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CONTENTS.

THE INSTITUTION OF ROYAL ENGINEERS.

All communications for the Institution should be addressed to :—

The Secretary,
The Institution of Royal Engineers,
Chatham.

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## *MONTGOMERIE PRIZE.*

CONDITIONS.

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

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

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

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

The following are suggested as subjects for contributions:—

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

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## *THE R.E. KITCHENER SCHOLARSHIPS FUND.*

THE original recommendation of the Education Sub-Committee of the General Committee of the R.E. War Memorial for the institution of this fund was stated in the following words:—

"They recommend that a sum of £2,000 shall be put aside from the "capital to form the nucleus of a permanent fund from the interest on "which Scholarships shall be given annually as a perpetual Memorial to "our Comrades who fell in the Great War, and of the part borne by the "R.E. in the War. It is hoped that this permanent Fund may be "increased by special gifts as time goes on."

This permanent Fund has now been established and subscriptions and donations to the R.E. Kitchener Scholarships Fund may be sent at any time to the Secretary, The Institution of Royal Engineers Chatham

# *WATER SUPPLY TO ARMIES IN THE FIELD.*

*By* LIEUT.-COLONEL R. P. T. HAWKESLEY, C.M.G., D.S.O., R.E.

IN November, 1919, *The R.E. Journal* published an article on "Water Supply of Troops in the Field." This was written by myself very shortly after the Armistice with a view to recording some of the experience in this important subject which was acquired during the campaign in Palestine. The present paper may be taken as amplifying the former.

I wish, in the first place, to bring to notice certain details which are not mentioned, not correctly mentioned, or not sufficiently mentioned in the text books; and in the second place to describe in narrative form the measures, as I visualize the subject, which would be taken by the administration under the various circumstances which would occur in a more or less normal campaign.

I propose, for this purpose, to assume that the campaign is being fought successively over four distinct classes of country as follows:—

(i).—A base, which is plentifully supplied with water from shallow wells of large capacity.
(ii).—A tract of desert country some 50 to 100 miles in width.
(iii).—An extent of country where deep wells only are found.
(iv).—A country of running water, streams, rivers, and springs.

In order to bring out the points in connection with water supply as fully as possible I will assume that we are continually advancing, except when stabilized periods assert themselves, and that the enemy is first met with at the far end of the desert tract, and will not attempt to describe engineering details exhaustively.

The troops operating on our side will be assumed as one Corps of three Divisions and one cavalry Division, with L. of C. troops and a labour organization, giving a grand total of some 90,000 men and 30,000 animals. This assumption is made in order to enable the work of the higher Engineer directorate to be discussed. The actual constitution of such a force does not affect matters of principle to any extent, but the water operations for quite a small force would differ considerably from those described here.

The supply of water to an army in the field is as essential as are supplies and munitions. Owing to its weight of 10 lbs. per gallon water cannot be economically carried by road except in very small quantities, such as in water carts or where special measures are

taken for special operations. It can only be carried in large quantities under great difficulties and at great cost by rail. A military railway is invariably more than fully occupied in the transport of troops, supplies, munitions and the necessaries for the railway itself, so that there is rarely any room to spare for water for the troops.

A soldier is a fighting athlete and should be brought up to his highest state of physical efficiency at the moment when he goes over the top, and from that point his efficiency should be maintained at its maximum, as far as is possible, until the end of the war. Failing an efficient and sufficient water supply, this condition cannot be ensured. It is highly undesirable to allow any training in reducing the consumption of water. The idea that men and animals can be trained to drink or use less water and maintain their efficiency is based on a complete fallacy.

The supply of water to troops in the field is a purely engineer proposition—but "Q" is responsible for the administration of the water areas. The supply of water to a large force in the field is quite as difficult and scientific a proposition as is the supply of water to a city of a similar number of inhabitants. The headworks may not be of such magnitude and the distribution may not be so complicated as those required by the latter but this is offset by the mere fact of the wide distribution of sources, of, frequently, unknown capacity, the uncertainty of tenure and the speed at which supply must be given. The supply of water must be as generous, within economic limits, as the skill of man can devise.

The actual requirements are as follows :—

*Men.*—One gallon per day for drinking and cooking. This is the allowance during operations. This amount should, if possible, never be reduced, although cases have occurred when a ration of half a gallon per day was essential for short periods. In addition men require a minimum of four gallons per day for ordinary washing and a further addition of as much as can be economically provided for disinfecting, bathing, washing clothes and other purposes. An allowance of more than one gallon per day must be given, as above, in stabilized positions and on L. of C.

Indian troops always require more for washing purposes than British troops.

*Horses and Mules.*—Ten gallons per day, but in very hot weather they often drink 12 gallons per day. This is given in three waterings, after sunrise, at noon, and in the evening before sunset.

*Donkeys.*—Eight gallons per day in three waterings.

*Camels.*—Fifteen gallons every third day. In very hot weather a camel will drink upwards of 20 gallons. Twenty minutes should be allowed for watering each animal. If camels are watered more frequently than every third day, they lose their normal ability to last three days without water.

*Oxen.*—Eight gallons per day. It increases efficiency if oxen can have free access to open water. Troughs for oxen should be free of lashings, etc., which entangle their horns.

The efficient and quick watering of men and animals depends on two main points:—

(*a*).—The efficient and quick supply of water from the source to the water area and

(*b*).—The organization of the water area.

A water area consists of two parts, firstly a parade ground to which free access is required from the camps, and an enclosure in which tanks, troughs etc., are erected, and from which egress must be easy. If these conditions do not exist near the source of supply and time allows, it pays to pipe the water to a site where these conditions obtain. A congested water area prevents efficient organization and re-acts on the efficiency of the force, and much more so on the temper of all concerned. From the parade ground water carts and animals pass into the water enclosure, which should be fenced and policed. The water carts pass, in turn, to the standpipes, and the animals in batches to the troughs. The animals should fill up the trough from the far end. As each batch finishes watering it should be turned towards the exit and marched off clear of the exit.

It is desirable to provide a trough specially for the horses of staff officers and others who are in a hurry.

Camels should never be allowed to use the horse troughs, but should be provided with separate ones at a distance from the horses, or better still, with a separate water area at a distance from that used by horses.

The number of standpipes should be calculated in the usual manner, in accordance with the speed of supply of water.

The number of troughs should be calculated, jointly, in accordance with the speed of supply of water and at the rate of 180 horses or 54 camels per hour, using both sides, in the case of troughs, waterproof, canvas, 600 gallons (33 ft. long), or their equivalent in timber or masonry. The lay-out of the water enclosure should be on a generous scale. The spacing of troughs in the clear should be not less than 30 ft., and roadways should be on the wide side.

Water should be delivered to the troughs and standpipes through pipes, whether iron or hose. It is usually the case that a reserve of water must be provided in the enclosure, and therefore tanks must usually intervene between the source and the troughs and standpipes. One or more of such tanks would be used for the chlorinating of drinking water. These tanks are, in the early stages, as a rule "Tanks, waterproof, canvas, 2,300 gallons," but, if a stay of any duration is expected, they should be replaced by tanks in wood, iron or masonry, as should the troughs. The supply from the tanks to

the troughs may be by hand L. and F. pumps, but it is better, unless pumping by hand is in any case deliberately considered as a means of physical training, to avoid the labour entailed and substitute small power land pumps or to site the tanks and troughs so as to make use of gravity.

In the case of gravity supply from canvas tanks, a connector in the bottom of the tank should be fixed as a part of the equipment of the tank, and the water led thence by iron pipe or by suction hose in the early stages to the troughs. Tanks are not now issued fitted with connectors as above described.

The supply to the water carts may be by hand L. and F. pumps, by power pumps or by gravity to standpipes.

Troughs, if of canvas or wood, should as soon as possible, even for temporary occupation, be protected from the rush of thirsty animals by strong guard rails. No amount of orders, regulations and discipline will prevent this rush.

Tanks, waterproof, canvas, 2,300 gallons, only hold about 1,500 gallons, and troughs, waterproof, canvas, 600 gallons, only hold about 350 gallons. It is desirable to alter the nomenclature, and it would be interesting to ascertain how the registered contents were originally arrived at.

When long troughs are provided the delivery of water must be sufficient in quantity and must be at several points at one and the same time, otherwise the animal at the near end gets all and the animal at the far end gets his watering but no water. The distance between deliveries may be 33 ft., which is the length of a trough, waterproof, canvas, 600 gallons. This trough may be taken as the unit.

An efficient water officer, appointed by "Q," should be in command of each water area. He should have a good command of language suitable for all ranks. None but officers inspecting, such as the Divisional Commander, C.E. and C.R.E., should be allowed to ride into a water area—all others, including general officers, should be made to dismount and lead their horses.

Small land power pumps used for distributing to troughs in a water area can be provided with a portable hose distributing system quite efficiently.

Troops in the field may, for water purposes, be considered as organized in Brigade groups. A Division therefore may, for water purposes, be considered as constituted as follows:—

| | Men. | Horses and Mules. | Gallons per day. Men. | Horses. | Total. |
|---|---|---|---|---|---|
| Divl. H.Q. group ... | 3900 | 3120 | 3900 | 31200 | 35100 |
| 3 Brigade groups (each) | 5000 | 1530 | 5000 | 15300 | 20300 |

These figures show the minimum requirements with men at one gallon per head per day and are approximate for an Indian Division, but are near enough for water purposes.

A British Division is somewhat weaker in animals and requires somewhat less. Corps troops vary in number, but may be roughly taken at 10,000 men and 5,000 horses and mules. For each group one or more water areas, according to the sites of camps and yields of water from the various sources, must be provided.

Water supplies may be conveniently considered as under two main headings :—

(*a*).—For troops when at rest or in a stabilized position or marching on a L. of C. or in preparation for operations, and

(*b*).—For troops when operating.

The scarcer water is, the more appliances are required for handling it. This appears to be a paradox, but is painfully true in warfare. The pre-war establishment of water gear with a field company was apparently limited to four pumps L. and F., with no tanks and troughs. The number of field companies with a Division was then two. How the 6,000 animals of a Division, with its 20,000 men, could be efficiently watered with this amount of gear, even at the openest of open water, is difficult to understand. It is hoped that more attention will be paid to the subject in respect of the post-war establishments.

In the Palestine campaign, which may be considered as more or less normal, the establishment per field company was :—

12 pumps, L. and F.,
4 tanks, waterproof, canvas, 2,300 gallon,
12 troughs, waterproof, canvas.

and each H.Q. Divisional Engineers carried two engines and two power pumps each, capable of 1,000 g.p.h. against 150 head. Each Field Company carried in addition a number of waterbag sets, of which more hereafter. Whenever possible and necessary, units should be provided, at their camps, with tanks to hold the water brought to them from the water area.

