{120} \times 2 = 16 \cdot 4 \text{ P.H.P.}$$

Deduction.—Suitable.

Alternative tenders for this job were Pump B—compound, non-condensing, 27 lb. steam per I.H.P. hour, and Pump C—single cylinder non-condensing, 31 lb. steam per I.H.P. hour. Both flywheel pumps. A compound condensing flywheel pumping engine for this job should have done the work on about 26 lb. steam per p.h.p. hour.

Pump U.—Triple-expansion, non-condensing.

Supplied to deliver 200,000 gallons in 8 hours against a head of 187′ at a piston speed of 137 f.p.m. This corresponds to $\frac{2,000,000 \times 187}{8 \times 60 \times 33,000} = 23{\cdot}6$ P.H.P. The pump is normally worked at about that output.

H.P. by formula for 90 lb. steam and 137 f.p.m. is

$$13^2 \times {\cdot}07 \times \tfrac{137}{120} \times 2 = 27 \text{ P.H.P.}$$

Deduction.—Suitable.

The steam consumption recorded in the Table, the results of a test, are very good, especially as there was no super-heat. The pump is jacketed on all cylinders. Jacket steam during test was excessive and amounted to 8·24 lb. per p.h.p. hour, giving a total steam consumption of $8{\cdot}24 + 18{\cdot}35 = 26{\cdot}6$ lb. per p.h.p. hour. Even this result compares favourably with other pumps of this type. The pump was run at a stroke of $15\frac{1}{4}$″ during the test.

This size of pump comes on about the border line between compound and triple.

Pump V.—Triple-expansion, condensing. L.P. jackets.

Supplied to deliver 417 g.p.m. against 133′. This is equivalent to 16·8 P.H.P.

A pump with this stroke can be readily run at a normal piston speed of 125 f.p.m. against a low head, and in emergency could certainly be run up to 150 f.p.m. *Vide* Pump U.

H.P. by formula with 100 lb. steam and a speed of 125 f.p.m. is

$$16^2 \times {\cdot}07 \times \tfrac{125}{120} \times 2 = 37{\cdot}3 \text{ P.H.P.}$$

Deduction.—Far too big for the job. For an output of about 17 P.H.P. a triple-expansion engine is scarcely justifiable.

Pump W.—Compound, non-condensing.

In normal work the pump gives an output of about 25 P.H.P.

H.P. by formula at 80 lb. steam and 90 f.p.m. is

$$16^2 \times {\cdot}06 \times \tfrac{90}{120} \times 2 = 23 \text{ P.H.P.}$$

Deduction.—Pump fully loaded.

A pumping engine of this size should certainly be condensing, where, as in this case, the plant is worked every day in the year for eight hours or more per diem ; indeed in this case triple-expansion condensing would have been justifiable.

The steam consumption is high (56·4 lb. feed per p.h.p. hour) and compares unfavourably with the flywheel Pump D which works at about the same power.

Pump X.—Triple-expansion, condensing; all cylinders jacketed.

Supplied to deliver 1,000,000 gallons per 24 hours against 360′ at piston speed not exceeding 150 f.p.m. This is equivalent to about 76 P.H.P. Owing, it is believed, to incrustation of the long rising main the head is now about 380′ and the horse-power has risen to over 80 P.H.P. in daily work.

Horse-power by formula with 100 lb. steam and a piston speed of 150 f.p.m. is

$$(21.5)^2 \times \cdot 07 \times \tfrac{150}{120} \times 2 = 81 \text{ P.H.P.}$$

Deduction.—Suitable. As a matter of fact, during the test the results of which are recorded in the Table, although the initial pressure in H.P. cylinder measured off the indicator diagrams was only 75 lb., there was no cut-off and the M.E.P. of the L.P. diagrams was over 12 lb., a rather high figure. These figures nevertheless suggest that this pump is working somewhere near its maximum output when loaded to 80 P.H.P.

Jackets use 3·86 lb. steam per p.h.p. hour giving a total of 23·54 lb. steam per p.h.p. hour; a poor result for an engine of this size. Efficiency *i.e.* $\frac{\text{P.H.P.}}{\text{I.H.P.}} = 96$ per cent., a very high figure.

General Observations.—The pumps listed in Table IV. have been dealt with in detail partly to illustrate the application of the formula given in Echo No. 20 and partly to invite attention to the performances of the engines concerned.

In the absence of criticism by a fully qualified expert in pumping machinery the formula can only be claimed to give approximate results, nevertheless, as regards pumping engines up to the sizes dealt with above it may be admitted that it will at least serve as *a* guide as to their suitability for the work they have to do.

Most of the pumping engines seem well suited to their work, so far as power is concerned, but it is hard to get away from the deductions applied to Pumps S and V as to their excessive size. It must be remembered that not only does a needlessly large pump entail a high capital cost, but it cannot be expected to work economically when greatly underloaded; this is especially so with a straight-line pump.

HISTORICAL DOCUMENTS OF MAJOR-GENERAL SIR J. T. JONES, BART., K.C.B., R.E.

(*Continued*).

In the December *Journal* the reports and instructions for the first and unsuccessful assaults on Badajoz was reproduced. The following papers refer to the final attack in 1812. Most, if not all of the documents, are believed to be in Lord Wellington's handwriting and give some idea of the personal attention he paid to the various details of the operations. The first document is a memorandum from Lord Wellington respecting the despatch of cars to Almeida and Ciudad Rodrigo. The second is also a memorandum respecting the safety of the bridges which had been damaged by the rising of the Guadiana in March, 1812. The third contains instructions for the transportation of shot across the Guadiana. The fourth contains instructions for blowing up the dam of the Lunette at Badajoz on the 2nd April, 1812. Nos. 5 and 6 are two rough memoranda from Lord Wellington concerning the bridge of boats at Villa Velha and the site of the flying bridge. The seventh manuscript is of particular interest. It is, apparently, in Lord Wellington's handwriting and is docketed by Sir J. Jones as "Original Orders for Assault on Badajoz, 1812." It gives minutely the details for the Assault on Badajoz and has a supplementary order giving "Notes" on the various paragraphs. Finally No. 8 is a letter from Lord Wellington to Sir Richard Fletcher, dated May 25th, 1812, giving detailed instructions for the repair of Badajoz.

No. (1). *Memorandum from Lord Wellington respecting the Transport of Stores to Ciudad Rodrigo.*

Separate Memorandum.

FRENEDA, *January 1st*, 1812.

For Mr. Bissett.
Col. Fletcher.
Major Dickson.

Ninety cars now at Freneda and sixty-six expected from Brigadier Alava to be sent on the 2nd to Almeida, to be loaded, 106 with Engineer's Stores and 50 with small stores of the Artillery; to carry these articles on the 3rd to Gallegos; return on the 4th to Almeida, and load with Powder and Shot; return on the 5th to Gallegos and lay down the Powder and Shot, and to be reloaded with Engineer's stores to proceed to Ciudad Rodrigo on the 6th.

W——.

No. (2). *Memorandum by Lord Wellington concerning the Safety of the Bridges on the Guadiana, March, 1812.*

Memorandum, March 22nd, 1812.

1. The Pontoon bridge to be taken up, and brought to this side of the River. A report to be made as soon as possible of the damage received; and inform Lt. Piper that it is very extraordinary that he should not have reported the damage to this hour; or even that any accident had happened.

2. The stage on the Right of the River for the flying bridge to be replaced as soon as possible: that part of the stage on the left of the River which is not necessary to be taken up.

3. At all events the Planks on both stages to be taken up during the night.

4. Mr. Piper Report whether it will be necessary to place Pontoons on each side of the River to communicate with the flying bridge.

(3). *Instructions from Lord Wellington for conveying Shot across the Guadiana.*

Memorandum, March 26th, 1812, for the Chief Engineer and Officer of Artillery and Q.M.G.

Mr. Piper to be desired to employ six Pontoons as Row boats near the flying Bridge to carry over principally Powder and Shot.

Care must be taken that they are not overloaded; not more than 40, 24 Pr. Shot to be put in each or an equal quantity of Powder.

Planks must be placed in the bottom, and the lower part of the sides should have a plank in order to prevent the Shot from rolling against the sides.

The Pontoons must not be used as Passage boats.

Mr. Piper to be requested to mention in his Reports whether he has Bullocks in sufficient numbers and in good order to move the Bridge.

(4). *Memorandum by Lord Wellington for blowing up the Dam of the Lunette, April 2nd, 1812.*

Memorandum, April 2nd, 1812.

An attempt is to be made this evening at ½ past 7 o'clock to destroy the dams in the Rivillas.

A Gun in No. 7 must be turned at 3 P.M. to fire occasionally upon the Howitzer in the Rear of the left flank of the Ravellin of St. Roque; which fire must be continued till the party will move to make the attempt.

50 Men of the covering party in the trenches must enter the covered way of the Ravellin at the place where the Palisades are destroyed at the Salient Angle, and proceed along the left face of the Covered Way, by turning to the Right after entering.

The men must be attended by 12 Carpenters to enable them to cut down the Gate or Palisade which is between them and the River Rivillas.

(5). *Instructions by Lord Wellington regarding the Bridge of Boats at Villa Velha.*

Memorandum, April 10th.

Major Burgoyne is to set out this evening for Villa Velha and if possible to arrive there to-morrow.

If on his arrival at Villa Velha he should find the Enemy at Castello Branco, he is to have the Bridge taken up at Villa Velha, and all the materials put into the Boats; and the Boats must be sent about a League down the Stream and kept there on the left bank in a place to which the Enemy cannot get at them, ready to be drawn up and replaced as a Bridge, as soon as the Corps will arrive at Villa Velha to cross the Tagus.

The bridge is not to be taken up till the Enemy arrive at Castello Branco.

The 1st Hussars have been ordered to Castello Branco and Major Burgoyne should communicate with Genl. Alten and General Le Cor.

(6). *Pencil Instructions by Lord Wellington on April 21st.*

Memorandum.

1. Fix the place for the flying Bridge.

2. Order one bridge at ——— to be placed on its carriage.

3. Order the Superintendents of Transports here to provide 300 Carts to attend the army at the Siege of Badajoz.

(7). *Original Orders by Lord Wellington for the Assault on Badajoz on 6th April,* 1812.

There may be some alteration in this plan which will be communicated by reference to the Number of the Paragraph altered.

No. 1. The fort of Badajoz is to be attacked at 10 o'clock this night.

No. 2. The attack must be made on three points; the Castle, the face of the Bastion of La Trinidad; and the flanks of the Bastion of Sta. Maria.

No. 3. The attack of the Castle to be by escalade; that of the two Bastions by the Storm of the Breaches.

No. 4. The Troops for the Storm of the Castle consisting of the 3rd Division of Infantry should move out from the right of the 1st Parallel at a little before 10 o'clock, but not attack till 10.

No. 5. They should cross the River Rivillas below the broken bridge over that River; and attack that part of the Castle, which is on the right looking from the Trenches, and in the Rear of the great battery constructed by the Enemy to fire on the bastion of La Trinidad.

No. 6. Having arrived within the Castle, and having secured the possession of it, parties must be sent to the left along the Rampart, to fall on the Rear of those defending the great breach in the Bastion of La Trinidad; and to communicate with the Right of the Attack on that Bastion.

No. 7. The Troops for this attack must have all the long ladders in the Engineers' Park; and Six of the Lengths of the Engineers' Ladders. They must be attended by 12 Carpenters with Axes; and by Six Miners with Crowbars, etc.

No. 8. The 4th Division with the exception of the Covering party in the Trenches, must make the Attack on the face of the Bastion of La Trinidad; and the Light Division the attack on the flank of the Bastion of Sta. Maria.

No. 9. These two Divisions must parade in close Columns of Divisions at 9 o'clock. The Light Division with the left in front, the 4th Division with its Advanced Guard with the left in front; the remainder with the Right in front. The 4th Division must be on the Right of the little Stream near the Picquet of the 4th Division; and the Light Division must have the River on their Right.

No. 10. The Light Division must throw 100 Men forward into the Quarries close to the Covered Way of the Bastion of Sta. Maria, who, as soon as the Garrisons are disturbed, must keep down by their fire, the fire from the face of the Bastion of Santa Maria; and that from the Covered Way.

No. 11. The Advance of both Divisions must consist of 500 men from Each, attended by Ladders; and the men of the storming party should carry sacks filled with Light Materials, to be thrown into the ditch to enable the troops to descend into it.

Note.—Care must be taken that these Bags are *not* thrown into the Covered Way.

No. 12. The Advance of the Light Division must precede that of the 4th Division; and both must keep as near the innundation as they possibly can.

No. 13. The Advance of both Divisions must be formed into firing parties and storming parties. The firing parties must be spread along the Crest of the Glacis to keep down the fire of the Enemy; while the Men of the Storming party who carry bags, will enter the Covered Way at the Place d'Armes under the breached face of the Bastion of La Trinidad; those attached to the 4th Division on its' right, those to the Light Division on its left, looking from the Trenches or the Camp.

Genl. Colville will observe that a part of the advance of the 4th Division must be allotted to Storm the new Breach in the Curtain.

No. 14. The Storming party of the Advance of the Light Division will then descend into the Ditch and turning to its left, storm the breach in the flank of the Bastion of Sta. Maria; while the Storming party of the 4th Divn. will likewise descend into the Ditch, and Storm the Breach in the face of the Bastion of La Trinidad. The firing parties are to follow immediately in the Rear of their respective storming parties.