Before the commencement of a campaign the Engineer-in-Chief should be in possession of all facts concerning the water supplies and kindred subjects in the countries in which the campaign will take place. This information should have been collected by the Engineer officers of the General Staff (Intelligence) who will have studied the present and other campaigns. As a matter of fact it is doubtful if such Engineer officers exist, or whether any Engineer intelligence has ever been collected for any campaign prior to the commencement

of that campaign, by Engineers. General Staff officers cannot be expected to collect such information and only Engineers can obtain the information they require, and only Engineers know from whom to extract such information and how to extract it. The result has been that Engineer intelligence has been indifferent. This applies not only to water but to all branches of military engineering.

It can be laid down as a basic condition that, unless the water situation of a proposed campaign as reported by Intelligence is satisfactory, the campaign either will be difficult or cannot be carried out. The Engineer-in-Chief having thus these facts as regards the campaign at his disposal and having in view the sources of water and the likely duration of the campaign, will be able to decide, as regards the four different phases of the campaign, on what lines estimates should be made for :—

(i).—Classes of pumps and pipe lines.
(ii).—Numbers of water stores of every description, such as pumps, L. and F., troughs, tanks, etc.
(iii).—Alterations in the equipment of Field and other Companies.
(iv).—Alteration in the establishment of Field and other Companies.
(v).—Establishment of machinery parks and shops, which must be efficiently controlled and manned.
(vi).—The establishments for working enemy workshops or civil workshops which will be encountered in enemy country.
(vii).—The raising of special companies for water purposes,

and, in general, will be able to visualize the water situation throughout the campaign.

The Engineer-in-Chief would consult the Commander-in-Chief and obtain from him a definite decision as to any large schemes which may be necessary.

It must always be remembered that campaigns are directed by politics and that it is in consequence very rarely the case that definite orders can be obtained, even by an Engineer-in-Chief, such as will enable him to budget completely, very far ahead.

The information gathered by the Engineer-in-Chief would be, as far as is desirable, transmitted to Chief Engineers and C.R.E.'s, with his views, in addition to receipt by the latter of the ordinary Intelligence reports.

In due course the Army will arrive at the base and will in such an area, where shallow wells occur, provide itself with water without much difficulty, using the company equipment, but in this case and all other cases the company equipment proper, should, wherever possible, be substituted by other equipment and the company equipment should be withdrawn and prepared for operations. As shallow

water is liable to pollution it is essential that the engineers shall work in close touch with the military medical authorities, and this close touch should be maintained throughout the campaign.

If the country is malarious special arrangements will have to be made for protecting the sources of all water from mosquitos. This, however, is another subject and cannot be dealt with in this paper.

It is probable that the machinery park and shops will be established at the base, and it is desirable that all machinery issued should be properly recorded and supervised from the first. Engine logs and history sheets should be instituted and should not be allowed to fall into disuse.

Salvage organizations should be formed for salving machinery and other water stores from water areas and sources to be abandoned by formations about to advance. These salvage operations should be carried out in such a manner as to relieve the Engineers of the Formations of the responsibility and the labour of salving and returning to store at the last moment before a move takes place.

The field engineers of the Chief Engineer and of the Engineer-in-Chief must be most active from the first in supervising all these arrangements, of which the principles should be ordered by the Engineer-in-Chief.

It is probable that a large water supply system will be required at the base for supplying camps, establishments, shops, factories and quays; and similar systems will be required at the posts on L. of C. and at the advanced bases.

The Engineer-in-Chief will have decided on the means necessary for dealing with the water supply in the next phase, namely, a tract of waterless desert, involving many marches.

The army requirements, together with those of the railway, without which an army of this size cannot move at all, would not be less than 500,000 g.p.d. It is quite out of the question to carry such a large amount by rail. It is certain that the problem would be solved by the provision of a pipe line with suitable gathering grounds, at the base, from the shallow wells or from a river, if such exists. If a river is used a large filtering plant will probably be necessary. If a pipe line cannot be constructed owing to insurmountable engineer difficulties it would probably not be possible to move such a large force across the desert at all.

If the Engineer intelligence given to the Engineer-in-Chief is at all efficient he will be able to decide what head it will be necessary to pump against and what plant at the base, relay stations and pipe line will be required. Unless this is decided before the assembly of the Army, and plant is got together in good time, much time will be lost. If the Engineer-in-Chief is in the dark on all these points

he will have to estimate on a very generous scale and at a very high cost.

The pipes and plant for relay stations, etc., must be carried by rail. The pipe line therefore must closely follow the route of the railway. The railway programme must include provision of trains for carrying and laying the pipe line. The speed of laying such a pipe line will thus depend on the speed of laying the railway. The details of laying a pipe line may be studied in the notes on water supply with the Egyptian Expeditionary Force. In this case 100 miles of pipe (more or less) was laid in 100 days, or thereabouts.

It must be borne in mind that the laying of such a pipe line with speed requires the exercise of the highest organizing ability and an establishment including specially suitable officers and other ranks together with a competent labour force is necessary. Such a work should invariably be retained in the hands of the Engineer-in-Chief or the Director of Works, and no formation or area commands should be allowed to interfere on any pretext whatever. The sites of the relay stations (if any) and of the various water areas on the route of the pipe line will depend on the tactical situation.

As the pipe line nears its objective it may be found that the enemy is holding the first wells in the third tract of country, namely, one of deep wells. In such a case the army would continue to be watered from the pipe line, which would be "T'd" off as required so that branch pipes would run along the rear of the line taken up. If this state of affairs was foreseen from the first it would have been necessary to calculate for far more than the 500,000 g.p.d. mentioned above.

As previously stated men and animals must be freely supplied with water and it is probable that in such a case the total amount pumped should be nearer 1,000,000 g.p.d. than 500,000 g.p.d.

The army thus gets into contact with the enemy on the fringes of the desert, and as the enemy is holding the first wells the army continues to be supplied from the pipe line. Water areas will be established in suitable positions and front line troops will be supplied from water areas sited as far to the front as possible.

During this stabilized period the General Staffs will be preparing schemes for attack and the Corps Commander will be able to give the Chief Engineer, long before receipt of definite operation orders, indications which will enable the latter to decide on the provision of such water areas as may be expected to be essential for concentration prior to attack.

As time advances it may be found that these will have to be altered, and the Chief Engineer must always be prepared for this, although, on the other hand, he can never afford to neglect to carry out such provision as indications appear to warrant. It is essential

that sufficient facilities shall be provided and it is far better to provide too many than too few.

Indications as to future operations must, of course, always be jealously guarded as very secret, and the camouflaging of the reasons for the establishment of extra water areas is always a difficulty. Probably therefore, from this point of view, the establishment of more water areas than apparently are necessary confuses the inquisitive and to some extent solves this difficulty. Generally speaking, however, some risk must be accepted in establishing water areas on indications. As the country in rear of the enemy is known to be one of deep wells and therefore of, more or less, uncertain supply, it may be necessary to still rely on the pipe line supply for the first day of fighting. Hence plans should be prepared, if such a course is necessary, and material collected for extending during the first day's fighting, the pipe line as far as is reasonably possible, to water areas beyond the present front line.

The equipment and personnel of the Divisional and Corps Engineers will have been revised to meet the new situation of the third phase, during which we will have arrived at the condition of supply of water to troops during operations.

During the actual fighting and until stabilized again, men must be prepared to subsist on the minimum allowance of one gallon per head per day.

The supply being from deep wells pumps L. and F., unless stagings exist for relay pumping and in practice they never exist, are almost useless except for distribution purposes. The essence of water supply to troops during operations is speed. One of the most pitiful sights during operations is that of a crowd of thirsty men trying to fill a bunch of water bottles tied to the end of a string, from a deep well. Cavalry have been known to travel for 72 hours without water, chiefly owing to the means which have been supplied for raising it being inefficient.

It is useless for disciplinary purists to murmur platitudes in which the words "water discipline" are frequently repeated unless the means of supply which are provided are efficient.

It should be made possible to obtain water from any reasonable source down to 150 ft. depth within 20 minutes of arrival, and the duty of raising the water should be carried out by mechanical power or by horse power specially provided for the purpose. While operating the soldier should be fighting, marching, and digging, and should not be, as far as can be avoided, exhausted by pumping water. The mechanical lifting devices hitherto adopted for such situations are not yet satisfactory. The chain Helice pump capable of 1,000 g.p.h. at from 100 ft. to 150 ft. is the most suitable yet devised. It is suggested that experiments should be made with high lift,

electrically driven, under water centrifugal pumps. It is believed that such outfits for supplying a Division could be devised for transport on a few lorries or their equivalent in horsed transport. Such outfits would get water with the speed necessary for operations and would be suitable for all varieties of water, whether open or deep well.

Failing this, the only known method of quick and efficient supply from deep wells is by means of a 20-25 gallon water bag. This bag is made in canvas or leather with a wooden bottom in which a valve is inserted. Such a bag is capable of lifting the best part of 1,000 g.p.h. from a well 100 ft. deep, and can be operated by a horse which should be supplied for the purpose. The valve enables the bag to be filled quickly even in shallow water.

The bags with their gear, consisting of blocks, tackle and scantlings for fixing, and the horses for operating them, should be added to the establishment of a Field Company, at the rate of six or eight per Company, for operations in a deep well country, until such a time as efficient mechanical devices are provided. If properly equipped in a manner suitable for the country the Field Companies of a Division can cope with the watering of their Division fairly well. One point, however, should be noted. The Divisional train as a rule moves independently to a great extent and frequently has to water at a distance from the Divisional Engineers. The train therefore should carry sufficient non-mechanical water gear to enable it to water itself when necessary.

As regards cavalry operating in anything like open country, the majority of the units very soon get completely out of touch of the Field Squadron of the Division, with the result that those so separated have to shift for themselves. It is considered, therefore, that each squadron should bear on its establishment one water bag set carried on a special pack horse. A cavalry unit could then water itself and avoid the scenes such as have been known to occur when thousands of cavalry with their tongues hanging out, have turned up at an infantry water area and demanded water from the already exhausted Divisional Engineers.

Prior to an army moving forward from a stabilized line, and especially when in contact with the enemy, the L. of C. Engineers should be prepared to follow up the formations, unrolling themselves from the head of the L. of C., and take over as quickly as possible such water stations as are relinquished by the formations in the course of their advance. It is desirable that the L. of C. shall carry with them water plants of the same nature, standardized as far as possible, as those carried by the formations, and effect an exchange in each case, an unerected set for an erected set, whenever such a course is necessary and practicable. This system is also desirable as between

Divisional Engineers and Corps Engineers. Much time and labour is saved by such a system, but the institution of the system should be regulated by orders which should include dire punishment for him who palms off a " dud " set.