No. 15. The Heads of the two Divisions will follow their Advanced Guards, keeping nearly
2 together; but they will not advance beyond the Shelter afforded by the Quarries on the left of the Road, till they will have seen the Heads of the Advanced Guards ascend the Breaches. They will then move forward to the Storm in double quick time.

No. 16. If the Light Division should find the bastion of Sta. Maria intrenched they will turn to the Right of the Intrenchment moving along the parapet of the Bastion. The 4th Division will do the same by an intrenchment, which appears in the left face, looking from the Trenches, of the Bastion of La Trinidad.

No. 17. The Light Division as soon as they are in possession of the Rampart of Sta. Maria, are to turn to their left, and to proceed along the Rampart to their left, keeping always a Reserve at the breach.

No. 18. The Advanced Guard of the 4th Division are to turn to their left, and to keep up the Communication with the Light Division. The 4th Division are to turn to their Right, and to communicate with the 3rd Division, by the Bastion of San

Pedro, and the Demi Bastion of San Antonio, taking care to keep a reserve at the Bastion of La Trinidad.

No. 19. Each (the 4th and Light) Division must have 1,000 Men in reserve in the Quarries.

No. 20. The 4th Division must endeavour to get open the Gate of La Trinidad; the Light Division must do the same by the Gate called Porto de Pillar.

No. 21. The Soldiers must leave their Knapsacks in Camp.

No. 22. In order to aid these operations the Howitzers in No. 4 are to open a fire upon the Batteries constructed by the Enemy to fire upon the breach, which they must Continue till they see that the 3rd Division are in possession of the Castle.

Will observe that the Enemy are aware of the attack.

The Attack Order in this Paragraph should be made from the right of the Sap instead of from the right of the Trenches.

The Commg. Officer in the Trenches must begin it as soon as he will observe that the attack of the 3rd Division on the Castle is perceived by the Enemy.

No. 23. The Commanding Officer in the Trenches is to attack the Ravelin of St. Roque with 200 Men of the Covering party, moving from the Right of the Trenches; and round the Right of the Ravelin looking from the Trenches; and attacking the Barriers and Gates of Communication between the Ravelin and the Bridge; while 200 Men likewise of the Covering Party will rush from the Right of the Sap into the Salient Angle of the Covered Way, of the Ravelin; and keep up a fire on its' faces.

These last should not advance from the Sap, till the party to attack the Gorge of the Ravelin will have turned it. That which will move into the Covered Way on the right of the Ravelin looking from the Trenches, ought not to proceed further down than the Angle formed by the face and the flank.

No. 24. The remainder of the Covering Party to be a Reserve in the Trenches. The Working Parties in the Trenches are to join their Regts. at ½ past 7 o'clock.

Twelve Carpenters with Axes and Miners with Crow Bars must be with each (the 4th and Light) Division. A Party of one Officer and 20 Artillery Men must be with Each Division.

No. 25. The 5th Division must be formed, one Brigade on the ground occupied by the 48th Regt., one Brigade on the Sierra de Vento, and one Brigade in the low grounds extending to the

Guadiana, now occupied by the Picquets of the Light Division.

A Plan has been settled with Lt. Genl. Leith for an attempt to be made to escalade the Bastion of St. Vincente or the Curtain between the Bastion and the Bridge if Circumstances should permit.

The Commg. Officer of the Light Division will attend to this.

Genl. Power will likewise make a false attack on the Tête de Pont.

No. 26. The Picquets of the Brigades on the Sierra de Vento, and that in the low grounds towards the Guadiana should endeavour to alarm the Enemy during the attack by firing at the Pardaleras, and at the Men in the Covered Way of the Works towards the Guadiana.

No. 27. The Commt. of the Forces particularly requests the General Officers Commg. Divisions and Brigades, and the Commg. Officers of Regts. and the Officers Commg. Companies to impress upon their Men the necessity of their Keeping together, and formed as a Military Body after the Storm, and during the night. Not only the success of the operation and the honour of the Army, but their own individual safety, depend upon their being in a situation to repel any Attack by the Enemy, and to overcome all resistance, which they may be inclined to make, till the Garrison will have been Completely Subdued.

Supplement to Original Order for Storming Badajoz, 1812.

Note upon the 6th Paragraph.

It is recommended that the attack of the 3rd Division should be kept clear of the Bastion of San Antonio, at least till the Castle which is above, and Commands that Bastion will be carried.

Note upon the 9th Paragraph.

This arrangement of the columns is made, in order that the Light Division may Extend along the Ramparts to the left; and that the 4th Division with the exception of the Advanced Guard, which is to communicate by its left with the Light Division might extend along the Ramparts to the Right. It may be necessary however for these Divisions mutually to support each other, and attention must in this case be paid to the formations.

No. 13 will run thus after the words "While the Men of the Storming party who carry Bags will enter the Covered Way" insert those of the Light Division at the Place d'Armes on the left, looking from Camp, of the unfinished Ravelin; those of the 4th Division on the right of that Ravelin at the Place d'Armes under the breached face of the Bastion of La Trinidad.

*No. 14. General Colville will observe that a part of the advance of the 4th Division must be allotted to storm the new breach in the curtain.

Note on No. 15. The Place here pointed out may be too distant. The Heads of the Columns should be brought as near as they can without being exposed to fire.

Note on No. 19. It will be necessary for the Commg. Officer of the Light Division to attend to the Ditch on his left as he will make his attack. He should post a Detacht. in the Ditch towards the Salient Angle of the Bastion of Santa Maria ; so as to be covered by the Angle from the fire of the next Bastion on its left looking from the Trenches.

Note on No. 22. Some signal must be arranged between the Commg. Officer of the Artillery and the Officer who will command the attack, on the Castle, for ceasing the fire in No. 12.

Note upon No. 23. It would be better that this Attack should move from the Right of the Sap.

†The Commg. Officer in the Trenches must begin it as soon as he will observe that the attack of the 3rd Division on the Castle is perceived by the Enemy.

2 ‡Memn.—A plan has been arranged with Lt. Genl. Leith for an attempt to be made to escalade the Bastion of St. Vicente or the Curtain between the bastion and the Bridge if circumstances should permit.

No. 26. 1 The Commg. Officer of the Light Division will attend to this.

General Power will likewise make a false attack on the Tête de Pont.

(8). *Letter from Lord Wellington to Sir Richard Fletcher approving of the Proposed Repairs to the Defences of Badajoz.*

MONTE GRIMALDO, *May 20th*, 1812.

MY DEAR SIR,

I have received your letters of the 17th and think that everything in the shape of boat should be sent to Elvas ; and you should apply to the Govr. of that Fortress for carriages from the boats already sent for the two Launches which you mention.

* Added in pencil.

† *Ibid.*

‡ These 3 last paras. were added in the margin of the original orders.—See ante.

As the weather will soon become very hot in Estemadur, you should take care not to work your Englishmen in the heat of the day.

It does not appear to me to have been necessary for Lt.-Col. Jones to resign his office of B. Major to the Engineers when appointed a Lt.-Col. by Brevet. But I have no objection to your appointing Captain Ellicomb to the situation till the pleasure of the Master-General will be known; nor to Col. Jones' going on the proposed Service.

By letters from Lord Mulgrave I learn that about 90 Sappers and Miners are coming here immediately. You had better give orders that if they should arrive they should go with Col. Jones. I'll endeavour to have Horses sent for the Officers, but I believe the best way would be to have places made for them in the ships with the Men; and that the Comt. should supply Hay and Corn for them. Lt.-Col. Jones might arrange this with the Agent of Transports.

I have considered the plan and estimate of the expense of the Improvements which you propose to the Works of Badajoz; and I have numbered them as they stand in your Estimate; and in giving my opinion I shall refer to the Number.

I concur with your reasoning upon the difficulty of connecting the Picurina with the Inundation; and approve of what you propose for the Communication and of the Expense of No. 1.

It appears to me that the expense of the wall in No. 2 to cover the existing sluice in the gorge of the Ravellin of St. Roque will not be necessary; if you should —— the Dam with the Sluice lower down the Revillas. You will observe however that this Dam and Sluice will be liable to the same danger as that is which now exists; viz. that of being destroyed by a mine by surprize; and it may be expedient to have a Wall in its front, as I proposed for the existing Dam or Sluice. You must be the best Judge of the necessity for the expence in No. 2, if you incur that in No. 4; of which I approve. I approve of the Sluice Gates to the Covered Drain which communicates from the Inundation to the Ditch.

I approve also of the excavation of the Ditch from the Inundation to the Quarry.

In regard to the works estimated for in No. 6 and No. 7, I consider them to be absolutely necessary. When all will be completed which we propose towards the Revillas, the point of attack which will be most eligible is the Right of the Pardaleras. Indeed that point has always in my opinion been the weakest, particularly in reference to an attack by the French who are well supplied with Sappers and Miners. But the Expense and the time which these works will require become matters of serious consideration.

I wish you could speak to the Marquis de M—— respecting the works estimated for in No. 6, 7, and 10. Point out to him how important it is that these works should be compleated; and let

him see the estimate of the Expense, and ask him whether the Province or Town or the Spanish Govr. will defray it. Let me know the Result; and I will then determine what I will do.

I approve of the work to the glacis of St. Christoval; and of that estimated in No. 9 to cover the left face of La Trinidad and the Right face of St. Pedro.

I have not made myself sufficiently understood respecting the admission of the Waters of the Guadiana with the Ditch. I see that the inundation of the Revillas can go but little further than it is; the point L in the plan. Can the Waters of the Guadiana be brought into the Ditch at all; and if they can how far at a reasonable rate of Expence. I should wish to have an answer to this Question referable to the State of the Guadiana at present, and to the State in which it is in the floods which usually occur every year.

You will observe that by Inundation and other measures the points of attack at Badajoz have been very much narrowed. They could be still more narrowed if by throwing the water of the Guadiana into the Ditch we could have a Wet Ditch as far as the Bastion No. 2, or even No. 1.

Ever your's most faithfully

WELLINGTON.

LT.-COL. SIR RD. FLETCHER.

You might Drive Piles or adopt any other mode for a Bridge across the Ditch to communicate with the Ravellin St. Roque. It will not answer to leave boats at Badajoz.

A LADY'S EXPERIENCES IN THE GREAT SIEGE OF GIBRALTAR (1779–83).

BEING THE DIARY FROM 1ST JUNE, 1779, TO 13TH JUNE, 1781, OF MRS. GREEN, THE WIFE OF LIEUT.-COLONEL GREEN, CHIEF ENGINEER OF GIBRALTAR (AFTERWARDS LIEUT.-GENERAL SIR WILLIAM GREEN, BART., CHIEF ENGINEER OF GREAT BRITAIN, 1786—1802).

THE MS. of this diary, which has never before been printed, is the property of Major-General O. H. Nicolls, late R.A., the great-grandson of Sir William and Mrs. Green, who has very kindly allowed it now to be published. Except for the occasional correction of an obvious mistake in spelling and for the somewhat free revision of punctuation (of which, however, the general characteristics are preserved as far as possible) the MS. is reproduced *verbatim et literatim*, a very few private lines only being omitted and also a detailed private account of the illness and death of a maidservant from small-pox. There being two versions of the greater part of the diary,—both written by Mrs. Green—much of this reproduction is a compilation from the two. The original language has been everywhere preserved but the two versions have been blended together where necessary in order not to omit any fact or comment included in either of them. The diary is not only of interest as giving a lady's experiences of the Siege which has hitherto been only described from the soldier's point of view, but also throws additional light on the trials borne by the garrison and the military events of the Siege. For instance, although Drinkwater and Spilsbury both mention the slight outbreak of small-pox in October, 1779, they make no allusion to the much more serious outbreak which looms so largely in Mrs. Green's diary from 15th January, 1780, to 15th July and which carried off some 500 people, chiefly children, including about 50 soldiers.

Sir William Green whose mother was a daughter of Adam Smith, author of *The Wealth of Nations*, obtained his first appointment in the Corps of Engineers on 12th March, 1744, as Practitioner Engineer. On 14th May, 1757, military rank was granted to the Corps and he was then commissioned as captain-lieutenant. He served at Fontenoy in 1745 and under Wolfe at the capture of Quebec in 1759, when he was wounded, and in 1760 was sent as a major to Gibraltar to command the Engineers and to fortify the place, or rather to bring its fortifications up to date. In 1762 he was promoted to lieutenant-colonel; and in 1772 the

Company of Military Artificers which afterwards developed into the rank and file of the Royal Engineers, was formed on his recommendation. During the great siege of 1779—1783 he was promoted to the rank of major-general. He was created a Baronet in 1783 as a reward for his services during the Siege; and from 1786 to 1802 he was Chief Engineer of Great Britain. He retired in 1802 and died in 1811. During the Siege his official quarter was approximately on the site of that which is still the Chief Engineer's Quarter, but he also had a private residence "Mount Pleasant" which he had built for himself outside the town and Mrs. Green's diary shows that both houses were used by them during the first two years of the Siege, and that at both of them bombproofs were constructed for use by the family whenever the enemy should bombard. At the "Mount,"—now the official residence of the Senior Naval Officer,—one of these shelters still remains and is used as a reservoir. It is possible that some of the underground tanks at Engineer House may have been formed out of Green's bombproofs, but the house was "entirely destroyed at the commencement of the enemy's fire from their batteries upon the Isthmus,"* *i.e.* in the bombardment of April, 1781. "The Mount" was sold by Green to the Admiralty in 1797, and the present residence on that site was built between that year and 1811, being considerably altered in 1846 and again enlarged in 1905. The baronetcy expired with Sir William Green's son, Lieut.-Colonel Sir Justly Green, who commanded the 1st Royals and was afterwards Military Preceptor to H.R.H. the Duke of Kent, father of Queen Victoria.

Mrs. Green was the eldest daughter of Colonel Justly Watson of the Corps of Engineers and grand-daughter of Lieut.-Colonel Jonas Watson, R.A., Chief Bombardier of England, who was killed at the Siege of Carthagena in 1741, aged 78. She died on 21st June, 1782, in England,† from the effects of a chill caught in the bomb-proofs in which she had to shelter in Gibraltar.‡

A few Mem^a relating to what passed in the Garrison of Gibraltar; during the Investment, and Blockade which commenced upon the 21st of June 1779—and a few Mem^a of what had passed, about 3 weeks before it happened, by which it may be seen how Unexpected such an Investment was to the English in Gibraltar. To make this more clear I shall begin with the first of June.

1779.

June Tues^d 1st. I was Then very ill, Confined to my room, and found it would be impossible for me to go to the Ensuing Birth

* W.D. Bill Book No. 228 at the Record Office.
† Porter's *History of the R.E.*, Vol. I., p. 107.
‡ *Dictionary of National Bibliography.* Article on Sir W. Green.

Night; for which there was great preparations making, and I learn 1st June, 1779.
that our Gov^r had been out himself to Invite the Spainish Gov^r of St Roque, Don Joa^in Mendoza and his Lady and all the Spainish officers to come In upon the 4th of June, which shew'd all was Well at that time; My Complaints Still remain bad,—all the 2nd, 3rd, and indeed for the rest of the month.

4th. Great bustle in the Garrison. The Field officers and Staff, all at Dinner at the Convent. At Noon there was as Many Guns as the King was years old. In the afternoon the Spainish Gov^rs Lady and Several officers came in; but not the Gov^r himself, At Sunset there was a feu-de-joye. Madame Mendoza went from the Line wall, where she had seen the Firing, to the Convent; where there was a very Grand Gala, a Ball; and the Inside Court Yard, all round the Colonade, was finely Illuminated, and all possible pains taken on the occasion.

From the 4th to the 15th I continued greatly indisposed, and in my Room most of the time; all this time things were very quiet, and Several of the officers and their Familys had gone out to St Roque, and in that Neighbourhood to stay for the rest of the Summer.

On Saturday the 19th the Gov^r and all the Colonels and Field officers of this Garrison were desired by the Gov^r to attend him in a Visit He made to Don Joaquin Mendoza, the Gov^r of St Roque, upon hearing of his having been promoted to the Rank of Lieut Genl. They formed a large Cavalcade, It was a very Warm Day. N.B. They returned to dinner. It was remarked that He did not receive This Visit as He ought to have done; but Seemed Uneasy the whole time they staid—which was not very long—as He did not even ask them to Partake of any Refreshment; and which indeed They ought to have had ready for our Gov^r &c, as they knew of his intended Visit. By what so soon happend, We can not help thinking that He had Rec^d some private hints, and in all likelihood was distress't at this Visit, Madame was there. The Party all came back in good Spirits, tho not much pleased. They all dined at the Convent.

Sun^d 20. I am much better and went to Church. Many people Riding out into Spain, and all quiet.

Mond^y 21. The Mail went out to St Roque as Usual, but We had not any come In! which We did not mind at first, as it is not Uncommon for the Mail to stay an hour later than common. However we soon learnt the occasion. In the afternoon as some of our English officers were Riding out they were inform'd by the Spainish officers at the Lines that they must not go through, Not only that but that all the officers and families who were out were orderd into the Garrison directly, and also every English Person, not even allowing them to bring away those Necessarys they had taken out with them. Mr Davies and Family were there, also Mr Booth and Family, Capt and Mrs Montgomery, of the 12th, and Several others,

21st June, 1779. With great difficulty the Spainish Gov^r allowed them to stay that one Night, but by 3 oclock He hurried Them away. From that hour all communication was shut up. At this time Colonel Ross and Captain Vinogles of the 39th was in Spain upon a Tour, and at Malaga when they heard of this. They Set off directly and arrived at St Roque on *Wednesday the 23rd*, but was not suffer'd to come into this Garrison! the Gov^r Assuring them it was not posible for him to let any Body come into Gib^r. They were thus obliged to go to Cadiz. There they staid some time, till an answere was returned from Madrid. They were then allowed to go anywhere but to this Garrison. They went to Farro,* From thence they got a Boat, and arrived at Gib^r upon the *25 July*, as well as did Capt Lafanue of the 56th who had got as far as Lisbon by means of a Convoy, Under Capt Allen, of the *Chatham* Man of War, who sailed out upon the very Morning of the 25th before it was known of our Communication being Stopt. It is not impossible but Mendoza waited on purpose to let them be saild first, before He sent In Word, as He has a full View of all that passes in this Bay. Capt Lafanue left all the Convoy at Lisbon, but that the Levant Frigate, Captain Murry, was gone home express. I think his going was owing to the first Paquet Boat, which went from this, which was upon Tuesday 29th June to Farro, by which I wrote to My Sister and to Capt Nicolls,†—and thus ended this month. Only I am to remark that a vast Number of Ships and Xebeques‡ were daily going over to Algezira, and from them Several Smaller Vessels went to the Orange Grove.

July began very quiet. I was tolerably well and in pretty easy Spirits, tho' at times We had our Fears particularly as our Admiral did not seem overforward to let any of our Ships go out to stop any Thing that was daily going over the Way. Several Persons in the Garrison Seem'd Inclined to Man Vessels by way of Privatters. In the beginning of this Month 3 Fine Cutters came In from Engl^d fitted out as Privateers to take either French or Americans. They were stout Vessels indeed.

Sun^d 11th. I went out to the Mount. Several Large Ships appeared round Europa, and at Noon made Signals to the Admiral, who sent out the *Childers* Sloop of War. She found it was a large Number of Xebeques and other arm'd Vessels. A pretty Smart Engagement began, between the *Childers* and the 3 Cutters. It was from them as they were out cruizing that the Signals were made. They took Several Small Prizes of wine &c. It was now Eagerly

* A small port on the south coast of Portugal, frequently mentioned in this Journal, being the nearest neutral European port.

† Husband of Mrs. Green's eldest daughter, afterwards General Oliver Nicholls. He was in the 1st Royals.

‡ A small sailing vessel.

wishd and expected that the Admiral and the only Frigate viz. the *Enterprize*, Sir Thomas Rich, would hasten out, as it was pretty certain this was a fleet intended for Algezira. At last Admiral Duff did make a Signal. The *Enterprize* got ready as Soon as possible, but it was 5 oclock before the Admiral got out. It was by much too late! and the Fleet got through that Night. This occasioned great discontent and in consequence some Vowes &c were made. 11th July, 1779.

Fri[d] 16. Two Line of Battle Ships, of 74 Guns each, went over to Algezira, from which time it may be reckon'd a fair Blockade, as it can hardly be expected that any Vessel will be allowd to come into the Bay.—We hear that the Fleet over the Way is to be under the Command of Don Antonio Barcelo, and it is well known that He is a Brave officer.

Sun[d] 18. At Mount Pleasant. The whole Garrison seems displeased and Uneasy. Not any Vessels of late has come from Barbary, and our live stock is but little.

Mon[dy] 19. The Colonel does not Seem to like our Situation at this time, and has order'd many things in the publick Way, and also inform'd me that He thinks it will be Necessary to be attentive to our having a good Quaintity of Useful Family things laid In. This Even[g] I was taken with a Cold Shivering like an Ague; and think I shall go to Town. Mr Logie, the English Consul, went over to Barbary.

Tues[dy] 20. The Colonel came out pretty Early, and inform'd me that the Garrison was this Morning put under an allowance of Fresh Meat! Each Corps is to draw in Proportion to their Number and the officers to have their Proportion, in Consequence our share came to two pounds, six ounces. N.B. This was what was allowed us to buy at the Common Market. He seemed so Very Uneasy, and said He was so much hurried, and at the same time not Well, that I was resolved not to Remain out any longer, as I thought I might be of Some little Use in Town at such a time as this. It was this Day reported that Mr Logie was taken in going over—(but it was not true, as We heard afterwards). The Vessel was Certainly Boarded by the Spainiards, and he was in the Dress of a Moor, not only So but hid himself under some Sails, and by that Means escaped. Otherwise He would most likely have been taken either to Ceuta or to Algezira.

Wed[y] 21. I came into Town and find things a little better. A Boat had arrived from Tangier with 48 Bullocks. The Col. now seemed greatly indisposed, and upon Sunday 25 was so much that Doctor Baynes* advised him to be attentive to himself. This afternoon it was observed that the Spainiards had pitched one Tent near to Fort Negro.

* Surgeon-Major Arthur Baines.

26th July, 1779. *Mond 26.* The Col had been much indisposed, and restless all Night. I really believe his Anxiety made him Worse. This Morning We saw a good Number of Tents pitched upon the Plains, or the Common, of St Roque, forming Several Streets. It now becomes Necessary to attend to every point, as it is not to be doubted but the Intention of the Spainiards is to attack this Garrison. I shall therefore from this time call them—*The Enemy*—whenever I have occasion to speak of them, which I shall do as long as Circumstances enable me to continue this Unconnected, Rough, Journal—and much I fear I should fall Short of any Stile or Method, were it intended for any Persons Information except such of my Family Friends who perhaps will not Dislike to pass an Idle hour in looking over these pages. God only knows who may have the Sight of this Book or who may ever See the Person who now writes this; however I go on; *Miriam Green.*

Tues 27. This day a Pacquet Boat went to Farro by which I wrote to my Sister. The Col still indisposed. Many Persons calling; and the Govr expressing great Uneasiness at the Col's indisposition.

Wed 28. This day the Enemy encreasing their Encampment and making great Preparation. In the Forenoon the Govr came to our House and had a very long Conversation, and fixed many points with the Colonel. He also appointed the Staff of the Garrison, and fix'd upon his aid-de-camps, also many other matters, advising the Colonel not to attempt Stirring out till he was quite Well, as his Health now became a publick Concern. All this time and to the End of this month the Enemy continued very Busy indeed. Several of the Inhabitants families gat away by order and some indeed from Inclination. Inhabitants were order'd to Lay In for six months at Least. I now began to Fear upon the whole.

The Staff of the Garrison was settled as follows

Aid de Camps to the Governor, Captain Vallotton, 56th Regt, Captain Paterson, Royal Artillery, Captain Evelegh, Engineers, Captain Forch, 12th Regt.

Aid de Camps to Lt Governor,* Captain Wilson, 39th Regt, Lt Buckeridge, 39th Regt.

Aid de Camp to Lt Genl La Motte,† Captain Wenzee, Lt Gen La Motte's.

The Brigade Major to Hanoverians, Captain Lowder, Hardenbergh's.

Adjutant Genl Major Horsburgh, 39th; Quarter Master Gen Major Hardy, 56th.

Town Major, Captn Burke, 58th.

Assistant Engineers, Lt Burton, Royal Artillery; Lt Chambre, 56th; Lt Att, 72nd; Lt Schants, Hardenbergh's.

* Lieut.-General Robert Boyd.

† Commander of the Hanoverian Brigade which consisted of La Motte's, Hardenburg's, and Reden's regiments.

Mr Evans, Draughtsman to Chief Engineer; Mr Tingling, Draughtsman to Chief Engineer. 28th July, 1779.

Director of the Hospitals, Doctor Baynes; and Several additional Overseers in the King's Works.

The Colonel also appointed Lt Holloway* of the Engineers to attend upon him in some particular Dutys, which obliges him to have one officer constantly about him; and He became one of our Family.

The Colonel got better now every Day. From this time the Garrison was in constant Bustle, and in getting every thing in the best order. The Enemy also making very great Preparations, Unloading Stores, Pitching more Tents, &c, &c, and Thus ended the month of July. Various were the opinions; tho' it Seemed most probable that the Enemy's Intentions were to make every possible and effectual Trial to Establish a stronger Blockade, nor were they Idle to keep that Spirit up, as No one Vessel appear'd, either from the East or West, that Barcelo did not try to Stop, and most times with Success, He must be allowed every praise due to a good officer, altho' an Enemy.

August 1. The beginning afforded no very Essential Matter. Not any Vessels came over from Barbary. We now Endeavoured to Lay In as good a Stock as possible, and all sorts of family Articles were Sought for and Laid In. It is to be remark'd how very greatly the Inhabitants that kept little shops used to impose upon any Body. Nor were the Merchants backward in that respect! and most things were now fifty pr cent dearer than before.

Sun^d 8th. Miss Wards left Gibraltar in a Swedish ship, also Miss Hardy. I wrote to my Son and to Helen. This Day Lt Skinner of the Engineers declared his Marriage. All pretty quiet.

Tues^d 10. I wrote to my Sister by a pacquet Boat by Farro.

27th. I wrote to my Son by a pacquet Boat, but it did not Sail till the first of Septr. Nothing happend particular the rest of this Month. It now became quite fashionable to get all the News each one could Collect; and by Way of Gaining all that, every Body was Using Spy Glasses from Morning to Night. All those that *affected* great *Cleverness* were ever ready with a pencil and paper, and it was realy Laughable enough to see with what a Jealous Eye each Aid de Camp look'd at the other, fearing *He* should be the first to communicate his *Ideas* of what He supposed the Enemy was about! Various therefore was the Reports, and could not always agree. Those remarks I have made (Such as I could not possibly make from my own Personal Observation) I think may be depended upon as they are from our own Corps, and mostly from the Gentleman that is in the Colonel's family, who would hardly bring a false account.