Obviously the closer the L. of C. Engineer units can get to the formation Engineers the better. The Engineers of L. of C. should arrange for pushing supplies of water gear as far ahead as possible. It is frequently the case that the *liaison* between the L. of C. and the formations is indifferent or that the L. of C., being a somewhat ponderous institution, is slow in extending its administrative system forward, following advances of the formations, and it may be found necessary to arrange that the Engineers shall carry out their forward moves, more or less independently of the remainder of the L. of C.

It may be desirable that detachments of the L. of C. Engineers shall actually, at first, accompany the Corps Engineer units in order to avoid more changes of personnel in manning power plants than are actually necessary and for other reasons. It is obvious, however, that this can only be done in the earlier stages of the advance.

We have now, thus, brought our army, from a water point of view, up to the point where they are about to go over the top. The men and horses are at the top of their form. The Divisional and other Engineers are on an establishment suitable for the next phase, and this includes a much larger proportion of engine drivers and fitters than has hitherto been allowed. The water stores of the Engineer units are suitable for quick supply from deep wells. Such units as are likely to get out of touch with the Engineers are equipped so that they can supply themselves. The Corps Engineers are equipped with sufficient transport to enable them to carry forward power pumps and other gear for establishing water areas on what, eventually, will be the L. of C. and with transport to enable them to carry forward a quantity of water stores for replacing worn-out and lost gear of the Divisional Engineers. The L. of C. Engineers are standing by ready to unroll themselves and take over from the Corps Engineers, and have ready packed on transport a further quantity of water stores for the purpose of establishing a comparatively small field park further ahead, and are, generally speaking, ready to push the Corps Engineers forward rather than be called up by the latter. Salvage operations for the present line have been arranged.

The Chief Engineer of the Corps has instructed C.R.E.'s to send back water reports frequently in order that the Corps Commander may be advised as to the water capacity of any particular area. C.R.E.'s have given similar instructions to their Field Company Commanders.

Special transport will have been forthcoming for the carriage of the extra water stores and C.R.E.'s and Field Companies will be in

possession of motor cars and motor cycles for quick forwarding of stores and for sending back reports.

I may add that this last paragraph is a vision of what should occur. In practice it is extremely difficult to get any transport at all, and motor cars and cycles for Divisional Engineers have never yet existed.

We may now assume that the fight has commenced and that we are pushing back the enemy.

A Field Company will have been detailed to each Brigade or Brigade group. The C.R.E. must give the Field Company Commander a free hand to serve the Brigade. The situation is far too uncertain and changes are far too frequent to enable the C.R.E. at Divisional headquarters to keep close control. The success of the water supply rests therefore on the Field Company Commander. He must be in the closest touch with the Brigadier and watch the situation with the closest interest in order to obtain the Brigadier's views as to when and where to establish a water area. He must remember that when once committed in establishing a water area much time is lost if a change is essential. He must, however, often chance his arm and must be prepared to take risks. In the meantime, his officers and men are scouring the country as far as they are able to and ascertaining the water resources and sending back reports which eventually reach the Chief Engineer. Such reports can be only vague at first, but, where water sources are used, some idea of their capacities can be formed and thus reports can be amplified as time goes on. If the actual capacity in gallons per hour cannot be given, a report as to the troops actually watered at a given area is of great value. As regards the method of sending back such reports, Signals are generally overloaded with General Staff messages which take precedence, and the best method is by motor cycle orderly.

The mechanical Engineers with the Field Companies as well as the Field Engineers of the Chief Engineer are active, during the course of operations, in ascertaining particulars as to pumping plants, both enemy, military and native, which may be met with, with a view to their use.

The enemy military plants are, as a rule, not to be relied upon, as they are, as a rule, put out of action before being abandoned. Land mines should be suspected in their neighbourhood, and electrically-fired land mines may easily be connected to the magneto of the engine.

As regards native plants, it is usual to find essential parts removed, especially the magnetos. The owner, if he can be found, usually responds to kindness combined with firmness and promise of water for his own use, and produces the missing parts. It may be found to be possible, if the intelligence received is sufficiently good, to carry a certain number of spares for native plants.

If a town of any size is encountered the municipal engineer should

be at once sent for and he should be instructed firmly but kindly to produce the water supply plans and to show the various areas where troops can most easily water. He should be instructed to place his resources in shops, stores and personnel at the disposal of the army.

Local workshops should be examined by the Field Engineer of the Chief Engineer and reported on. If it is decided to take any of these over, the necessary staff would be brought forward for the purpose. They would become L. of C. organizations eventually, unless sited too far forward.

It is very essential that the health of the native inhabitants shall be maintained, in order that they shall not become a menace to the health of the army. The native water supply must therefore be maintained and it may be necessary to arrange for repairs to native plant being carried out in shops thus taken over by the army as payment of local rates for the services rendered.

As the fighting and pushing back of the enemy proceeds, it will be found that very great deterioration of the company water gear will occur and within a fortnight a considerable proportion of the pump L. and F. will have become lost or broken, troughs and tanks worn out. These must be replaced quickly from the stores carried forward by the Corps Engineers.

In an oriental country, in addition to mechanical water plant, all sorts and conditions of native appliances will be found. These are often of the greatest value and should be used. In a stabilized position it often pays to erect these where natives can be hired at a low rate of pay to work them.

Gradually the operations will cease, both sides will become exhausted, temporarily, and we may assume that we will have arrived once more at a state of stabilization, although here and there the line will alter, as one side or the other straightens itself out locally. When this state occurs the water situation as in the last stabilized line, will repeat itself, except that the sources of supply will be at scattered deep wells instead of from the pipe line.

The Divisional Engineers' water areas will be found established at certain deep wells and the C.R.E.'s will be examining all other sources in their Divisional areas.

A very great deal can be done in a deep well country towards increasing the yields of wells. Old wells often have a considerable depth of rubbish at the bottom which, if cleaned out, may increase the yield very considerably. The winding gear of a boring rig is of the greatest use in such an operation.

Questions will now arise as to pumping forward towards the front line for the establishment of water areas for front line troops and for concentration as previously described. In selecting a well or other

source of supply for this purpose, two conditions are essential, namely the capacity of the source must be sufficient and the site of the source must be reasonably far back and concealed in order that the pumping plant shall be as secure from observation and capture as is reasonably possible.

It is probable that a number of sources are safer and better than one large source for that purpose, unless the latter is very far back.

All engines and other machinery now sent up to fulfil demands at the front must have been thoroughly tested at the base shops before being issued and those responsible at the base must realize that this cannot be done at the front. A fault in an engine discovered when erected in the field may, quite conceivably, entirely upset a military operation which depends on the supply of water from that particular engine. All engines should be duplicated.

Arrangements must be now made for repairing the front line water plant in the shops established at an advanced base, or in the native shops taken over, unless the excellence of the railway traffic warrants the repairs being still carried out at the base.

The preparations for the next operations now become a repetition, with local variations, of those in the last stabilized position.

We have arrived at the time when further review should be made of the establishments and equipment of the Engineer units for the next operations. We have in front of us a certain stretch of deep well country and beyond that a country of open water. It follows that we must be prepared, as at present, for deep wells for a certain distance, and beyond that we need only carry the equipment required for open water. If the centrifugal pump outfits were available they would be carried right through the campaign as being suitable for all varieties of water. The water bags may be useful for open water. In open water country very much greater control of sanitary arrangements is clearly essential in order that the water shall not become contaminated. The red, white, and blue flags so dear to regulations may once more be brought into use, but even in open water country the typical water areas must be established and control must be maintained. It is not possible to water thousands of men and horses by the methods suggested in the text books. When an open water country is reached it is then especially necessary to investigate from local information what conditions may be expected in the driest season of the year.

Springs and rivers have a habit of drying up in the summer and they should be gauged from the first, when the stay is likely to be prolonged, in order that some forecast of the situation in the driest season may be made. In a country of springs it is often possible to make use of gravity in bringing the water to the water areas. An

expenditure on pipe line is, therefore, very often the cheapest method in the long run, especially as it is better to use water from the source.

It is very rarely possible for an army to supply itself with water from wells dug for the purpose. The one condition in which this is possible is when the army is moving in a manner sufficiently leisurely for the purpose. In practice it can only be done where water exists at not more than 6 ft. depth in sandy soil which can be dug easily, and then only when not interfered with by the enemy and when a force can be sent forward to protect the works. The Norton tube, in such cases, is invaluable for testing depths, but as a means of supply it is practically useless.

Where a number of shallow wells are dug or a number of 3 in. tube wells are sunk and yield from each is only moderate, several can be coupled up to a land pump set by means of an arrangement of hose fitted with T's. Tube wells of this nature work very well in coarse sand, but are disappointing in fine sand.

A water boring organization is often of the greatest use in stabilized lines or on L. of C. This work requires highly specialized officers and trades and cannot be carried out by amateurs. Officers for this work are most difficult to find, but it may be noted that the governments of the Union of South Africa and probably also that of Australia, maintain boring sections as part of their irrigation departments. These sections are in every way efficient and suitable for service with an army.

Boring can only be made use of in the field where the source of supply is reasonably close to the surface, say within 200 ft., and the conditions are suitable for quick work. A boring section is most useful for the repair or renewal of native boreholes, if such exist. Such an organization should be attached to an Engineer Company at the head of the L. of C. unless it is, itself, a company. It should have the use of the repair shops, where a special expert in this class of machinery should be stationed.

The method of demanding engines, power pumps and pipe lines from the base requires co-ordination and control by the Engineer-in-Chief. Stock at the base is always limited. The demand, therefore, should give all such information, that is to say, quantity, static head and distance, as will enable the base to decide what plant of that available should be sent forward to fulfil the requirements.

Several chief reasons have prompted me to write this paper. One of these is that an opinion clearly exists that troops must not be spoon-fed and must be taught to shift for themselves. This is all very well, and I quite agree in principle, but the practice cannot be extended to water supply, except perhaps in the case of very small detachments. If troops are left to shift for themselves as regards water supply, then their efficiency will suffer.

It is clearly our business to improve efficiency and we can only do this in the case of water supply by improving our system and equipment.

My second reason is to insist that mechanical means of raising water must as far as possible supplant man-power. A commander wants his men to be physically perfect when he starts operations, and wants them throughout operations to put every ounce of energy into marching, fighting, and digging, and none into domestic services such as water supply.

The mechanical means must therefore be mounted on first line transport, and must be available for use during operations.

# *USE OF ELECTRICAL POWER ON THE WESTERN FRONT.*

*A lecture delivered at the S.M.E., Chatham, on 7th Oct., 1920, by* MAJOR T. RICH, O.B.E., T.D., R.E. (T.).

## INTRODUCTORY.

IT is a difficult matter, in the short time available, either to give many details of the work done by the belligerents on the Western Front, or to draw lessons from the work done and experience gained. The present lecture will therefore take the form of somewhat disconnected notes, concluding with some lantern slides dealing with French and German work.