* Afterwards Major-General Sir Charles Holloway.

1st September, 1779. *September 1st. Wed^y.* Easterly wind, exceedingly Warm and Close. Hear that the pacquet Boat had sailed for Farro in the course of last Night, and that those Vessels which were in Sight last Night were gone through. N.B. At this time the camp had not made any Material alteration for some Days, excepting two more Laboratory Tents, making 5 in all.

Thur^d 2d. Westerly wind. At one this Morning it rained exceedingly hard for half an hour, the first rain this Season. We all expected it would be Worse as at this time of the year it is often very Violent, but it turn'd out a pleasant Morning and forenoon. We this Day Laid In Several family Matters. No change in Camp this Day. Beef very bad at Market, and only 3 Bullocks to be killd, and those very Dear.

Fry 3rd. Westerly wind. Fine Morning. The Spainiards busy in Unloading Stores at the Orange Grove; and every Morning and Evening they bring down from that Landing place and from Fort Negro, Large Quaintitys of Stores in Carts, likewise many Cannon may be Seen from our Upper Batterys. Great complaints are now making in the Garrison for Want of fresh Provisions, not any Beef or Mutton in the Market to Day. Inhabitants, particularly Jews, are Laying In provisions for Six Months.

Sat^y 4. Westerly wind, pleasant Morning. A pacquet Boat arrived from Farro, last from Tangier, brought 10 Sheep only! An other Regt came to the Camp this morning. Some few persons had letters from England, but none from our Friends. No meat in Market Mid-Day had Soup Meagre for the first time.

Sun^d 5th. Westerly wind. Exceedingly Close and Damp. No Boats would Venture over to Barbary upon account of the Spainish cruisers. A man of the Hanoverians deserted this morning, was fired at from Williss. The wind came Easterly in Evening.

Mon^d 6th. Easterly wind. The Same Close Damp Weather. This Evening a Boat went to Tangier in which Several Inhabitants went over. Amongst the Number were Mr Butler, Dutch Consul, and his Niece. I wrote by this opportunity to My Daughter Nicolls. The Same Movements in the Camp. Most people now begin to think *We* ought to take Some Notice of our Neighbours, as they continue to *Work* on very Briskly; and are very Busy at Fort Negro, Fort St Philip and Fort Barbara.* Our *Admiral* and his Small Squadron remain perfectly quiet. Many Town Vessels go out and are very active!

(*To be continued*).

* St. Philip was on the west, and Barbara on the east, flank of the Spanish lines, the ruins of which still remain on the Spanish frontier.

Lt Colonel Henry F O Lewin RE

MEMOIR.

LIEUT.-COLONEL HENRY F. C. LEWIN, ROYAL ENGINEERS.

By Colonel R. H. Vetch, c.b., late R.E.

It is always sad when someone we have known as a boy passes away from this world and we reflect that in spite of occasional meetings in after life no opportunity has offered or, if offered was seized, of closer acquaintance and friendship. We feel that something has been missed in life. This thought struck me when I was asked to write a short notice for the *Royal Engineers Journal* of my old schoolfellow, Lieut.-Colonel H. F. C. Lewin.

A brother officer, an old friend of Lewin, who was first asked to write it, objected that his friend, like himself and nine-tenths of the R.E. officers, was, as far as he was aware, never employed outside ordinary routine work of the Corps, about which he thought nothing could be written. Nevertheless he suggested that someone else should be asked to do it!

It is quite true that the ordinary routine work of the Corps is not a very inspiring theme to write about, but behind all work always stands the man. I do not propose to say much about his work but only a little about Lewin himself and his family.

Retiring over 30 years ago Lewin's name is not likely to be known to many officers still on the active list of the Corps, the number of his surviving contemporaries is small, and his work had nothing very distinctive about it. But we cannot all be among the select "tenth" who make their mark and I think that a short account of Lewin's services and a few kind words about the man himself may fitly find a place in our *Journal*.

The Lewins are an old Kentish family who have lived for generations at Bexley and Eltham in Kent and their names are to be found in county histories and on monuments in Bexley Church.

Henry Frederick Chapman Lewin was the son of Henry Lewin (1802—1890), M.A., of Eltham, Kent, and of Mary Wray, his wife, a first cousin of the late Lieut.-General Henry Wray, C.M.G., R.E. Born at Eltham on the 2nd May, 1839, he was sent as a small boy to Mr. Thomas Hopkirk's preparatory school for Woolwich, Sandhurst,

and Addiscombe in that same country village, as it then was, and when he was old enough, was there specially prepared for the entrance examination to Woolwich. Those were the days of nomination and not of open competition. All who were nominated had to attain a certain standard for admission to the Royal Military Academy and the competition was limited to the place to be taken among those who qualified.

I well remember Lewin as a schoolfellow, but he was two years older than I was and, therefore, much senior to me in the school. It was then the time of the Crimean War and Lewin passed into Woolwich Academy, first of his batch, towards the close of 1854, I think. I can recall his coming over from Woolwich on a Sunday afternoon to see his old school and schoolfellows in all the glory of his first uniform as a gentleman cadet and how his old friends crowded round to admire and to ply him with questions about his Woolwich life.

He did well at Woolwich and was gazetted a lieutenant in the Corps on the 21st June, 1856. He was third in a batch of five Engineers, of which Major-General F. B. Mainguy was the head. He and Colonel A. G. Durnford are the only survivors.

After the usual courses of instruction at Chatham Lewin was sent in 1857 to Aldershot, whither Mainguy had already gone, and served there until April, 1859.

From Aldershot he sailed in May, 1859, to Malta, where General Sir Gaspard Le Marchant had recently succeeded Major-General Sir William Reid as governor, and he remained there for five years returning home in January, 1864.

After some six years in the Home District during which he was promoted to be captain on the 22nd December, 1865, Lewin was selected for an instructorship in fortification at the Royal Military Academy at Woolwich in August, 1870. He was on the staff of the Academy for over three years and during this time the French Prince Imperial and several officers of the Corps who afterwards became distinguished—among whom may be mentioned Field Marshal Lord Kitchener of Khartoum—were among his pupils. Colonel E. M. Lloyd, who was a fortification instructor at the Royal Military Academy for about a year with Lewin, writes:

"He was an excellent draughtsman so that his plates (*e.g.* the Antwerp front) could be hung up as models setting a high standard to the cadets. I never heard him lecture, and I don't know that he took much interest in the subject outside the course, but he was a good instructor."

It was while he was employed at Woolwich that he married, on the 25th February, 1873, at St. James's, Piccadilly, London, Mary Anna Eliza Grote, daughter of Arthur Grote (1814—1886), a distinguished member of the Bengal Civil Service (see *Dictionary of*

National Biography) and President of the Asiatic Society of Bengal (1859 to 1862, and again in 1865), by his wife, Mary Howel, daughter of Ilted Howel, a member of an old Welsh family. Another daughter of Ilted Howel married Mr. Robert Ellis Cunliffe, eldest son of General Sir Robert Henry Cunliffe, 4th baronet, and grandfather of the present baronet, Sir Foster H. E. Cunliffe.

The families of Lewin and Grote were doubly connected, for Arthur Grote's elder brother was George Grote (1794—1871), F.R.S., D.C.L., LL.D., the historian of Greece, M.P. for the City of London (1832—1841), who took an active part in the agitation for parliamentary reform, and was Vice Chancellor of London University (see *Dictionary of National Biography*). He married Harriet Lewin (1792—1878) daughter of Thomas Lewin (1753—1843), who was a first cousin of Lewin's father, by his wife, Mary Hale, daughter of John Hale, of The Plantation, Guisboro'. Harriet Grote was a lady of great vivacity and conversational powers, an accomplished musician and authoress. She wrote the lives of Ary Scheffer, the painter, and of her own husband, the historian, and is accorded a separate notice in the *Dictionary of National Biography*. She was thus on both sides a relation of Mrs. H. F. C. Lewin and a close intimacy existed between them.

Lewin was promoted to be major on the 26th August, 1873. In the following November he was moved from Woolwich to the Chatham District on promotion. Colonel J. W. Lovell, C.B., was his Commanding Royal Engineer until the end of 1874, when Colonel (afterwards Lieut.-General Sir) John Stokes succeeded him, but held the post for less than a year taking up the appointment of Commandant of the School of Military Engineering in November, 1875. He was succeeded by Colonel J. C. B. de Butts and under him Lewin served during the rest of the time he was stationed at Chatham, occasionally acting as Commanding Royal Engineer.

While stationed in the Chatham District Lewin lived first at Rochester and afterwards at Rings Lodge, near Wouldham, when he had charge of the land forts, extending from Borstal to Horsted, in course of construction by convict labour for the defence of Chatham Dockyard.

It was in 1877 on my return from service at Malta that I met Lewin again for the first time since our cadet days. Interested in his work, especially the defence work, and assiduous in the performance of his duties, he equally enjoyed his recreations. He was a skilful archer, a fairly good cricketer in his younger days, playing in some of the R.E. and West Kent matches, and an excellent racket and billiard player; indeed he retained his skill at billiards to the close of his life. He was also a keen musician, playing both the violin and violoncello.

Lewin enjoyed society in a quiet way and at Rochester Mrs. Lewin gave musical parties, at which by their own musical gifts they

were able to enhance the pleasure of their entertainments, while it is needless to say that they were themselves most desirable acquisitions at the musical parties of their friends. An old friend who knew them well in those days and kept up his friendship to the end of their lives, Dr. J. V. Bell, of Rochester, writes :

"My chief knowledge of the late Lieut.-Colonel Lewin was in the earlier years of his married life during his residence in Nile Terrace, in the house now occupied by General Sir Francis Thomas, Royal Marine Light Infantry, and afterwards at Rings Lodge, near Wouldham. Mrs. Lewin was a niece of George Grote, the historian, and Mrs. Grote used to come and stay with them and they had many friends in common especially in literary circles. Colonel and Mrs. Lewin were both very musical. Her piano and his 'cello found frequent employment in the quartettes which were a great delight to them, in a group which was mainly completed by musical members of the Corps. They were always present at any good concerts in the neighbourhood and gave their patronage and support to all local efforts for the advancement of music among the inhabitants. In addition to his refinement and culture Colonel Lewin was noted for his great kindness and consideration towards all who came in contact with him. Mrs. Lewin was delicate for many years and he seemed to think of everything which could be of any advantage to her."

In the summer of 1879 Lewin was moved from Chatham to Athlone in Ireland and in the following January to Woolwich. It was on account of his wife's health that he then decided to retire on a pension as a major with the honorary rank of lieut.-colonel, which he did on the 22nd May, 1880. After retirement he resided in London at 6, Ovington Gardens, S.W., until the summer of 1891. In the autumn of 1892 he went to live at Ovingdean, Bournemouth, Hants, where he passed the rest of his life.

Lewin was not what is called a reading man, but he occupied the spare time at his disposal by one of his hobbies of carpentering, printing, etc., and in doing what he could to benefit those about him. His old-world courtesy to all with whom he came in contact, his charm of manner and straightforward character gained him the esteem and affection of all classes. If he was not a great reader, he thought much on many subjects and his shrewd common sense was apparent in his conversation. Holding decided views himself he was yet most tolerant of the opinions of other people and was always willing to give his advice when sought, but not otherwise.

He joined the Royal Toxophilite Society in 1868, was honorary treasurer from 1882 to 1892, and vice-president from 1892 to 1895. Though an uncertain shot he made many good scores at the Public and other archery meetings which he always attended when possible. Perhaps his best performance was at the Grand National Meeting at Doncaster in 1878, where he won the medal for the 6th gross score of the whole meeting. He was Honorary Secretary of the Grand

National Archery Society. From 1881 to 1883 he was honorary secretary of the Crystal Palace Archery Meeting and, in 1896, he succeeded the late Major C. H. Fisher as honorary secretary of the West Berks Archers, resigning that office in 1909. He contributed occasional papers to the *Field and Archers' Register* on archery subjects, and was a recognized authority on this pastime (see *Badminton Library*).

During the years he lived at Bournemouth, Lewin did a great deal of quiet public work. He took especial interest in the Royal National Sanatorium, and was an active member of the Committee of that institution from 1893. Owing mainly to his influence a successful meeting of the Grand National Archery Society was held at Bournemouth on the Dean Park Ground when he acted as local secretary. At the same place in July, 1900, he pioneered the annual meeting of the Grand Western Archery Society. He interested himself in local questions and served on the committee of the Bournemouth Residents' Association for several years and also on the Board of the Income Tax Commission.

Mrs. Lewin died at "Ovingdean," Cavendish Road, Bournemouth, on the 20th May, 1909, and was buried in Bournemouth Cemetery.

From several brother officers and friends comes the same story, the loss of his wife completely broke Lewin down. Dr. Bell says:

"Two or three years ago she died, almost suddenly, just after she had completed the rearrangement of a very pretty garden behind their house in Bournemouth, and it was sad to see how terrible to him was the blank which was left by her removal. He seemed to have looked forward to some happy declining years in her society, but her death appeared to have taken away all desire for the prolongation of his own life. He just brightened up for the time to give my wife and myself the kindly welcome to which we had been accustomed many years before, but we could see that the charm of his life was gone, and we missed the dry humour which used to be so characteristic of him."

Lieut.-Colonel H. F. C. Lewin did not long survive his wife. He died suddenly of heart failure, at his Bournemouth residence on the 19th April, 1911, aged 72 years all but a few days. He was buried at Bournemouth beside his wife.

There was only one child of the marriage, a son, Henry Grote Lewin, born in Rochester on 4th January, 1874, who, after education at Clifton College, and Trinity College, Cambridge, entered the service of the North-Eastern Railway Company and is now at York as Mineral Train Superintendent of that system.

A local paper wrote of Lewin:—

"In the death of Colonel H. F. C. Lewin, R.E., at Bournemouth on the 19th ult. there passed away one, who after giving the prime of his life to his country, spent his later years in rendering services to the town

of his adoption, which were none the less efficient because they were quietly and unostentatiously performed.

. . . Himself a keen musician and a fine performer on the violoncello, he took the greatest interest in the rendering of classical music at the Winter Gardens, and was a constant attendant at the Symphony Concerts as long as his health permitted. His loss is felt deeply by a wide circle of friends and acquaintances."

Colonel Sir Duncan A. Johnston, K.C.B., wrote of his old and valued friend:

"I knew him first many years ago at Chatham when he was a major and I a young subaltern. He was very kind and friendly to me and I learnt to appreciate his sterling good qualities. He never pushed himself forward but was a first-rate officer, a good sportsman, and a genuine and true friend."

"I wish," writes Major-General F. B. Mainguy, "that I could tell you more about my old friend Lewin. He followed me to Aldershot from Chatham in 1857, but we were not long together there; and I only had an occasional glimpse of him from time to time while he remained in the Service. We renewed our acquaintance a few years ago when he came over to Guernsey one summer with his wife. We were both young fellows together at Woolwich and Chatham and were very friendly. He was, I always considered 'religious' and with high principles."

TRANSCRIPTS.

AN ELECTROLYTIC A.C.-D.C. TRANSFORMER.

(Taken from the *Kriegstechnische Zeitschrift*).

SEARCHLIGHTS, accumulators, galvanic baths, mercury vapour lamps and Röntgen ray apparatus normally require D.C. electricity for their working; the electricity supplied by the majority of power stations is A.C.; hence can be easily seen the need of an inexpensive and permanent transformer, to use the town supply for the more household purposes above mentioned.

The Siemens & Halske Allgemeine Gesellschaft have recently placed on the market an electrolytic A.C.-D.C. transformer, the low price of which (£6) compares favourably with that of the more cumbersome rotary transformers, and which is also superior to them as regards simplicity of handling and construction.

The principle of this transformer is as follows:—

"If one or more electrolytic cells be inserted in the circuit of a simple alternating current, the A.C. curve is flattened towards the abscissa axis (see *Fig.* 1).

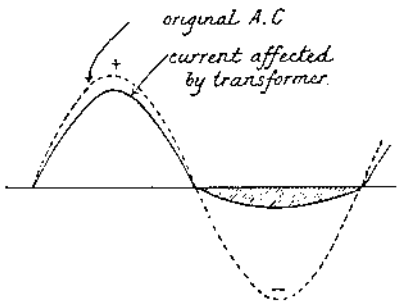


FIG. 1.

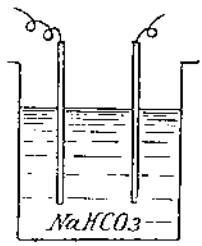


FIG. 2.

The action of such cells, which consist of two different electrodes in a liquid electrolyte (see *Fig.* 2) is to break up the alternating current attempting to pass through them, *i.e.* one pulsation, say the positive one, is but weakly affected by the counter E.M.F. and internal resistance of the cell, whereas the negative pulsation is reduced to the minimum possible, the net result being that the issuing current is practically a D.C. one."

Fig. 3 shows the actual transformer. Only two electrolytic cells are employed, the one in parallel with the machine (A) using the direct current, the other in series with this machine; it will further be seen that these cells oppose one another.

The cells consist of two plates: Aluminium (+) and iron (−) in a 5 per cent. to 10 per cent. solution of $NaHCO_3$.

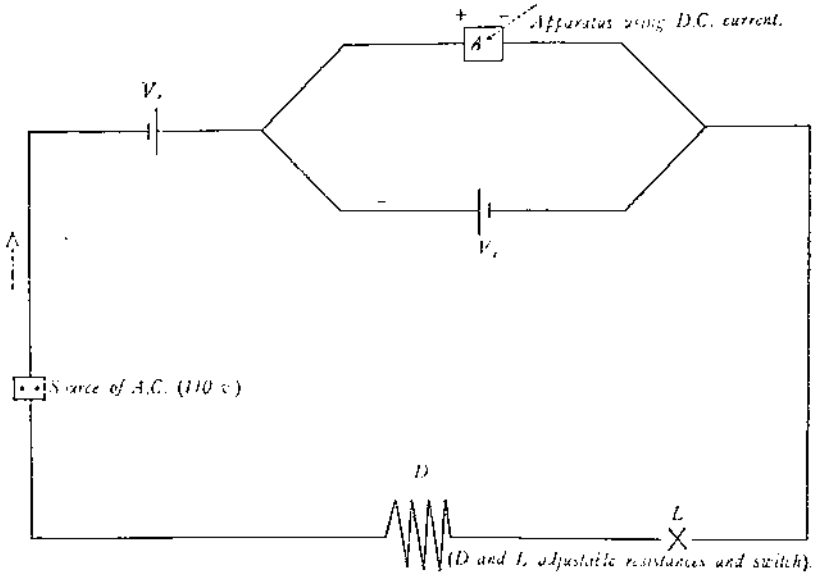


FIG. 3.

"D" and "L" are inserted resistances (glow lamps), by means of which the D.C. can be adjusted and kept as regular as possible (see *Fig.* 4). With an A.C. of 110 volts, the D.C. available at A varies from 65 to 75 volts.

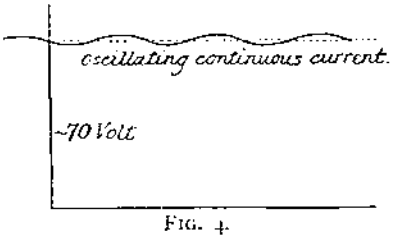


FIG. 4.

The action of the transformer is that the positive pulsation passes almost entirely through the cell V, whereas the negative is reduced to the small quantity shown shaded in *Fig.* 1. This minimum is allowed to pass through by the cell V_2 which only affords a path to negative pulsations. The positive pulsations do not attempt to pass through V_2 as the resistance of the path through A is infinitely the lesser.

As regards the military and naval applications of this instrument, it is suggested that it can be used to connect accumulators or searchlights direct on to the mains of town supplies, or to the large lighting plant of warships, and thus not only avoid the use of separate engines or rotary transformers for these apparatus, but also save the cost of the *personnel* required to attend to these machines.

A. H. SCOTT.

AUTOMATIC LAND MINES AT PORT ARTHUR.

From an article by L. Debogori-Mokrievich in the December, 1910, number of the *Injenerni Jurnal.*

The Charge.—For the automatic mines, for the sake of lightness and convenience of handling, the charges were fixed at 1 *pūd* (36·11 lbs.) and the explosive used was gunpowder from the Chinese war loot of 1900.

The receptacles were made double, the inner cases being kerosene oil tins, 14″ in height by 12″ square, and the outer cases of wood as shown in *Fig.* 1. Their sides were of planks laid horizontally, held in place at the corners by outside and inside vertical battens, the latter of which served as supports for the second of the three lids. The bottoms were also made of plank, with a cross of battens laid on the inside.

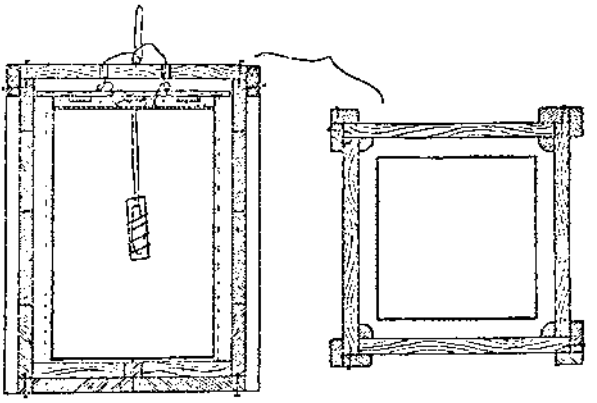


FIG. 1.

When an outer case was ready for the reception of an inner one a mixture of asphalt and pitch was poured into it until the cross battens at the bottom were covered. As soon as this had set the inner case, which had been previously filled with sand, or better still with stones, to prevent it from collapsing inwards, was placed carefully inside, so that the space between it and the outer case was equal on all sides, and this space was then filled with the composition. When this had set the inner case could be emptied and prepared for charging, but it could not be left empty in the heat of the sun without collapsing inwards.

The receptacle being now ready for charging, the tin was filled with powder to a height of 13½″, and covered with an inner cardboard lid with a single opening for the leads, the fuse having been fixed in the middle of the powder in the usual way. The rest of the tin was then filled up with sawdust, and the second lid, in which were two openings for the leads, was nailed over the whole interior space of the outer case.

Above this was poured a thick layer of composition, and finally planks forming the outer lid were nailed over all. The outside of the receptacle was painted with composition made without sand, and the leads, where they emerged from the openings in the cover, were made fast to small staples and then coiled with their ends insulated.

The Trap.—The *trap*, which is shown in *Fig.* 2, consisted of a square frame with a cover resting on interior springs, which could be pressed downwards if trodden upon, and from the underside of which was suspended an electric contact-maker. In general features the trap was similar to that given in the existing textbooks, but, from some experiments which had been carried out in 1903 by the Kwantung Sapper Company, during their summer course of instruction, certain faults had come to light for which at that time there had been neither time nor materials for finding remedies.

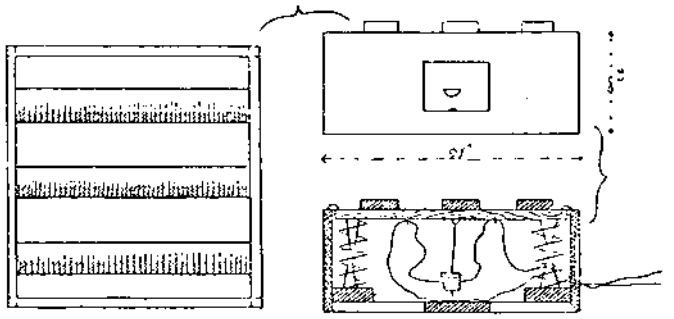


FIG. 2.

In 1904, by orders of General Kondratenko and Lieut.-Colonel Krestinski, further experiments were made by the author, with the result that (i.) a loose leather covering was nailed over the gap between the cover and the sides of the trap, in order to prevent earth from falling in and clogging the action, (ii.) a "window" was made in one side of the frame to allow of adjusting and testing the contact-maker without disturbing the trap, and (iii.) the size of the frame was reduced from a square of 28″ to one of 21″, as it was found that with the larger trap a man treading on one corner of the lid would only raise the further one without lowering the centre, from which the contact-maker was suspended.

The sides of the frame, which were 8″ deep, were made of ¾″ planks, and the bottom was a cross of battens, left open in order not to hold water. The top was of continuous planking, strengthened by cross fillets. At the corners on the wooden cross which formed the bottom of the trap, blocks were fixed to support the springs. This was done partly to economize the steel wire used in the springs, of which the supply was limited, and that very expensive, and partly because the shorter the springs the less liable were they to bend or get out of place. Wooden cores were also fitted to both blocks and lid to keep the springs in position.

The "window" in the side of the frame was closed by a sliding shutter, and an opening was left in its lower edge through which the leads were carried to the contact-maker.

The springs were made of steel wire bent into a spiral. The gauge of the wire, the length, diameter, and grade of the spiral were arrived at after a series of experiments, the results of which have been unfortunately lost. The springs must be strong to prevent the trap being affected by light accidental blows. A method of testing them is shown in *Fig.* 3, the weight used and the required length of compression, x, having been decided upon in the course of the experiments. The springs and the rest of the traps were made by the fitters and carpenters of the mining detachment.

Contact-Maker.—The contact-maker is not described, as it was similar to that authorized in the existing manuals, but it appears to have consisted of a copper vessel suspended by a cord from the centre of the underside of the cover of the trap. On its underside was a needle which when the vessel was lowered struck the bottom cross of the trap, and caused the vessel to tilt, disturbing a copper pea-ball which rested in a hollowed plate and thereupon made contact between the plate and an inner ring in the contact-maker.

The following defects were discovered in the service pattern :—

(i.). Insufficient weight, which caused the vessel to be diverted from its position by the stiffness of the leads.

(ii.). The hollow of the plate was too deep, requiring too great tilting to release the pea-ball, so that the trap might be lowered and released without making contact.

(iii). The contact-maker was not waterproof and damp was found to penetrate into it through various openings.

These defects were remedied as follows :—

(i.). The contact-makers were made more heavy. The cases had formerly been made of copper tubing but General Kondratenko now arranged to have them cast in copper in the dockyard. The leads after passing into the trap through the opening in the shutter, were now made fast to screws on the underside of the cover, from which they passed with so little slack to the contact-maker that they brought little pressure to bear on it.

(ii.). A shallower design of bottom plate was arrived at after many experiments.

(iii.). All the openings in the contact-maker were closed with rubber solution and tape. But it was not found possible to entirely prevent damp from penetrating into the vessel.

(iv.). For suspending the contact-maker, gut was found to be the best material, as it did not twist and its length was unaffected by damp or temperature.

The plates, pea-balls and inner rings were electro-plated with silver.

Details Influencing the Sensitiveness of the Apparatus.—The sensitiveness of the apparatus was influenced by the following :—

(i.). The shape of the hollowed plate.

(ii.). The diameter of the pea-ball.