In Germany the applications of electricity have been divided into two groups, "Starkstrom"—strong currents, meaning those used for lighting, power and heating; and "Schwachstrom"—weak currents, as used for signals, fire control, detecting and other apparatus. As the term "strong currents" is convenient, it will be used on several occasions during the lecture.

Strong current electricity began to be of value in military work soon after the pioneer developments of Siemens, Gramme, Hopkinson and Edison, the invention of the filament lamp being an important step in this direction. The first applications were in connection with coast defences and the lighting of barracks and depôts. The potential value of electricity in land warfare was recognized by the Council of the Institution of Electrical Engineers during the Fashoda crisis, and the Corps of London Electrical Engineers was then founded, with the idea of making a reserve of mechanical and electrical men who would be useful, not merely for coast defence, but also in the field.

During the South African war, besides doing searchlight work, a number of men of this Corps were engaged in the lighting of hospitals and railway stations, in addition to the protection of the piers of important railway bridges.

## EARLY DAYS OF THE WAR AND SUBSEQUENT DEVELOPMENTS.

When the Great War broke out, however, the powers engaged had not properly realized the extent to which electricity could be used and all were to a material extent unprepared. The matter was taken in hand very rapidly by Germany, and arrangements were made for a strong body of electricians and auxiliaries to be attached to each army for electrical and allied work. This policy was followed by Austria in the Serbian campaign and in 1915 by the French. Each

of these three powers realized that, for efficient working, it was necessary, with very few exceptions, to place electric lighting and power in the hands of a definite and responsible organization.

With regard to the British Army, the lessons of the South African war were apparently forgotten; the different services to a large extent made their own arrangements, there was very little co-ordination and it was not until 1918 that the necessity for some form of unity was recognized, and even then such centralization as existed was largely of a permissive character.

Although before the war a certain number of R.E. officers had been specially trained in the use of strong currents, very few of those so trained were, at the beginning of the war, put in positions where their experience could be utilized to the best advantage, this being largely due to the general shortage of trained officers.

A great deal of creditable electrical work was done in France by all branches of the service in the face of great difficulties, and it is to be hoped that the lessons bought at the expense of time, man power and money, will not be forgotten in the future.

Immediately the Americans joined the Allies, special electrical troops were got together, and, although in many ways the organization was defective, it was not apparently due to any lack of appreciation of the possibilities of electrical work on the part of those in control in the States or in France. The Americans, however, were able to take advantage of the experience of the Allies.

When comparing the use made of centralized power by the British Army in comparison with other powers it must be remembered that electrical distribution in the United Kingdom had been subjected to numerous obstacles in the past and it has received unsympathetic treatment, at the hands of the various authorities concerned, to such an extent that the rural distribution of power which exists in so many foreign countries is almost non-existent at home. The low price of coal made the problem more difficult. High-tension currents in this country were looked upon as a danger to the community, and proposals for the erection of overhead lines, whether for high-tension or low-tension work, were usually strenuously opposed. An indication of this conservative spirit is to be found in the fact that pressures of over 3,000 volts are still called "*extra* high-tension," a term likely to be applied in other countries to something over 70,000 volts.

In the New World and on the Continent, owing to the sympathetic treatment received, the overhead power line is a common feature of the landscape, the lines being usually run alongside the roads. In France about 4,000 Communes, in Germany about 16,000 Communes and in America probably well over 20,000 Communities are supplied with electricity, mostly through overhead lines. It was natural therefore for the French, Germans, Americans and Austrians to make

use of local power supplies and to recognize the value of an organization for the whole army to deal with such questions. On the contrary, with us, it was often very difficult to get officers to recognize the value of uniformity in methods and co-ordinated supply. The war has proved the old saying that " where there is a will there is a way " and arrangements were often termed impracticable which were actually being used by the French and Germans. It must not be forgotten, however, that in France we were not in our own, or in any enemy's country, and that fear to give offence often tended towards timidity.

## Applications of Electricity in the Field for Lighting and Power.

Now in modern war the nerve-wracking strains resulting from the use of high explosives, gas, and aircraft form a very important factor and necessitate the provision, where possible, of a degree of comfort for the troops, especially when resting, of a character quite unheard of in past wars. Good and convenient lighting in billets and dug-outs goes a very long way towards comfort, and good lighting is also an important factor towards the improved sanitation, which has so greatly reduced the death-rate from disease.

Up to date no form of lighting is able to compete with electricity for general convenience and safety. For the lighting of depôts, barracks, hutments, schools of instruction, hospitals, casualty clearing stations, the headquarters of formations, and dug-outs, electricity was supplied in France from portable or semi-fixed plant or from civil or military power supply systems. Electricity has the great advantage that, during air raids, lights can be controlled at a moment's notice. Despite the customary remark that this or that fire has been caused by the " fusing of an electric wire," surprisingly few fires are actually caused in civil and military life by electricity. Oil lamps are dangerous and are a nuisance ; it is very difficult to find men capable or willing to keep them in order, and very large quantities of paraffin are used for lighting fires. Acetylene is sometimes useful, but for work in dug-outs it has the disadvantage of being very susceptible to shock, and may be put out by a neighbouring explosion.

Strong currents are useful for motors for pumping for water supply, chaff cutting and grinding, general machine tool and workshop driving, concrete mixing, bakery machinery, laundry machinery, wood chopping and, in mines, for ventilating and pumping. It is interesting to note that both the French and Germans often used power from power lines for driving forest saw-mills in preference to steam-engines, even where water supply was not a matter of great difficulty, the refuse wood being used as fuel for the troops and the sawdust as bedding for horses. In hospitals, owing to the powerful apparatus used, as much as 10 kw. has been used for one X-ray tube, and strong currents are especially useful for combined light and

heat baths, which can be improvised with old carbon filament lamps; these baths are very useful for wounded men who are suffering from exposure.

Owing to the complicated nature of the appliances used in warfare the different workshops, for repairs and for experimental work and for the temporary manufacture of special expedients, have become important establishments, requiring a considerable amount of power.

With regard to the general question of motive power, petrol and oil engines with direct drives are the competitors of the electric motor. The extra labour for supervision and repairs, the extra lubricating oil, the fire risk, the low efficiency usually resulting from the low engine load factor, and the difficulty regarding fuel supply make the individual internal combustion engine a less formidable competitor, however, than would appear at first sight. Electric generators and motors have proved to be reliable machines in war and, considering the amount of knocking about to which they have been subjected, the amount of repairs found necessary has proved to be small, especially as compared with petrol-engines.

### Requirements of Different Zones.

The conditions which exist during different campaigns must of necessity differ greatly, but in most cases the area of operations can be divided into the following zones :—

(i).—Home bases, with which can be included emergency camps.
(ii).—Overseas bases, base camps, depôts and workshops.
(iii).—Line of Communication (generally termed L. of C.).
(iv).—Forward areas.

The requirements vary considerably in each of the above zones.

In the first three zones the lighting of hutments and depôts forms a material part of the work to be done, and in forward areas the lighting is largely confined to casualty clearing stations, mobile workshops, headquarters of formations and shelter tunnels; in the former zones current is supplied usually from local power stations or from semi-fixed plant, while, in the latter, portable generating plant is largely used. Motors are used in all zones.

### Types of Current and Voltage.—British and Continental Practice.

Whenever strong currents are to be used in civil or military life, the question of the type of current and voltage to be used is a matter requiring great care; general practice at home has naturally an influence in the matter, especially regarding the rapid supply of suitable apparatus. In the United Kingdom in civil life direct current is mostly used for low-tension distribution on the three-wire system, with 200 or 220 volts between outer and neutral, and 400 or 440

across the outers. Low-tension three-phase distribution is the exception, and practically all the high-tension and low-tension distribution is done with underground cables.

In France and in several other continental countries the older power stations were laid out for direct current and therefore in the central districts of such towns as Boulogne and Rouen direct current is supplied. In order to supply the suburbs and outer areas three-phase current is usually generated, being transmitted at high tension and distributed as three-phase through static transformers. In France, as in many other countries including America, the lamp voltages are usually from about 110 to 125 volts and, where three-phase current is used, the motors are usually arranged for 190 to 220 volts across the phases. Outside America, where alternating current or three-phase are to be found, 50 periods are the rule. It is naturally desirable so to adjust matters during warfare that the utmost use can be made of local facilities.

With perhaps the exception of Germany, all the powers began by using direct currents, but during the war the advantages of the three-phase system, except for perhaps the smallest installations, became so apparent that at the end of the war it was being used extensively, the French using it for quite small generating units such as 20 kw. In some sections of the British Army in France, there was a great prejudice against the use of three-phase current, and this was especially the case in the Transport Directorate.

## Advantage of H.T. Lines, 3-phase Distribution and Co-ordination of Supply.

Once a site has been selected at the base or on the L. of C. for use as an important military centre, rapid expansion takes place, and camps, depôts, and workshops begin to be formed. Too much concentration is undesirable from the point of view of safety from aircraft, so that a number of points requiring light and power get scattered round important centres on the rail or road. The problem is the supply of light and power with the minimum of labour and delay. Originally each little point had its own, or at least wanted its own generating plant, so that the labour for maintenance and repair became a serious matter.

The practical limit of distribution of direct current from a temporary power station is limited to a few hundred yards, especially if the use of very heavy copper cables is to be avoided; whereas, once three-phase current is adopted, the limit runs into miles. A temporary high-tension power line can be run up almost as rapidly as a telephone line and for small branches galvanized iron wire can be used. The result of the use of this system is that, once three-phase plant is put down to supply a workshop or depôt, neighbouring camps

and institutions can be rapidly supplied without further moving plant, with the aid of step-up and step-down transformers. For the practical development of such a system it is absolutely necessary that the generation and distribution of power should be in the hands of one organization ; otherwise there is a danger that " dog-in-the-manger " tactics will be adopted and one unit may refuse to run their plant to suit the requirements of another.

Three-phase current supplied from civil stations was largely used by us at such places as Calais, Boulogne, Dieppe, Havre and Rouen, and but for the set-back of March, 1918, it would have been used extensively in the area round St. Omer.

The French and Germans, and later, the Americans adopted the policy of linking up the main power stations with special trunk lines at 30,000 volts or more, the subsidiary stations being as far as practicable interlinked by lines at lower voltages ; from the resulting network three-phase current was supplied to a number of forward areas. The Germans probably put up over 2,000 miles of high-tension line on the Western front, the French over 1,000 miles, and, although the conditions were not so favourable in the British area, probably something like 80 miles were put up by us. One great difficulty we had was the lack of any definite detachments for the construction and maintenance of aerial lines.