(iii.). The length of the gut.

(iv.). The vertical length of the vessel itself and the needle below it.

(v.). The strength and sensitiveness of the springs.

The degree of sensitiveness required was such that a weight of 4 pūds (144 lbs.) rapidly pressing on the cover of the trap should cause a contact long enough to ensure the raising of the temperature of the bridge of the fuse to a red heat.

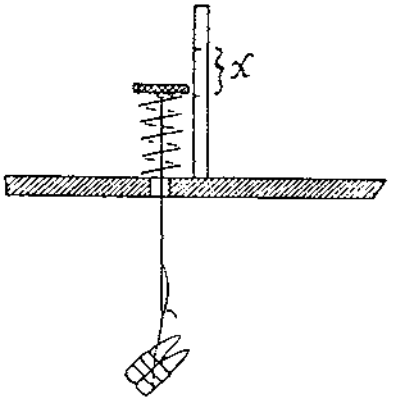


FIG. 3.

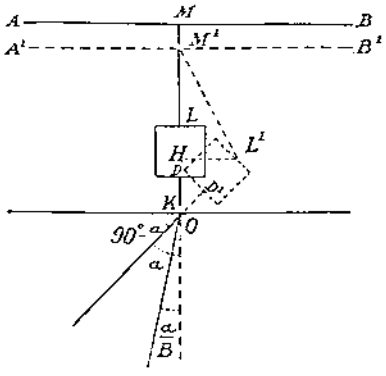


FIG. 4.

Before experimenting on the details of these requirements, it was decided to calculate the theoretic data affecting them. In *Fig.* 4, we will consider that a man stepping on the trap presses down the cover from the position AMB to A'M'B'. The point of the needle passes through the distance KO and is then stopped by the bottom battens of the frame, and the vessel tilts through the angle α. We will suppose that contact is made when it has tilted through the angle $\frac{\alpha}{\beta}$, so that while the vessel is being tilted from $\frac{\alpha}{\beta}$ to α and back to $\frac{\alpha}{\beta}$ the bridge of the fuse is being heated. The size of the angle $\frac{\alpha}{\beta}$ depends upon (i.) the length of KO (ii.) the curve of the plate and (iii.) the diameter of the pea-ball.

The size of the pea-ball was left unaltered. As the more KO is reduced the more sensitive is the apparatus, it was made as small as possible, always allowing the needle to swing clear of the cross battens. The uniformity of the bottom plates was secured by stamping them on a steel pattern which was made as the result of the experiments already mentioned.

The calculations show that the relation of MM' (h) with ML (m), LK (a) and the angle α is as follows :—

$$h = m + a + \mathrm{KO} - a \sin \alpha + \sqrt{m^2 - a^2 \cos^2 \alpha}.$$

m must be greater than $a \cos \alpha$, and it will be seen that if the vertical length of contact-maker and needle is made very great and the gut very short the vessel will not tilt sufficiently to reach the angle α or even $\frac{\alpha}{\beta}$.

If h is made very long a man passing very rapidly over the trap might not press it down far enough. If the springs are made weak then sometimes they might not remain extended. A very small h might not allow

long enough contact to fire the fuse. If *m*, *a* and KO are reduced then *h* must also be reduced proportionally. KO may be taken *a*2*mm*. The limit to which *a* may be reduced is found from the equation. A very short needle with a wide contact vessel might not allow the latter to tilt to the required angle and a very long needle might cause the vessel to upset. Therefore for a given size of contact-maker, *a* is constant.

As shown above *m* cannot be reduced beyond a known limit. Neither should it be increased beyond a limit fixed by the convenience of tying the gut and testing the contact-maker through the "window" in the side of the frame.

Originally the frames were tarred, but later on this was omitted for want of time, though when tarred the frames were less conspicuous for night work close to the enemy.

The Electric Battery.—The cells which were available for use with these mines were of various kinds, but most of them were of the "Hambourg" type, large and small, the former of which were used for firing the charges and the latter for testing. There were also 50 dry cells which were made up locally in the dockyard, and some others of a type which was apparently nameless.

In order to preserve the cells, and especially the Hambourg ones which were of glass, from damage and damp during transport, storage, fixing, and when left in the ground, they were fitted each into a strong wooden case and packed tightly with sawdust. Seven foot lengths of cable were soldered to the electrodes and brought through the outer lids of these cases and made fast as usual to staples on the outside.

In the latter end of March a series of experiments was carried out to ascertain the number of cells required to fire the mines. The cable available was taken from the Chinese War loot of 1900, and was 7-cored, the fuzes were two types of platinum fuse made by Messrs. Clarkson & Co., No. 1 being distinguished from No. 2 by having the picture of a lion on the case.

The experiments showed that (i.) No. 1 type of fuse could be exploded by one large Hambourg cell through a circuit of 700 yards of the Chinese cable, or, through a contact-maker, through a circuit of 115 yards; that (ii.) No. 2 type required a stronger current and was more suited to be used with Clarkson's exploder; and that (iii.) only one fuse could be fired at one time by means of the cells without very largely increasing the size of the battery.

From (ii.) it was decided that a group of four contact-makers and four charges could be worked by one cell, and yet be placed at sufficiently wide intervals to avoid the probability of simultaneous contact in two or more contact-makers.

The Groups of Mines.—The mines were consequently laid in groups of 1, 2, 3 or 4, in parallel, fired by a single battery (see *Fig.* 5). The "nets'

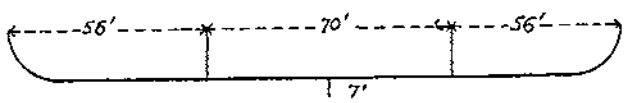


FIG. 5.

of cable were made up in readiness beforehand and a reserve was kept in case of necessity. All joints were welded, cleaned and insulated. As will be seen from *Figs.* 5—9, all the groups were designed so that the internal resistance of each was small for a single cell.

The necessity for having some reserve of electric power was due to the following causes :—

(i.). The contact-makers were found to get dirty from the damp and this increased their resistance.

(ii.). It was necessary to take into consideration the leakage of current due to the imperfect insulation of the cable.

(iii.). The gradual exhaustion of the cells due to this leakage which was largely increased by the frequent showers.

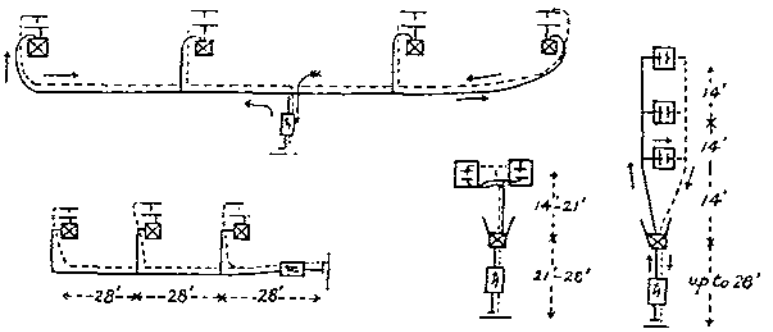
(iv.). The very short period of time during which contact would be made by an enemy stepping on the trap.

The end leads of each group were made very short—not more than 7'—as it was not intended to use any group more than once.

Disconnecting Boxes.—In every case a disconnecting box of the form described in the article on Observation Mines (see *R.E. Journal*, February, 1911) was placed in connection with each firing battery. Its object was to enable the mine to be put into a condition of safety during tests or repairs to the traps, etc.

The positions of the disconnecting boxes were always marked on the ground by a special arrangement of stones, etc.

Details of the Various Groups.—*Figs.* 6, 7, 8 and 9 show the general arrangement of the various systems of automatic mine obstacles.



FIGS. 6, 7, 8, & 9.

INDEX.

Cell.

Trap with contact-maker.

Charge.

Disconnecting box.

It will be seen that there were two distinct classes :—

1. Ordinary mines.
2. Fougasses.

In the case of the latter, in view of the considerable amount of labour involved in making the fougasses, and with the desire to mine a large area, it was usual to fit two or three traps to each fougasse.

The Cable Trenches.—For concealment, the cables were buried to a depth of 8″ to 16″. As the mines were always laid at night, in close proximity to the enemy, and outside the Russian firing line, it was not possible to do more than this. In this work the experience gained by the miners when concealing the cables of observation mines, before the close siege commenced, was invaluable.

The Chambers.—*Fig.* 10 shows in plan and section a chamber for an ordinary mine and trap. In order to save labour both were included in one excavation, with the trap towards the enemy. In the case of fougasses the traps were placed further to the front, in order to secure a larger field of action. The fougasse chambers were similar to those shown in the article on observation mines.

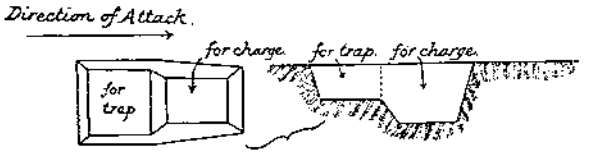


FIG. 10.

The Mine Laying.—The party detailed for laying a group of automatic mines consisted of one or two electricians and an unskilled working party. During the daylight a complete "net," together with charges, traps, etc., was taken from the Mine Laboratory to the district headquarters; at the approach of night it was carried on in the same carts to the firing line and there unloaded. A group of four mines required two carts, and one of two fougasses with four traps required four carts.

Beyond this they were carried forward by hand. Sometimes it was possible to push beyond the outlying sharpshooters, but often it was not possible, on account of the nearness of the enemy, to work much beyond the outpost line.

First the sites of charges and traps were decided upon, and then in accordance with the results of this reconnaissance the "net" was unrolled on the ground and the cables themselves acted as tracing tapes. The mines were then laid and the final connections made in accordance with the system decided upon, the last operation of all being that of fixing the plug in the disconnecting box.

With fougasses (see *Figs.* 8 and 9) the disconnecting boxes were placed 15 paces in rear of the fougasses, so that an accidental explosion should not injure the man operating the plug.

The occupation of laying a group of fougasses took from four to six hours, and that of laying a group of ordinary mines from two to four hours, depending on the nature of the soil and the size of the working party.

On two occasions the enemy temporarily stopped the work of mine-laying:—(i.) on the night of 6th–7th September in front of the Aqueduct Redoubt, and (ii.) on that of 28th—29th September in the ravine in front of the interval between Fort No. III. and Open Caponier No. 3. But in each case the Russians were able to complete the work during the same night.

There were occasions when mines had to be laid during the fighting, but for this advantage was taken of lulls, as the main conditions of success in the work are concealment and protection for the required number of workers. If the work could not be finished in one night the mine was discovered by the enemy at daybreak and destroyed. This also happened if he heard the sound of the work or blundered upon it in the darkness.

Reasons for using Electrically-Fired Mines.—The following are the reasons for choosing the electrically-fired mines of the kind described :—

(i.). Safety in laying. There was only one accident, on Long Hill.

(ii.). Facility in testing, repairing and disconnecting.

(iii.). Facility of concealment.

(iv.). Insensibility to water and damp. The contact-maker could be modified to preserve it absolutely from the penetration of damp, but the measures taken made it very nearly damp-proof.

(v.). Indifference to cold and frost.

(vi.). Insensibility to light blows from stones, or vibrations of the ground.

(vii.). Simplicity of construction, with the artificers available.

(viii.). Abundance of materials available for construction of traps, springs, contact-makers, etc.

(ix.). Safety of storing the several parts.

Tactical Application.—Automatic land mines may be laid :—

1. In front of the fighting line itself.

2. In places where it is not intended that our troops shall advance either in attack, sortie or by isolated sharpshooters.

3. In dead ground.

4. In places weakly defended by fire.

5. At points of probable attack, when rapid work is necessary.

6. In all cases when mining is desirable but when the want of men, electric batteries, or cable, preclude the use of observation mines.

7. In front of the enemy's sapheads.

8. In front of the salient angles of works.

9. In roads.

10. In abandoned works, houses, etc.

Their mutual siting is governed by the same rules as that of observation mines.

DETAILS OF AUTOMATIC LAND MINES LAID AT PORT ARTHUR IN 1904.

No.	Date.	Place.	Number of Mines, etc.	Object.	Result.
1	28th Mar.	In an advanced position to which Junior Under Officer Antonov was sent by order of Lieut.-Col. Jerebtsov.	Issued from the mine laboratory :— 10 charges, 10 traps, 5 'nets' of cables, 14 contact makrs.	Mining roads.	Never laid.
2	Night 26th–27th July during fighting.	In an advanced position in the nullah on the left flank of the 13th E. Sib. Rifle Regt.	12 charges, *i.e.*, they were carried on 12 carts.	In the valley weakly commanded by fire and the approaches to which were concealed. It was easy to advance up singly but in a line difficult.	During the fighting 26th to 28th July no advance took place here. It is not known if the enemy struck them after the position was abandoned.

DETAILS OF AUTOMATIC LAND MINES LAID AT PORT ARTHUR IN 1904—*Cont.*

No.	Date.	Place.	Number of Mines, etc.	Object.	Result.
3	5th–6th Aug.	In the ravine on the west slope of Angle Hill.	Mines (?) with cells of submarine mines.	To mine the approaches to the position. Ensign Berg with 4 miners.	They say that during the attack on Angle Hill a Japanese column was blown up.
4	18th Aug. by day.	Between 203-Metre Hill and Fort No. V. in 2 places.	6 ordinary mines in 2 groups.	Mining dead ground to protect 203-Metre Hill from being turned.	No information received. The enemy only reached here in December.
5	19th Aug.	Same place.	4 charges.		
6	24th–25th Aug. and other days three times.	In front of Redoubt No. 1 after a sortie.	4 charges.	To take the redoubt and then mine the approaches to it. By order of Lt.-Gen. Smirnov and Col. Grigorenko.	The task was impossible. They did not reach the redoubt and therefore never laid the mines.
7	Night 28th–29th Aug.	In front of wire entanglement in the nullah between Long Hill and 203-Metre Hill, opposite the Interval Hill.	2 fougasses and 4 mines.	To mine the ravine against an inroad of the enemy in rear of Long Hill.	No accurate details.
8	Night 2nd–3rd Sept.	Between Long and Division Hills.	6 mines in 2 groups.	To mine the dead ravines in front of a weakly defended part of the position.	No accurate details. At 12.30 p.m. on 23rd Sept. a mine was seen to explode.
9	Night 3rd–4th Sept.	Between 203-Metre and Long Hills.	2 mines.	To mine the dead ground in front of 203-Metre Hill.	?
10	4th Sept.	To 203-Metre Hill and Flat Hill.	7 cart loads.	Charges despatched.	—
11	Nights 5th–6th and 6th–7th Sept.	In front of glacis of Fort No. II.	4 automatic fougasses with 2 traps each.	To mine the dead salient angle against the enemy's advance.	In the night 10th–11th Sept. one fougasse was exploded by one of the enemy's sharpshooters and on 11th at dawn one was exploded by the bombardment.
12	Nights 6th–7th and 7th–8th Sept.	In front of glacis of Temple Redoubt.	7 mines in 2 groups.	Opposite the front face in the road of a former advance of the enemy.	No information.
13	Nights 6th–7th and 7th–8th Sept.	In front of the glacis of the Aqueduct Redoubt.	7 mines in 2 groups.	Opposite the front face and in the road of a former advance of the enemy.	On 19th Sept. between 4 and 6 p.m. a mine exploded under the enemy.
14	Night 8th–9th Sept.	Between 203-Metre and Flat Hills.	6 mines in 2 groups.	In dead ground.	No information.
15	Night 10th–11th Sept.	On the left slope of 203-Metre Hill.	6 mines in 2 groups.	To mine dead ground near the trench.	One mine exploded about half an hour after the miners left.

DETAILS OF AUTOMATIC LAND MINES LAID AT PORT ARTHUR IN 1904—*Cont.*

No.	Date.	Place.	Number of Mines, etc.	Object.	Result.
16	Night 12th-13th Sept.	In front of the glacis of Fort No. II.	1 fougasse with 2 traps.	To replace those exploded.	No information.
17	Night 13th 14th Sept.	Same place.	1 fougasse with 2 traps.	Ditto.	—
18	Night 13th-14th Sept.	Between Long and Dead Head Hills.	6 mines in 2 groups.	In the road of a probable and early attack.	According to report they exploded in the night of 20th Sept. and at 2 p.m. on 22nd Sept.
19	Nights 19th-20th Sept.	In front of Aqueduct Redoubt.	2 mines.	To replace exploded ones.	No information.
20	Night 21st-22nd Sept.	To left of Fort No. II.	2 mines.	In dead ground.	Unknown.
21	Night 24th-25th Sept.	In the valley of the Lunho. In front of the Crematorium enclosure.	6 mines in 2 groups.	In dead ground.	No information.
21 (*sic*)	Night 25th-26th Sept.	Same place.	6 mines in 2 groups.	Ditto.	Unknown.
22	Night 27th-28th Sept.	Same place.	6 mines in 2 groups.	Ditto.	Unknown.
23	Night 28th-29th Sept.	In nullah between Fort No. III. and Open Caponier No. 3.	4 mines in 1 group.	Dead ravine in road of enemy's advance.	During the laying an attack by a small party was beaten off. After laying one exploded. The enemy took away the charges.
24	Night 10th-11th Oct.	In front of Battery Letter B.	2 fougasses with 2 traps each.	Approaches to the position. Changed from observation mines as the cables were badly damaged.	In the night 23rd-24th Nov. during the attack one fougasse exploded. The attack was renewed only after half an hour.
25	Night 12th-13th Oct.	In front of Battery Letter B.	3 fougasses with 2 traps each.	To mine the approaches.	Ditto.
26	Night 13th-14th Oct.	In front of Signal Hill in Small Bay Ta-Ho.	4 mines in 1 group.	In the road of a previous advance.	No information.
27	Night 19th-20th Dec.	In front of the salient angle of Tumulus Battery.	3 mines in 1 group.	In dead ground, in the road of a former attack by the Japanese.	There was no advance here.

F. E. G. SKEY.

THE ENGINEERS AT THE AUTUMN MANŒUVRES OF THE 20TH (FRENCH) ARMY CORPS IN 1910.

Two articles under the above title appear in the May and June numbers of the *Revue Militaire Générale*. The articles contain an account of the operations of the companies of the 20th Battalion of French engineers allotted to the Red side on the manœuvres, and the lessons which the writer deduces from them regarding the employment of engineers in the field and the training, organization and equipment requisite to fit them for their *rôle*. The bulk of these lessons, for us the most interesting feature of the articles, are collected together in the conclusions which follow the narrative of the operations.

The manœuvres were divided into three periods. During the first and second of these the Red force consisted of a division with a cavalry brigade and an additional battalion of chasseurs à pied, strength in all four infantry regiments and one extra battalion, three brigades of artillery, and two regiments of cavalry. With this force were two companies of engineers acting in the capacity of divisional companies. An opportunity was thus afforded of testing the projected provision for war of two companies to an infantry division of two brigades.

In the third period the Red force was organized in a division of four infantry regiments and two artillery brigades, and a mixed brigade of two infantry regiments, two battalions of chasseurs à pied and one artillery brigade. Two brigades of artillery formed the corps artillery, and there was a cavalry brigade, of two regiments. The engineer companies were allotted one as a divisional company and one as corps engineers.

For the purposes of the manœuvres each of the companies had been provided, in addition to its normal technical vehicles (three 3-horse tool carts and a light explosives cart), with a bridging wagon carrying trestles, baulks, cordage, chesses, and raft-bags. The material on each wagon was sufficient for the construction of a footbridge 1·50 metres in width and 14 metres long.

During the first period the Red force represented part of a retreating army and its special mission was to prevent if possible the passage of the Moselle by the enemy and in any case to delay his advance. This task the commander of the force proposed to carry out by taking advantage of the dispersal inseparable from the passage of the river to attack the enemy at a favourable time and place and to drive his main body back into the river.

No. 2 Company was allotted to a detachment consisting of two battalions, one battery and a squadron under the command of the commander of the infantry regiment. Three sections were each employed on the preparation for demolition of a bridge across the Moselle. The fourth had the task of preparing for defence a rallying position. The reconnaissance of the position was carried out by an infantry captain

assisted by an engineer lieutenant and the infantry co-operated in the execution of the works.

No. 3 Company was retained with the main body and was employed on the construction of bridges to facilitate the advance of the main body. For this purpose the bridging wagon of the other company had been temporarily attached to it. The bridging equipment proved insufficient and clumsy and the construction of the bridges took four hours. If only material found on the spot had been available still more time would have been required. To avoid delay in urgent cases engineer companies need a light bridging equipment designed for rapid construction.

The enemy having effected the passage of the Moselle on the first day the Red force continued its delaying tactics on the second day, the 9th September. No. 2 Company was detailed to prepare a village for defence to form the pivot of a delaying position. Pending the arrival of the infantry garrison the officer commanding the engineer company reconnoitred the village for tools and materials, and took immediate steps for its security. On arrival the infantry co-operated with the engineers in the execution of the defensive works. In the afternoon a verbal order reached the lieutenant commanding the company, from the G.O.C., directing him to proceed at once with his bridging equipment to a point where a local offensive had attained some success. The successful troops having been brought to a standstill by the time the engineers arrived, the necessity for the bridging did not arise but the company was at once set to work on measures to secure the ground already gained.

The other company was employed in the preparation for defence of two woods, as positions to fall back upon in case of necessity. This they had to undertake single-handed, no infantry being told off to assist in the preparations. On this occasion the time available sufficed to allow the company to complete the necessary works but the writer gives it as his opinion that as a rule, in field operations, clearances, abattis, trenches and the preparation of the edge of a wood on an extensive scale will be out of the question for a company of engineers. When in touch with the enemy the works that can be executed for the defence of a wood will be only very hasty and the principal function of the engineers will be the improvement and construction of interior communications.

During the progress of these works one section was withdrawn to organize, in conjunction with a company of infantry, the defence of a neighbouring village.

On the 10th September, the third and final day of the first period, the Red force was compelled to fall back. The two engineer companies were employed at different points on the preparation for defence of woods, farms, and villages.

At one of the villages no infantry were detailed to assist in carrying out the measures for defence. The writer of the articles takes the opportunity to emphasize the provisions of the official instructions, that engineers should intervene "in all circumstances which demand either the special technical knowledge which their *personnel* possesses, or the tools and equipment which they carry." This he reads as indicating that simple works such as ordinary trenches and the preparation of hedges, and enclosures should be carried out by the infantry, the engineers being

reserved for such work as the construction of loopholes in masonry, clearance of the field of fire and the construction of covered communications, shelters and barricades. The issue of the necessary orders for the execution and occupation of the defensive works is the duty of the commander of the garrison. Engineers may assist in the defence of a pivot but to detail them to organize and defend such a point is a misuse, and involves an unjustifiable risk of depriving the infantry prematurely of their services. At the same time it is better to employ the sappers as infantry than not at all.

The tool wagons (weighing 2,200 k.g.) drawn by three horses proved too heavy to negotiate steep slopes or bad roads. They were often unable to follow the *personnel* closely and were in consequence not immediately available when they were urgently wanted.

The advisability of breaking the company up into half-companies and sections, employed independently in different parts of the field, appears to be a question on which opinions differ among French engineer officers. The chief argument adduced against it is the loss of control by the captain commanding the company. The writer of the articles contends that efficient co-operation with the other arms will demand such dispersion on occasions, and that a better organization of the technical transport, and adequate provision for communication would minimize the evils attendant on it. In his view however the detachment of a section or half-company should only very exceptionally be for a period exceeding 24 hours.

The special idea in the second period was that the main Red Army (imaginary) was now in a position to assume the offensive. The Red force was to disengage itself from the enemy before it and to act in such a way as to cover the deployment of the main army.

On the first day reconnaissances were ordered to be made by engineer officers of a route, of a position, and of the passages of a river.

With this exception both companies were employed during this period solely on the preparation of villages for defence. In one case the object was to meet a hostile turning movement which was developing and, at the suggestion of the chief engineer's staff officer, corresponding to our adjutant R.E. in a division, two companies of infantry were detailed by the brigadier concerned to co-operate in the work.

The third period consisted of a general assumption of the offensive by Red.

Again the preparation of villages for defence, to serve as pivots of manœuvre, was an important feature of the work of the engineers but, as was to be expected in an advance, the need for bridges furnished them with several opportunities of rendering valuable assistance to the other arms. The advantage of having readily available even a clumsy bridging equipment, instead of having to rely solely on material obtainable on the spot was clearly demonstrated.

Conclusions.

Manœuvres do not give a very satisfactory idea of the employment of engineers on service. The absence of fire effect, the necessity of keeping within bounds claims for compensation for damage, and the extent to which existing passages over streams and rivers are used detract from the

value of the experience they afford. To these might be added the rapidity with which events move and fresh situations develop.

They do however give an indication of the *rôle* of the engineers in the field and a criterion for estimating their fitness to fulfil that *rôle*. The experience of the manœuvres under consideration convinced the writer of the articles that the French engineers are not in a position to render "in the shortest time and with the means at their disposal the services which the other arms will expect of them." In his conclusions he examines the reasons and remedies for this condition of affairs.

The principal services which the engineers can render to the other arms in field, as distinct from siege operations may be classified under three heads:—

(1) Those which facilitate the movement of the other arms,

(2) Those which strengthen their hold upon the ground that they have won or are endeavouring to deny to the enemy, and

(3) Those which assist commanders and their staffs in the fulfilment of their duties.

To the first class belong the construction of roads and communications and the improvement of those already in existence, bridging, and the removal of obstacles to movement. Mobility being one of the most essential factors of success in modern warfare services under this class may be placed first in importance among those which fall to the lot of the field engineer.

To the second belong the organization and preparation of localities for defence, to serve as rallying positions, *points d'appui*, or pivots of manœuvre.

In the performance of services under either of these two heads the work of the engineers should be carried out in co-operation with the other arms. Their numbers are of necessity small and, in order that they may be able to concentrate their labours on such tasks as demand the special technical knowledge and aptitude which they possess, the simpler tasks which do not demand those qualifications should be executed by the other arms.

In the defence of a locality the responsibility for the measures taken must rest on the officer who commands the troops detailed for its defence, and the general line of action should be defined and the orders for the construction and occupation of the works given by him. The engineer officers can assist him in this by technical reconnaissance and advice as to engineering measures for developing the facilities for resistance which the locality presents.

As regards the execution of the necessary works the principle of co-operation with a view to the economy of skilled labour must be applied. The infantry should dig the trenches or improve the natural cover which they will occupy and may construct simple obstacles, and the artillery should prepare their own gun emplacements, whilst the engineers, assisted where necessary by infantry working parties, will, in all probability, find full employment in such works as clearance of field of fire, construction of abattis, preparation of buildings for occupation, communications, particularly within villages, and any others which call for the special qualifications which they possess or the special equipment which they carry.