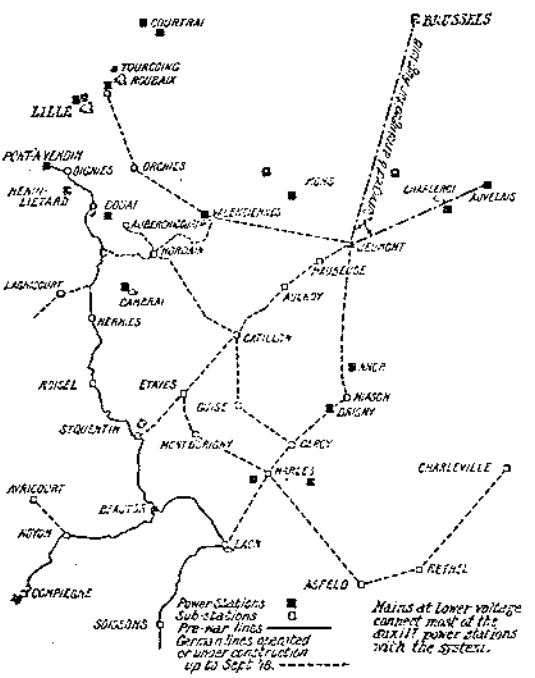



FIG. 1.—*German Power Lines at 45,000 volts in the Occupied Zone.*

## Portable Plant.

The great problem is the supply of strong currents for mobile and semi-mobile workshops, casualty clearing stations and other electricity-consuming points in forward areas. In France with us there was no material uniformity in system nor yet in channels of supply of apparatus and accessories. Each branch of the Service wanted to run its own show, so local co-ordination was a difficult matter. A large amount of portable generating plant will always be wanted in warfare, but its use should be cut down to a minimum. During the war the question of the conservation of fuel supply was a matter of the utmost importance, and at one time things were almost touch-and-go with the available supplies. Economy in liquid fuel is therefore a matter of great importance.

It is difficult to lay down the law regarding the best type of portable plant. Generators direct coupled to high-speed petrol sets are convenient for transport, but experience of the British, French, German and Austrian armies tends to show that they are difficult to keep in order with the inferior labour usually available, and are extravagant in petrol and lubricating oil. The medium and low-speed paraffin and petrol engines undoubtedly gave the best results, but they are difficult to transport. French and German makers of portable generating sets usually used channel iron bed-plates, but unfortunately nearly all the British makers insisted on the use of heavy cast iron bed-plates. On all direct coupled sets some form of flexible coupling between generator and engine is desirable, but as far as possible the couplings should be standardized to enable generators to be changed when required.

The excessive repairs and other difficulties with all classes of internal combustion engine, whether for electric or direct mechanical drive, would have been largely reduced if schools of instruction had been set up for the auxiliary labour liberated for such work. This was done to a certain extent by the Germans and Austrians. Any man-power taken up for such instruction would have been more than set off by the reduction in breakdowns and general repairs. An unofficial school for such work was started in one area on the L. of C. and, despite the short training period, the experiment proved successful. At the end of the war the French were beginning to adopt portable superheater steam-engines for some of their generating plant, and this arrangement should prove very useful for hospitals which require steam for baths, cooking and washing. The exhaust steam could also be used for other purposes.

The A.S.C. sent to France a number of M.T. repair shops, mounted on motor chassis and fitted with $3\frac{1}{2}$ kw. high-speed direct-current, direct-coupled petrol sets. With these sets it was found that, if the generator was taken off the engine bed and bolted to the flywheel of the four-cylinder engine of the chassis, which engine had then

merely to jog round, the repairs and petrol consumption were reduced to a minimum. The Ordnance for their larger mobile workshops had a number of steam tractors to haul their machine tools and gear; these tractors were also used to drive generators by means of belts. Practically all the portable sets used by the British were arranged with D.C. generators at 115 or 220 volts.

One branch of the Directorate of Transport ordered 25 three-phase 50 kw. direct-coupled sets with eight-cylinder petrol-engines mounted on channel beds. These were intended for use after an advance, to take the place of plant destroyed by the enemy, for connecting up to such part of the three-phase supply networks as remained. Owing to lack of *liaison* with those in France, ignorance of conditions in the war area and the absence of any centralized organization for the control of electric power matters, the bulk of these sets were constructed for a voltage range practically unknown from Antwerp to the Mediterranean. Owing to the lack of flexible couplings moreover, these so-called portable sets, some of which were supplied with wheels, could only be run satisfactorily on a bed of concrete.

The Germans had some three-phase steam-engine sets, mounted on railway trucks, of a capacity of 125 K.V.A. at 15,000 volts and one of these sets is now at Gosport. The Austrians had a 300 kw. set similarly mounted and the British Transport Directorate had several 200 kw. D.C. sets with steam turbines mounted on trucks. We had also two 1,000 kw combined D.C. and three-phase floating power stations. At the end of the war the French were beginning to use three-phase portable sets, so arranged that they could supply power to a hospital or workshop direct and supply other points in the neighbourhood through transformers. When conditions allowed, the generating plant would be replaced by a power line from the rear, and the portable plant kept in reserve or sent elsewhere.

It should be noted that both the French and Germans wired out a number of villages and small towns in order to supply billets with light, the French arranging with power companies to take over the work when done with.

### CENTRALIZATION OF SUPPLY.—STANDARDIZATION OF APPARATUS.

If electrical light and power and, for that matter, general mechanical power is to be made use of efficiently in the future, it would seem to be necessary to hand over the general control of such work at home and in the field to the Engineers, on somewhat similar lines to the work done by Signals. All general lighting and power work should be carried out by Engineer men or men responsible for their technical work to the Engineer officers. In the field a number of auxiliaries are always necessary, and the French found that it was desirable for the local unit to choose the men and hand them over for training and

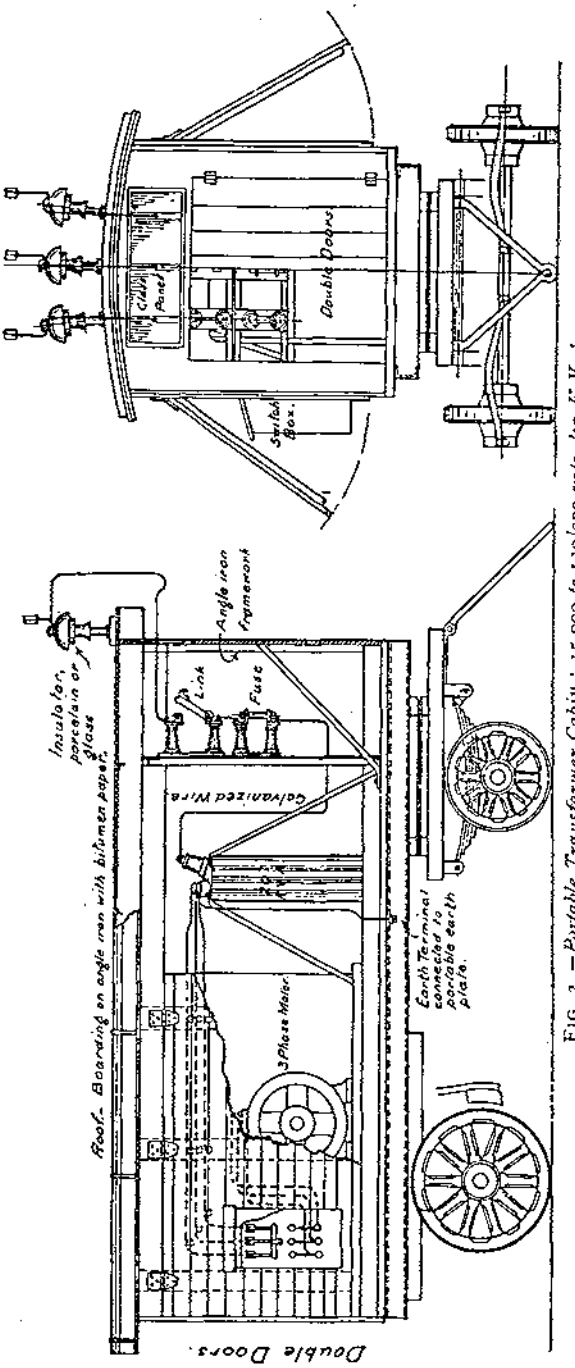



FIG. 2.—*Portable Transformer Cabin*; 15,000 to 120/200 volts, 120 K.V.A.

technical supervision to N.C.O.s and men of the electrical corps; with such an arrangement local units are not likely to detail "rotters" to take charge of work affecting their own comfort.

To avoid competitive buying and claims for departmental priority, and to reduce the number of types in use, all apparatus should be purchased by the Royal Engineers, or, where special motor-driven machinery is required by a specialist corps, the motors and special generating plant should conform to R.E. standards.

With regard to the question of the supply of stores it is unnecessary to purchase the very best class of electrical accessories for temporary work at home or in the field. The life of a hutment installation is short and in the many cases where cleat wiring is used the question of the mechanical protection of conductors is the main point. For war work commercial pattern apparatus which can be turned out rapidly has proved to be the most convenient. Again, it is useless to use high-grade wire if it is to be installed by comparatively low-grade wiremen. Except where batteries are concerned moving iron instruments are preferable, they are stronger than moving coil instruments and can be used for D.C. or 50-period alternating current. At one time in France many electric generators and motors were ordered almost as they were wanted and to avoid this and to facilitate supply the mechanical officer attached to the staff of the Engineer-in-Chief ordered petrol electric sets and other machines in batches. Owing to the delay in the supply of accessories from England through the official channels large quantities of accessories were ordered in Paris and these proved on the whole to be satisfactory and economical. When the question of using three-phase apparatus in more forward areas arose, a series of motors were ordered in England and standardized, different sizes being ordered from different makers. To assist other Services these were supplied as far as stocks allowed, a voluntary standard system being thus introduced. These motors were designed so as to be usable in connection with public supply in most parts of France. A certain number of transformers were ordered with multiple windings so that by different connections they could be used for 5,000 or 15,000 volts and some were ordered suitable for 3,000, 5,000, 6,000 and 10,000 volts.

### Organization of E. and M. Work.

It is interesting to note that, acting independently, the Germans, Austrians, French and British evolved the electrical and mechanical unit, which, to a greater or lesser extent, handled electric light and power, air compressors for drilling (with the exception of the last), water supply and petrol-engines for direct driving. The Germans had an Electrical battalion for each army, the French a large company, the British a company; but the British E. and M. Cos. had not the same control as those of the French and Germans. It is desirable

to continue and develop this system. Furthermore it is an advantage either that the O.C. E. and M. Company should be *ex officio* staff officer to the Chief Engineer for such work, or, as in the 2nd Army at the end of the war, that a staff officer should be detailed to keep the *liaison* between the staff and the O.C. unit. It is most important that electric light and power on the L. of C. should be under the same general technical control as that in army areas.