Neglect of the principle that the officer commanding the garrison should give the order for the works to be executed may result in the engineers expending their time and labour on works which will never be occupied or utilized, and neglect of the principle of co-operation will almost inevitably lead to a failure to develop to the utmost, in the time available, the defensive capabilities of the locality. The manœuvres afforded instances both of the right and of the wrong way of employing engineers in preparing a defensive position.

Since time is an all-important factor in war, the training, organization, and equipment of the engineers should be designed with a view to rapidity in the performance in the field of such services as the other arms have a right to expect of them.

Delay may in the first instance be saved by foresight on the part of the commander and his staff, who should provide in their dispositions for adequate numbers of engineers being immediately available at any spot where a need for them can be anticipated.

A thorough knowledge of the tactics of the other arms is essential to the engineer officer to enable him to recognize at once and to seize any opportunity of assisting them in the execution of their duties. This and the powers of endurance necessary to ensure that the engineers shall not only be able to keep up with the other arms but shall at the end of the march still be in a condition to carry out the work required of them, can best be attained by exercises in conjunction with the other arms. The rudiments of their profession must be learnt on the fieldwork ground and at bridging schools and camps, but the time devoted to such instruction should be reduced to a minimum in order that more may be devoted to combined exercises. Such exercises besides developing powers of marching and imparting tactical training teach the application of the technical lessons learnt during the preliminary instruction.

The speedy execution of orders conveyed to the commanding engineer by the general commanding a division demands adequate provision for communication between the former and his companies. The writer advocates giving him in addition to his staff officer or adjutant two cyclist orderlies. Similar provision should be made within the company to meet the case of its dispersion in half-companies or sections.

This question of dispersion is, as already mentioned, much debated among French engineer officers. Its opponents fear that, if the company is organized and equipped so as to make sections self-contained, there is a danger of their permanent detachment to brigades or regiments. Except perhaps in the case of a small force detached to a distance and for some time such a course would certainly seem unjustifiable. Any distribution of the parts of a company should be made with a view to meeting some situation involving a probable call for their services. That such a distribution may on occasions mean a saving of time, consequent on technical assistance being available without delay, can hardly be denied and, if it be admitted, the organization and equipment of the engineer company to meet it follow as a logical conclusion.

The author of the articles suggests the inclusion in every field company of a cyclist or mounted detachment. When the company was ordered to carry out any task at a distance the cyclist or mounted detachment could

move, with an officer, in advance of the main body of its company and assist the officer in his reconnaissance or make a start on preliminary works, such as, in the case of a bridge, the approaches. Mounted men would have the advantage over cyclists of being able to move more rapidly, across country or by soft roads.

A propos of the dispersion of the sections of a company the writer outlines a reorganization of its technical vehicles so as to render the sections self-contained, which is interesting mainly because of its similarity to the organization of our own field companies. A feature of his proposals is the lightening of vehicles to ensure their being able to follow the *personnel* closely under all conditions. He advocates further the inclusion in the company of some light, handy bridging equipment. Each company would have nine bridging wagons, one for trestles, four carrying a half pontoon each (metal boats) and four carrying superstructure. This would enable each company to construct rapidly 35 metres of footbridge or 15 to 20 metres of medium bridge. The French like ourselves have organized their bridging material in bridging trains which the writer fears may often be inaccessible to meet a sudden call consequent on unforeseen developments.

Provision on the company vehicles for carrying the equipment of at least a section so that the men may arrive fresh for work at the end of a march, and arrangements for the carriage of light tools on the person so as to relieve the men from having to carry them long distances in the hand are also recommended.

The French recognize the growing demand for the technical services of engineers in the field and that an increase in the proportion of their numbers to those of the other arms is not in any sense to be regarded as a loss to the offensive strength of the army. The concentration of bridging material into bridging trains, the development of airships and the advent of aeroplanes as engines of war, and the more comprehensive provision for telegraphic and telephone communication have led to the abolition of corps engineer companies, but the increase of the number of divisional companies to two per division is projected.

General Langlois contributes a note at the end of the final article, in which he emphasizes the importance of time and the view that the chief mission of the engineers is the provision and improvement of communications. He strongly supports the contention that the first aims of the training, equipment, and organization of engineer companies for the field should be mobility and rapidity in the execution of their mission.

It would appear that in the matter of organization and equipment our field companies are, to some extent, more favourably situated than are the French engineers to meet the demands that may be made on them. In other respects, however, many R.E. officers will probably recognize a marked similarity between the difficulties with which the French engineer has to contend in the field and those which they have themselves experienced.

T. T. GROVE.

REVIEWS.

HISTOIRE ÉLÉMENTAIRE DE L'ARCHITECTURE MILITAIRE DEPUIS L'ANTIQUITÉ JUSQU'AU XVI^E SIÈCLE.

Par ALBERT MERSIER, Membre de la Société Française d'Archéologie.

"THE writing of a universal history of the art of fortification from antiquity to our own day is one of the finest works possible for the archeologist," was the sentiment expressed by Viollet-le-Duc in his essay on medieval military architecture. The author of the present book further endorses this opinion by saying that fortifications have played such an important part in history that the art is well worthy of study. The value of ancient fortifications is brought home to us by the fact that the sites chosen for them have been approved of by so many successive generations, and that in many cases the work of our early ancestors has been continued and developed so as to meet the ever-advancing requirements of the art of war.

The first volume deals with fortification up to the end of the "classic" period, as the author expresses it, *i.e.* to the fall of the Roman Empire. The second volume carries us to the XVI. century, when the general adoption of gunpowder for artillery changed the whole art of fortification.

The book is divided into two parts. The first deals with the general methods of attack and defence, and the offensive and defensive weapons in vogue. The second part consists of a historical account of the development of the art of fortification as practised by the Egyptians, Mesopotamians, Persians, Carthagenians, Sardinians, Greeks, Romans, and Gauls. The works of the last two are divided into two categories: those made of some permanent building material, and temporary earthworks.

There are numerous illustrations and diagrams; and the text is enlivened by historical sketches and anecdotes. The descriptions of the fortifications of Susa, with its ditch 125 metres broad and its triple "enceinte," and of Babylon with its "enceinte" of 90 k.m., give us some idea of the stupendous works undertaken at these remote periods. The account of ditches filled with tigers, snakes, scorpions, and such like dangerous creatures, will, perhaps, appeal to the modern mind as strange. Perhaps the addition of a few dates would enable one to better appreciate the evolution of the art of fortification. The book has only about 200 pages and forms easy reading.

K. J. MARTIN.

REINFORCED CONCRETE CONSTRUCTION.

Reinforced Concrete Construction, Elementary Course, with examples worked out in detail for all types of Beams, Floors, and Columns by M. T. Cantell, Licentiate, R.I.B.A.; Associate, Surveyors' Institution; Head of Architecture and Building Department, Municipal Technical College, Brighton. Size $7\frac{1}{2}'' \times 5''$; pp. 125; illustrations 65. Price 4s. 6d. net. Published by Spon.

A CONCISE little book written for students, as well as for those who have practical experience but only an elementary knowledge of mathematics and mechanics.

Simplicity—the aim of the book—has been nearly achieved. It contains principles, descriptions of materials and falsework, bending moment and shearing stress diagrams for cantilevers and beams supported and fixed in various ways under concentrated and distributed loads.

The main part comprises theory and examples of singly and doubly reinforced beams, slabs, tee beams and columns.

The calculations for shear and adhesion are clear.

The R.I.B.A. system of notation might have been adopted with advantage.

At the end are tables of squares, cubes and roots and various areas. If it is thought desirable to include figures which can be obtained from the ordinary engineering pocket-book a table that would better merit inclusion in this work would be one of areas, circumferences and weights of market sections of round steel bars.

The general description is clear and concise.

The bending moment diagram in *Fig.* 11 is incorrectly drawn, and the statement near the top of page 32 with regard to the lever arms being equal is confusing.

These inaccuracies may cause difficulties to those whose mathematical training is weak and for these the work is intended.

In the same connection it may be mentioned that the bending moment and shear diagrams for simple beams are plotted without any convention as regards sign, so that the derivation of the diagrams for the fixed and continuous beams is not so obvious as it might be.

On the whole we recommend the little book to those requiring a simple treatment for a first study of its subject.

The preface refers to an advanced course by the same author, but so far it has not been brought further to our notice.

RECENT PUBLICATIONS OF MILITARY INTEREST.

REVIEWS OF BOOKS.

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* * * *

AERIAL NAVIGATION.

AVIATION IN THE ARMY AND NAVY AND IN THE COLONIES AND OTHER MILITARY QUESTIONS OF THE PRESENT DAY (L'aviation aux armées et aux colonies et autres questions militaires actuelles). By General H. Frey. 168 pp. 8vo. Paris, 1911. Berger-Levrault. 3s.

The author of this book will be remembered as the Commander-in-Chief of the French Expeditionary Force which took part in the march on Pekin in 1900.

Although the greater part of the book is devoted to the subject of aviation, a number of other questions which have no connection with this subject are sandwiched into it, without any apparent relevance, and are discussed at some length.

So far as aviation is concerned, the writer points out the advances which this science is making almost daily, and he gives his views as to the effect of the introduction of aeroplanes and dirigibles on naval warfare, and on the tactics of infantry, cavalry, and artillery. Attention is also drawn to the great advantages to be gained from the systematic use of aeroplanes and dirigibles in Algeria and French West Africa. General Frey suggests in this connection that a regular service of airships should be established as follows :—

(1). From the railway terminus at Biskra to Beni-Abbas.

(2). From Biskra to (*a*) Insalah and (*b*) Timassinine, the most southerly military posts in Algeria.

(3). From Insalah to Timbuctoo, and Timassinine to Agades, and then, if possible to Lake Chad.

He further recommends the construction of ports for air craft at Timbuctoo and Lake Chad, and the despatch of a number of airships to Wadai.

The author finally urges on the French Government the necessity for immediately constructing a large air-fleet, and appointing an inspector of aeronautics to deal with all questions relating to aerial navigation.

The other questions unconnected with aviation which are discussed in the book are :—

(*a*). The French umpire regulations. These do not satisfy the author, who proposes various amendments, among others the somewhat novel one that, with a view to modifying the severity of the comments of the umpire staff, umpires and commanders of troops should be made to change places at certain periods of the operations !

(*b*). The conferences held at the conclusion of manœuvres, which the writer contends are at present not carried out in accordance with the regulations.

(*c*). The visit of the President of the French Republic to the autumn manœuvres, which General Frey considers should never be omitted because of the encouragement given to the troops by the fact of the President being present at the manœuvres.

(*d*). The etymology of certain African names, such as Wadai, Tibesti, etc.

(*e*). The application of the law of universal service to the natives of Africa with a view to raising a large army of black troops which could be utilized either for relieving white troops for employment in France, or, in case of necessity, to aid the Home Army in the defence of French soil.

HISTORY.

THE FRENCH GENERAL STAFF ACCOUNT OF THE CAMPAIGN OF 1870-71. ITS TRUTH AND ITS ERRORS. Vol. X. Part 2. (Das französische Generalstabswerk über den Krieg 1870-71. Wahres und falsches). By Colonel E. v. Schmid and Colonel P. Kolbe. 111 pp., with 1 sketch map. 8vo. Leipzig, 1911. Engelmann. 3s. 6d.

Part 2 of this work is devoted to the French "Army of Châlons," and this volume deals with the movements of the French 13th Corps (Vinoy) between the 20th August and the 2nd September. As in previous volumes, the narrative is based on the French General Staff account of the operations, and this is critically examined by the authors.

ORGANIZATION AND ADMINISTRATION.

THE ORGANIZATION OF TELEPHONE DETACHMENTS, THEIR DUTIES IN BIVOUAC, ON THE MARCH, AND IN ACTION. By S. Agapov. 52 pp., with illustrations and diagrams. 8vo. St. Petersburg, 1911. Marks. 1s. 6d.

This little book is intended to supplement the instructions for the use of telephones contained in the Russian "Manual of Military Engineering for Officers of all Arms, 1910." Technical details of the apparatus are not dealt with, and the author confines himself to the consideration of the practical employment in the field of the material and *personnel* of a regimental telephone detachment. The method of laying cable is described, and various expedients for overcoming the difficulties of different kinds of ground are given. Several diagrams are provided to illustrate the tactical employment of the telephone with the regiment, on outpost duty, in action, on the march with an advanced guard, or in two columns on parallel roads. The descriptions are, however, rather short, and the book would be of greater value if this part had been expanded.

TELEGRAPHS AND COMMUNICATION.

TECHNICAL MEANS OF COMMUNICATION IN WAR (Die Verkehrs- und Nachrichtenmittel im Kriege). By H. Thurn. 278 pp., with index, and 32 illustrations and diagrams. 8vo. Leipzig, 1911. J. A. Barth. 6s.

The author, who is a Post Office official, states in his preface that his object in writing this book is to demonstrate the necessity for the existence in peace of a well-trained corps of communication troops.

The work is divided into twelve chapters and an appendix. Each chapter deals with a separate subject in a semi-technical manner, the headings being as follows:—Waterways, roads, and lines of communication; railways; motor vehicles; cycles; aeronautics; pigeon post; photography in connection with balloons and carrier pigeons; state telegraphy; field telegraphy; optical telegraphy; wireless telegraphy; field postal service. The appendix deals with orderlies on snowshoes and ski, the war dog, comparison of the strengths of the communication troops in various armies, and gives a list of works of reference.

The subjects are dealt with in an interesting manner and not too technically, so that it is possible for the non-expert reader to gain a very clear idea of the various means of communication, their advantages, and their limitations.