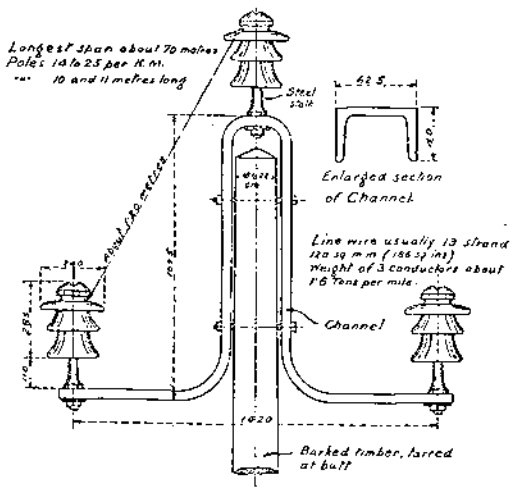



FIG. 3.—*Standard Cross-arm for* 45,000-*volt Power Line.*

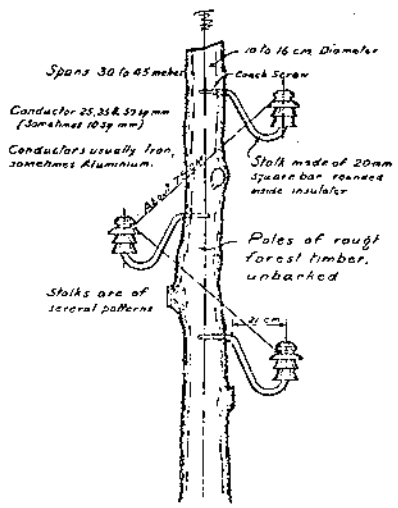



FIG. 4.—*Branch Line Construction, up to* 15,000 *volts.*

In the German army the "Starkstrom" troops were on a basis of territory, so that changes in army or L. of C. areas did not lead to great alterations in work. Owing to the fact that power lines may

have to pass through several commands, a strong central control is desirable, and it is to be noted that during the war the French had periodical conferences of electrical officers.

The E. and M. companies should be divided into sections for erection of plant, maintenance work, workshop work, water supply when included, and a power line construction section is usually necessary. During manœuvres men should be trained in the rapid construction of power lines.

It would be desirable for a Territorial Force of Electrical and Machinery men to be formed, so that, either by expanding peace time skeleton formations or creation of new units, the requirements of a modern army could be met.

The work of an E. and M. Company is of such a varied character, that for efficient working it is practically impossible to lay down a rigid mobilization table; and during the war it was difficult to get the authorities to understand this. The French and German organizations were much more elastic than ours in this respect. The work of such companies on the L. of C. is of such importance that it should not be reserved for men of the lowest medical categories only; men for handling high-tension lines and climbing poles must be active and have their wits about them.

It would be desirable for the Intelligence Branch of the War Office to keep in touch with electrical developments in all likely seats of war, collecting notes, maps and statistics regarding power stations, power lines and voltages. A large amount of useful information could be gathered from the British and Foreign Electrical and Engineering Press.

When starting a campaign in a country where electric power schemes are in operation, it is desirable to have all possible information collected as, even if the main power stations have been destroyed, quantities of useful material would in most cases be available

A number of lantern slides were then shown, many of them depicting German practice. The author has often been told that, as we won the war, adverse criticism of some of our own work, and praise of some of the German work are stupid and futile. A man in a boxing match who sticks out sixteen rounds before getting a knock-out blow, and nearly knocks his opponent out several times during the fight, must show in his methods points worthy of commendation and imitation, and must be a better man than one who goes down during the first round. There are many features of German military electrical work worthy of study.

Further particulars of work done by the German Army can be found in a pamphlet by the author, *Notes on Electric Light and Power Work of the German Army*, published by H.M. Stationary Office, price 1s. 6d.

FIG. 5.—Stock of Poles and Cross-arms at Jeumont for German Military 45,000 volt Line.

FIG. 6.—German 45,000-volt Line and Anchor Pole: Stranded Aluminium Line 120 sq. mm.

FIG. 7.—Sub-station Attached to Farmhouse.

FIG. 8.—Sub-station at a Sawmill.

## USE OF ELECTRICAL POWER ON THE WESTERN FRONT

# *TWO NEW METHODS OF CONCRETE CONSTRUCTION.*

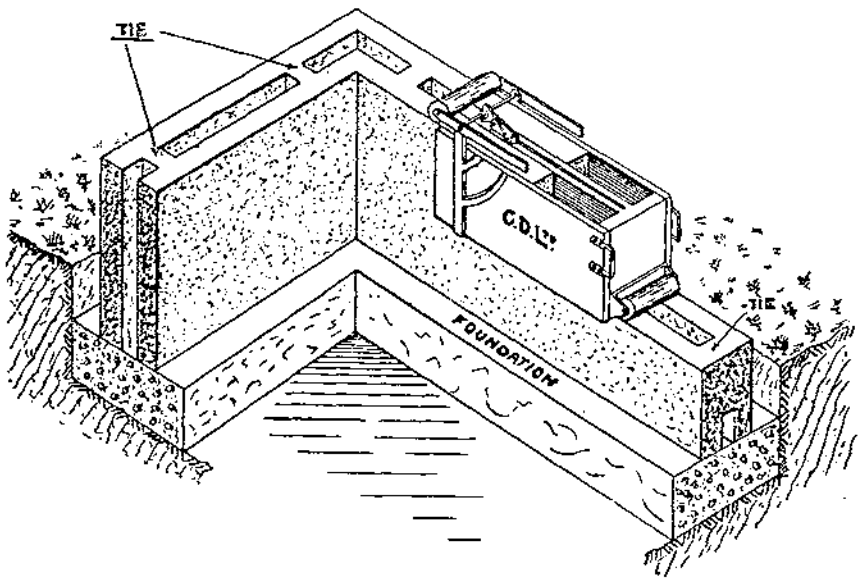
*By* MAJOR G. C. V. FENTON, D.S.O., R.E.

## THE "C.D.L." SYSTEM OF CONCRETE CONSTRUCTION.

THIS system of construction, which is the property of the Concrete Dwellings (Parent Company), Ltd., of 1, Carteret Street, Westminster, London, S.W. 1, was exhibited at the recent Building Trades Exhibition at Olympia, and should prove of interest and value to officers employed on the construction of barracks and other buildings.

The system offers the great advantage of the construction of the walls of buildings of concrete, *in situ*, without the use of wooden or other form of shuttering, and by means of a machine which requires no skilled labour to operate. Its use in the United Kingdom should give considerable economy over other forms of concrete wall construction and in Indian and Colonial stations, where labour of a skilled nature is scarce, it should prove exceptionally advantageous. The company claims that unskilled labour can obtain proficiency in the use of their machine in two weeks.

The ordinary concrete block machine generally entails the pre-casting of blocks, and their storage to permit setting before incorporation in the building. They then have to be built up in mortar, plumb and level. The "C.D.L." system eliminates all handling of the concrete once it has been placed in the machine and provides a monolithic structure.



The machine is shown on the diagram in actual use on the construction of hollow walls. It consists of four cheeks or sides, hinged on to an end plate, which, by the operation of simple clamps, can be fixed parallel with each other. The release of these clamps permits the cheeks to fall into wedge-shaped positions in relation to the base. In the former position, the filling of the machine takes place and the concrete can be tamped without any fear of distortion. After filling, the clamps holding the cheeks can be released, permitting the cheeks to assume the wedge-shaped position and thus be out of contact with the new green concrete, and the machine can be moved away without disturbing it. Rollers are provided to facilitate easy motion.

The method of working is that the machine is placed in position on the previously laid foundations or plinth, clamped in the filling position and filled with concrete, which is well tamped. It is then unclamped, pulled forward for the whole of its length, reclamped in the filling position, and again filled. The process is repeated until the whole course round the building is completed. The following day, the machine is placed on the top of the course made the day before, which has by that time partially set, and the next course completed. By short intervals between the courses, a homogeneous monolithic structure is obtained.

Machines can be made to construct any thickness of wall, but the standard machine generally supplied for use in the United Kingdom builds a 9 in. hollow wall, consisting of $3\frac{1}{4}$ in. inner and outer shells, separated by a $2\frac{1}{2}$ in. cavity. Regarding the courses, it has been found that 15 ins. high gives the best results. This standard machine also forms the ties in concrete, but each tie only goes half the depth of a course, and breaks joint with the others, thus securing a continuous air space within the walls of the building and thereby precluding damp or condensation. If however considered desirable the machine can be made without the concrete ties and metal ties used instead.

The main drawback to this method of construction, as far at any rate as the Colonies are concerned, is that the machines are not for sale. The company hires them out at a Royalty, based on a small percentage of the total cost of the building. In India however the machines are manufactured and sold by the Empire Engineering Company of Cawnpore.

### CLIMBING STEEL SHUTTERING FOR CONCRETE WALLS.

AT the same Exhibition, the Climbing Steel Shuttering Company, of 515, Queen's Road, Sheffield, exhibited a very simple and effective method of construction of concrete walls.

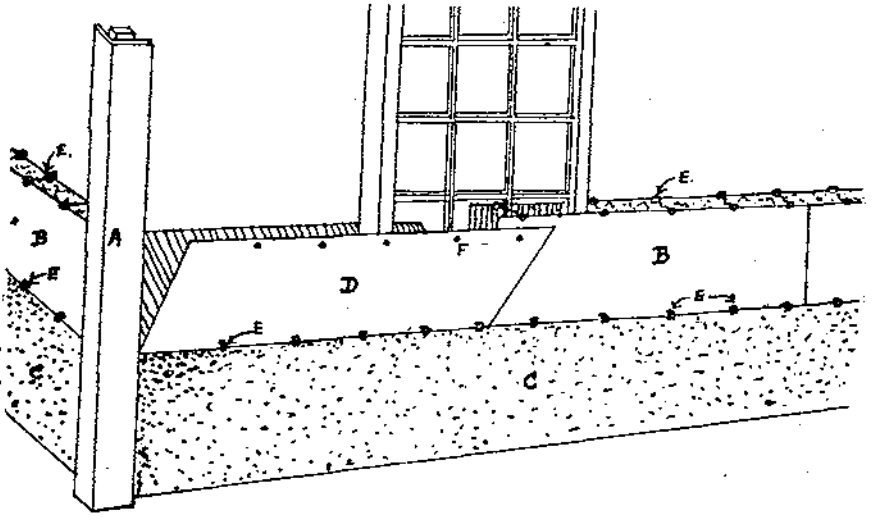
Their method is merely by what they term "Climbing Steel Shuttering," which consists of light bolstered galvanized steel plates,

with a number of holes pierced in the upper and lower edges of the shutters. The shutters are held apart the thickness of the wall to be constructed by means of wires which are passed through these holes. No uprights or guides are required except at the extreme corners of the building, where ordinary corner casing of wood is erected and fixed plumb. From these corners a line is required to keep the work straight and true.

As soon as the casing has been fixed in position, the concrete is filled in, and when it has set sufficiently stiff, the lower wires are cut on the outside and the plates are turned up from the bottom, the upper wires acting as hinges. The upper edges are then wired by means of the holes, the casing is aligned and is then ready for the fresh charge of concrete. In short, the plates revolve to the top of the wall. These plates are made in lengths 5 ft., 6 ft., 7 ft., 8 ft. and 9 ft., height 17 inches, thickness $\frac{3}{4}$ in., weight 4 lbs. per superficial foot. The size of the wires used is No. 15 or 16 gauge.

This system of construction can be used with either plain or reinforced concrete and a special point is the very light nature of the plates, which facilitates easy handling. The firm claims that a square yard of shuttering, both sides, is got ready, that is, wires cut, plates turned up and rewired, in less than five minutes.

The method of building by means of this form of construction is as shown in the following isometric sketch :—




References :—A. Corner casing of wood.
B. Patent shuttering fixed and filled with concrete.
C. Completed concrete wall.
D. Patent shuttering being folded up.
E. Wire fastenings.
F. Holes in shuttering for wire fastenings.

## *SURVEYING ON THE SOMALI COAST.*

THE following is an extract from an officer's narrative of the operations on the Somali Coast :—

The *Odin* was continually moving along the coast keeping up communication between Berbera and Las Khorai and assisting the Military Staff to map, in conjunction with other information, the unknown country in the vicinity of Jidali, by providing a base at sea from which to take bearings. A landing compass was also set up at Burnt Island for this purpose and valuable data were obtained by the military authorities from these two sources, enabling them to fix, with some degree of accuracy, the positions of several of the Mullah's forts. One method used was so unusual, and yet so successful, that it seems worthy of record. Certain natives with an intimate knowledge of the country were taken to sea in the ship, and these men seemed to have an uncanny sense of the direction in which lay any place with which they were acquainted, which one can only compare to the homing instinct of the carrier pigeon. On arrival off the desired spot they would be asked the direction in which, for example, Jidali lay. It is necessary here to explain that at a distance of, roughly, three to eight miles inland from the coast there is an enormous, almost flat, limestone ridge running parallel to the shore and about 7,000 feet in height, and behind which were situated Jidali and Medishi. The native would at once point in the direction and would then be told to "lay" a maxim gun on the exact spot ; the Staff Officer then looked through the sights and noticed the place the sights were laid on ; a compass bearing of this spot was then taken and the ship's position fixed as accurately as possible. This operation was then repeated at various positions along the coast, and thus a large number of cross-bearings were obtained of Jidali and other places. When plotted on a map they came out with extraordinary accuracy, the resulting "cocked hat," in most cases, being exceedingly small, and thus the position of many of the Mullah's strong places in unknown country were definitely fixed within a very small margin of error.

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# *CORRESPONDENCE.*

## A NOTABLE GROUP OF R.E. OFFICERS.

*To the Editor of the* R.E. JOURNAL.

SIR,—On looking over some old photographs I came upon one taken in Simla in 1884 which I think is worthy of some comment in the *R.E. Journal*, on account of the evidence it affords of the influence of the Corps on Indian administration at that time. The group consists of 25 R.E. officers, including:—the Military Member of Council (Chesney), the Secretary to Government P.W.D. (Trevor, V.C.), the Director General of Railways (Stanton), the Director General of Military Works (Innes, V.C.), the Accountant General of P.W.D. (Filgate), the Surveyor General of India (Gore), the D.Q.M.G. for Intelligence (Bell, V.C.), the Chief Engineer, Punjab Irrigation (Home), the Chief Engineer, Punjab Roads and Buildings (Limond), the Secretary Defence Committee (Nicholson), the Engineer-in-Chief, Sind Peshin State Railway (Browne).

The enumeration of these appointments shows the variety and importance of the work being done by the Corps, mainly in connection with civil engineering works. Probably in that capacity the period in question gives the high-water mark of the R.E. in respect of the Indian Public Works. But it also shows that in some important military appointments R.E. officers were even then doing valuable work in peace time, as they had done gallant work in war (it will be noted that there are three V.C.'s in the above list). This latter branch of R.E. work developed more and more, until in the Great War thirty years later, the Chief of the Staff and several divisional and brigade commanders were selected from the R.E.—a choice which hardly would have been made in 1884 in India. But the purely engineering element had to some extent declined.

Of the other officers in the photograph, mostly of junior ranks, five served with distinction in the late war, and received decorations:—Maxwell, Buston, Abbott, E. Hemming and Norton.

I am,
Yours faithfully,
G. K. SCOTT-MONCRIEFF, *Major-General.*

July 16th, 1921.

# NOTICES OF MAGAZINES.

## *MILITÄR WOCHENBLATT.*

No. 51.—*Earl Haig's Dispatches.*—Earl Haig's collected dispatches have been translated and are reviewed. The writer thinks them of considerable value, in spite of the restraint with which their author treats many important subjects, and evidently admires the competent and professional manner in which they are drawn up. He naturally takes exception to some points, particularly those which mention the numerical superiority of the Germans at different times, and says that to estimate relative strengths merely by counting the opposing divisions is misleading, because the German divisions were so much below establishment. He also finds it extraordinary that Lord Haig should still believe that he was making war for the preservation of civilization, and says that no one now doubts that the true motive was *Ceterum censeo Carthaginem esse delendam.* All German writers like to compare Germany with Carthage.

No. 52.—*The Military and Political Situation in the World.*— Holland is reducing her army considerably; the yearly recruit class falling from 23,000 to 13,000 and the service from 8 to 6 months. On the other hand machine-guns are being considerably increased. The question of the Scheldt and the Limburg province is constantly being raised by Belgium, and naturally influences any projects for reducing the army. The Far Eastern question is followed with great interest, and the 40,000 strong colonial army is considered too weak to safeguard the immensely valuable Dutch East Indies. Their chief defence is, however, considered to lie in the jealousies of the Great Powers. The action of the Entente towards Germany is condemned, because it is feared that the collapse of Germany would be followed by that of Holland. Economic situation is bad and has led to disturbances. The eight-hour day and high wages have led to anxiety as to Holland's power to compete with foreign countries.

*Switzerland.*—The lessons of the war are being applied as far as circumstances allow. It has been agreed that the Army shall consist of six Divisions plus four Mountain Brigades, supported by three Divisions and two Brigades of Landwehr. Apparently infantry regiments are to come directly under Divisional command, Brigade Headquarters being done away with.

*Eastern Siberia.*—Semenov's position is said to have considerably improved and an advance towards the Lena River is expected. The *M.W.B.* says the Entente is doing its best to bring about his downfall,

because he is against Wrangel and his policy. Kappel has died of typhus, but his troops form the 3rd Division of the Hetman Semenov. Chita has been taken from the Bolsheviks and Semenov's cavalry is pushing west and south of Baikal.

No. 1.—*French and German Officers.*—A German actor called Moissi, in an interview with a Norwegian journalist, said, "The French private soldier is a gentleman, but the French officer is just as much a swine as the German." *M.W.B.* is naturally furious and gets back on Moissi by giving some particulars of his career. He seems to have been commissioned in 1915 in the Flying Corps and to have seized his first chance to fly to Dunkirk, where he landed and gave himself up as a prisoner of war.

*Regimental Associations.*—These are going strong. At a re-union of one battalion of Bavarian artillery no less than 300 members turned up.

No. 2.—*The Death of the German Corps of Officers* is a complete *résumé* of the casualties suffered by the officers during the war. As already mentioned, 24 per cent. of the regular officers were killed (11,357 out of 45,923) and 15 per cent. of the reserve officers. In all the losses in officers amounted to 52,006 killed or died, while the grand total of all ranks, including about 14,000 coloured troops is given as 1,822,545. Regular officers serving on the outbreak of war lost 40 per cent. killed or died. Losses in other ranks were far less severe amounting to 15·4 per cent. During the war the strength of regular officers remained nearly constant, but the reserve officers were largely increased and the grand total increased from 49,051 on 1. 8. 14 to 164,823 on 10. 1. 19.

*The Checho-Slovakian Officer.*—A report published concerning a class of young officers of the Russian legion shows an extraordinarily low standard of education among them. They could hardly write, believed a triangle had four corners, and did not know what an angle was. As leaders they showed stupidity and lack of energy, and though they studied laboriously they made no progress. The only satisfactory point about them was their physical development; through years of idleness in various prison camps they have lost all power of concentration.

*In Chains to Leipzig.*—The German officers association sent a telegram to the Chancellor protesting against Lieut. Bolot of U-boat 86 being brought to Leipzig in handcuffs. Apparently this was done at the instance of German authorities.

No. 3.—*The Military and Political Situation in Great Britain.*—In this article, General Balck discusses the situation with which the Imperial conference had to deal. As regards the Anglo-Japanese treaty, he thinks that Japan will no longer be satisfied with the clause which allows England to remain neutral in case of war against America, and that the proposed inclusion of America in the alliance is out of the question. He considers that the situation in the Near East makes it very desirable for England that the treaty be renewed. He speaks of the much-discussed Russo-Turkish *rapprochement* as if it were a *fait accompli*, and foresees much trouble for England accordingly. The situation on

the N.W. frontier also pleases him immensely and he attributes all the recently introduced (though long projected) Indian legislative reforms to the direct pressure of existing conditions! His forecast of events in Ireland has, so far, proved fairly accurate. The reduction of the British fleet is, he thinks, foolhardy, but he admits that lack of money compels it. Bernard Shaw's forecast of war with America and Japan is taken quite seriously.

*The Leipzig Trials.*—The *M.W.B.* compares the attitude of the French towards the results of the Leipzig trials with the view they take of their own court-martial results. The latter have, in several instances, been recently reviewed and found to have been faulty; but the French Minister of War says that mistakes are bound to happen in war, and that after this lapse of time it is impossible to fix responsibility. The *M.W.B.* says that this is the view that should have been taken of the Leipzig results. On the whole there has been very little comment on Leipzig in the *M.W.B.*, though violent counter-charges against the French have been fairly common.

*Reduction of Pensions.*—The law which lays down that pensions shall be reduced if the pensioner has any other income is, naturally, severely criticized. The writer says, truly enough, that work must now be reckoned an expensive luxury; and, since a number of officers will now no longer be able to afford it, the economy of the country will suffer accordingly. He says that already it is unfortunately a fact that many ex-officers are engaged in illegal trading of various descriptions, and that this law will add to their number.

No. 4.—*The Military and Political Situation.*—French recruiting difficulties are discussed, as well as France's probable attitude towards any proposals about disarmament. *M.W.B.* does not think she will do much in that way, since the fear of Germany is too deeply branded on her. A comment on the trial of Lieuts. Dittmar and Boldt, of U-boat 86, is surprisingly moderate in tone. It says that, though they could almost always assume that hospital ships were carrying munitions, in this particular case they were wrong; and the punishment, though most excessive, is not altogether unjustified. The honour of the officers is however untarnished.

*The Army Council of Delegates.*—This seems to be working satisfactorily and held its third meeting in July. Among other subjects the following were dealt with—Insurance, marriage of officers, punishments and many points of interior economy. As already stated, this Council, which is composed of all ranks, has advisory powers only.

*The Reckoning.*—This is the title of a book which purports to summarise the atrocities committed against Germans. It is, of course, intended to prove that the only cruelties in the war were those committed by Germany's enemies, who now have the effrontery to accuse her of acts against the law of nations.

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

## *REVUE MILITAIRE GÉNÉRALE.*

### *January & February* 1921.

*The Revision of the Regulations* (*continued*).—From the tactical point of view imperfections of method became evident to the French command from 20th August, when all armies were warned (*a*) of the preponderating effect in battle of modern firearms, more especially of the machine-gun, and (*b*) of the lack of co-operation between the artillery and infantry. The teaching of the *Service des Armées en Campagne*, that "artillery no longer prepares the attack, it supports it," is at variance with the requirements of warfare. In forbidding "preparation" the regulations intended to put a stop to the *artillery duel*, but that the necessity was recognized for destroying by artillery fire everything tending to impede the advance of the infantry is definitely shown in the report forwarding the regulations to the Minister for War. Possibly here too may be found the reason for the insufficiency of heavy field artillery which became so evident early in the war. However that may be, the artillery must be well acquainted with the action and needs of infantry, which raises the problem of inter-communication, a problem not yet solved. The note of 20th August also pointed out (*c*) that the lateral intervals between the individuals in attack formations should be wider, and that the firing lines should be continuously fed from similarly extended formations in rear. (*d*) Sufficient attention was not being paid to the instructions in the F.S. Regulations in respect of field fortification. The German organized position on the Aisne was a surprise though the trenches had only been hastily dug; they were, however, covered by considerable stretches of wire entanglement. (*e*) Cavalry must be supported by infantry, as the German cavalry by retirement endeavoured to entice the French cavalry under infantry fire. More rest must be allowed to the horses to eat and sleep.

*Second Period.*—The fronts now extended from Belfort to the North Sea, and the Germans, realizing that their outflanking efforts had failed, struck at the coast ports—Ypres, 22nd October, and Dixmude, 13th November—but without success, their second great check. In these battles the Germans suffered heavy casualties due to attacking in too dense formations troops sheltered by at least elements of trenches, just as the Allies had suffered on the Aisne.

*Third Period.*—During the winter the French were learning that the war was not destined to be finished out of hand. Gradually it was realized that a period of siege warfare was inevitable, and little known special regulations were being studied. These indicated that infantry must be turned into sappers, and artillery into siege units, facts foreign to preconceived ideals. Heavy guns were dragged from fortresses and coast defences, but were too few in number, and none were quick-firers. Further supplies of the same patterns, ammunition, and additional machine-guns were put in hand as quickly as the small means of production allowed, but heavy quick-firers were not yet thought of. The period can best be considered in two phases, first, the local attacks on the German

positions of the winter, and second the French offensives in Artois in May–June, and in Champagne–Artois in September, 1915. It must be remembered that the enemy held only a first position of two or three lines of trenches. Mining was attempted in favourable situations, and the Germans introduced asphyxiating gas. At the end of the first phase, on 2nd January, 1915, a fresh series of instructions was issued to the effect that attacks must be slower and more methodical, must be arranged beforehand to the smallest detail, and preceded by a formidable artillery preparation. Attacks must be as numerous as numbers would allow of, and delivered simultaneously at various points in the line on as wide fronts as possible to prevent the enemy concentrating on one point, and be prolonged to the flanks by fire calculated to destroy the enemy flanking fire. As the artillery could only bombard one line of trench at a time the attack must be in a succession of waves, and the infantry must avoid strong points until they had been effectively dealt with by the artillery. Captured trenches to be at once organized against counter-attack. The instructions were sound in view of the insufficiency and slow fire of the artillery, which entailed lack of depth in the preparation, delay in precise ranging on the next objective, and consequently long waits between the successive waves of the attack. Under such conditions the battle of Perthes opened (15th February). Want of artillery (100 heavy guns only) limited the front to seven, then to three kilometres. According to the German account, the attack might have succeeded if it had been resolutely pressed *home*, but, the preparation had not included the artillery position, and such a heavy cross fire was brought to bear on the narrow salient that it could only be held subject to terrible loss of life.

On 16th April a fresh set of instructions enjoined rapidity and continuity in the attack, which must be pressed right through the position to prevent the preparation of counter-attacks and the establishment of a position in rear. Artillery must be as far to the front as possible for counter-battery work, and to accompany the infantry by a barrage, and must be prepared to change position as the attack advanced; ranging was to be assisted by balloons and air-craft. The infantry attack would be preceded by three or four hours' preparation by the heavy artillery, and then by about ten minutes' bombardment of the enemy by all calibres. During the attack there would be an artillery barrage in front, and a bombardment of the next line of trenches Divisions would attack on a front of 1,000 to 1,200 metres, and be organized in depth so that they could hold out for several days. Here again the weak point was that lack of artillery would not allow of the scheme being carried out on a sufficiently wide front, and if the trenches were to be bombarded successively there were no guns for counter-battery work, and the enemy artillery would be free to fire on the infantry. It should be noted that the normal extension of one man per metre for the infantry was adhered to.

During this winter the French field defences improved considerably, supports and reserves entrenched themselves, trenches were deeper, and firing platforms were made, at least the busy sectors of trench were continuous, and communication trenches were constructed by degrees.

Meanwhile the Germans, better trained in the defence, and determined to trust to it, had been constructing deep bands of entanglement, concrete shelters, flanking casemates, covered communications, etc. A second position had not been completed, but was commenced early in 1915.

A. R. REYNOLDS.

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*REVUE MILITAIRE SUISSE.*

No. 3.—*March*, 1921.

*The Strategical Position of Switzerland as a Member of the League of Nations.*—Colonel Feyler points out in the original article that the authors of the Pact of Nations in no way claim to have brought into existence the reign of a universal and perpetual peace; their object has been to increase the length of the periods which separate "explosions of hate." It is recognised that, in the future, there may be "private" wars which may be waged without in any way implicating the League of Nations; wars which cannot be prevented by the machinery at the disposal of the League. Colonel Feyler deals briefly with the manner in which Switzerland, in view of the provisions of the Treaty of Versailles, is likely to be affected in the case of such "private' wars. The signatories of this Treaty have declared that the neutrality of Switzerland guaranteed by the Treaties of 1815 is to be "maintained in the interests of general peace." It is pointed out that the fundamental character of the neutrality imposed on Switzerland in 1920, which, by the way, is different to the former "perpetual neutrality"—affects alone, and is limited to, the movement of armies. In other respects Switzerland is not required to be a neutral, for she will in future espouse the cause of the League of Nations. Consequently, she will, in the event of a war, have to break off diplomatic, financial and commercial relations with the "enemies" of the League, and take part in an economic blockade of them. Switzerland will naturally retain friendly relations with the other members of the League, who will provide her with essential supplies, and with them alone she will, during a state of "private" war, continue to maintain commercial relations. Switzerland will thus occupy a somewhat anomalous position in the event of future hostilities in which the States on her borders may participate. Colonel Feyler deals in his article with the problem of the mobilization of the Swiss Army in the event of Switzerland occupying a position analogous to that in which Belgium found herself in August, 1914. Five sketch maps accompany the text of the original article, showing respectively the concentration areas first occupied by the French armies on the violation of the Belgian neutrality in 1914; the concentration areas of the German, French, and British armies during the first half of August, 1914; the positions of the Belgian Divisions on the 3rd and on the 5th August, 1914; the territorial areas assigned to the Swiss Divisions in 1912. (*To be continued.*)

*The French 9th Corps at the Marshes of St. Gond.*—An article on the above subject begun in the number of the *Revue* for January, 1921,

is concluded in the number under notice. In this part of his article Col. Poudret deals with the operations on the right wing of the French 9th Corps. The narrative shows by how narrow a margin it escaped defeat. Indeed, it was the tenacity of purpose of General Foch and the skilful dispositions made by him when the battle began which saved the situation; it was fortunate, too, that he was so ably seconded by his Divisional Commanders and an energetic staff.

*The Morale of the Army and Memories of the Mobilization.*—Major de Vallière deals in the original article with the disaffection which existed in some portions of the Swiss Army during the period of its war mobilization, and traces the causes which were responsible for the unhappy state of affairs which prevailed at one time. Fortunately, the disaffection was not at all widespread, as is evidenced by the great number of pamphlets and other publications, giving the history of the mobilization period, which are being published in Switzerland at the present time.

NOTES AND NEWS.—*Switzerland.*—Lieut.-Colonel Corda, Professor at the Artillery School, Fontainebleau, has been giving a series of lectures at Zurich to the officers of the Swiss Army on the practical aspects of the Great War. These lectures have included subjects such as the handling of reserves, the use of railways and automobiles, the minutiæ of preparations for a counter-offensive, the wastage of war, flexibility of command.

*Belgium.*—The question has recently been under consideration as to the minimum period necessary to train a recruit. It is now recognized that the drafting of men to the front after only five to six months' training, during the early days of the war, was a mistake; although in many cases such drafts were well reported upon, they did not always meet all the requirements of war. It has now been decided to provide a ten months' course of training for the infantry, a twelve months' course for other arms and services, except cavalry and horse artillery, for which the course has been fixed at thirteen months.

*France.*—The suggestion is on foot to deprive infantry captains of their mounts; General de Maud'huy is said to be the proposer of the scheme.

W. A. J. O'MEARA.

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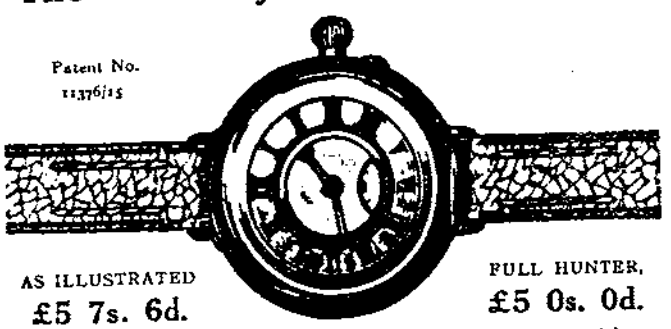

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