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MONTGOMERIE PRIZE.

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

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

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

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

The following are suggested as subjects for contributions:—

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

NOTES ON THE HISTORY AND EMPLOYMENT OF ARMY TROOPS COMPANIES, R.E.

By "BUCCANEER."

Origin.—Army Troops Companies were a creation of the Great War. In the pre-war army the only units that might be called the precursors of Army Troops Companies were the 20th and 42nd Fortress Companies, at Plymouth and Portsmouth respectively, and certain Fortress Companies abroad, such as the 24th at Malta and the 25th at Hong Kong. There were also of course, the Works Companies of the Territorial Force.

When the battle line in France and Flanders ceased to shift to and fro, and trench warfare became the order of the day, the need for more R.E. Companies to supplement the work of the Divisional R.E. was at once felt. Accordingly in the spring of 1915, eighteen new Fortress Companies numbered from 132 to 149 were gradually formed and trained at Buxton. The original intention was that six should be allotted to each army, so the 132nd to 137th Companies were called First Army Companies, 138th to 143rd Second Army and 144th to 149th Third Army. But this distinction was not of long duration as several of the first companies to proceed overseas were sent direct to Gallipoli. Besides these 18 companies, other companies were raised locally in various places—such as Tottenham, Isle of Wight, the Tees, and so on. After formation and preliminary training these latter companies were sent to Buxton for the major part of their training before going abroad.

The first six of the Buxton companies proceeded abroad in June, 1915, and the next six early in August; they all went as Fortress Companies with a total establishment of about 100. Immediately after this it was decided to change the name of the companies from Fortress to Army Troops, and a 50 % increase of establishment in men was given, and also far better transport, including two 3-ton lorries and three motor cycles with side-cars for the use of officers.

Establishment.—The original establishment of an Army Troops Company was as follows:—Captain, 1; Subalterns, 2; C.S.M., 1; C.Q.M.S., 1; Serjeants, 5; Shoeing & C.S., 1; Corporals, 7 (including 1 mounted); 2nd Corporals, 8 (including 1 mounted); Sappers & pioneers, 101; Drivers, 15 including 3 batmen. Total 142.

Attached:—R.A.M.C., 2 for water duties; Drivers A.S.C.M.T., 4 for lorries; Drivers A.S.C.H.T., 1 for 2nd line transport. Grand Total 149. This establishment includes 9 lance-corpls. (1 mtd.)

Transport.—2 3-ton lorries, 3 G.S. Wagons (one being classed as 2nd line transport), 2 Limbered G.S. Wagons, 4 Tool carts R.E., 3 Motor cycles with side-cars, 10 Bicycles.

Animals.—2 Heavy draught horses (for 2nd line transport), 18 Light draught horses or mules, 3 Riding horses for officers, 3 Riding horses for N.C.O's.

Criticisms of establishment.—This establishment was a vast improvement over that of a Fortress Coy. The transport was immeasurably superior. Several weak points, however, revealed themselves in practice:—

(*a*).—Too few officers, taking into consideration the class of work that had to be done. Most companies actually had at least one more subaltern attached to them. See also under (*b*).

(*b*).—Too small a unit even now. As shewn below the actual working strength of dismounted men was about 100, the following necessary "duties" having to be done:—1 C.S.M., 1 C.Q.M.S., 1 Pay Serjt., 1 Orderly N.C.O., 1 Saddler, 2 Shoemakers & tailors, 2 Farriers, 1 Draughtsman (also assists Pay Serjt.), 7 Cooks and cooksmates, 1 Storeman, 4 Guard (not always necessary), 17 Mounted men. Total 39.

This leaves only 100 dismounted N.C.O's. and men actually available for works—2/3rds of the unit's strength. If the establishment were augmented, the "duties" would not increase proportionately. It is thought that an establishment of 250 to 300 would be most suitable. The mounted branch can be reduced by increasing the mechanical transport, but some horsed wagons should be retained, in some situations they are essential. The O.C. should be a major, with a captain as 2nd in command and 5 subalterns.

(*c*).—The limbered G.S. Wagons are of doubtful utility to an A.T. Coy. One may come in handy for fetching the unit's mail, or rations for a small detachment. Tool carts are really quite useless to the unit. Tradesmen always collect a few tools for their own use, and are quite prepared to carry them to and from their work. If the distance is great, a wagon can be detailed to carry the tools, which are best stored in rough chests. The solemn packing of a tool cart in the regulation way is simply a nuisance to the section sergeant. 2 G.S. wagons should take the place of the 4 tool carts.

(*d*).—A light box car or motor van and one motor cycle and side car would be better than 3 motor cycles and side cars, and more economical to maintain. The life of a motor cycle and side car under most favourable circumstances rarely exceeds 5—6 months on active service.

(*e*).—No water cart is allowed. This is really necessary.

(*f*).—The tools &c., authorized by the Mobilization Store Table were generally sound with the exception of the pile-driving gear. Heavy

equipment of this kind is best kept at Advanced R.E. Parks and issued when required.

(g).—It would be better to have R.E.M.T. drivers in lieu of R.A.S.C. This helps Administration and *esprit de corps*.

Few companies ever saw the R.A.M.C. attached to them, and consequently were permitted two more sappers or pioneers in their place. An interpreter was added to the establishment and is essential for billeting &c., in moving warfare. When units were practically stationary, one with C.R.E. Corps Troops would have sufficed, and his services could have been made available for any company requiring them. By 1917, the establishment had been reduced to 143 all ranks, a few men having been taken from every company to form E. & M. Coys, and boring sections. Some good men also went to Army Tramways Cos, but these were replaced.

Training.—It was a pity that practically no information was given to the companies training at Buxton as regards the nature of work they would be expected to undertake in the field. Consequently training was carried out largely in the dark. Companies did not know whether they would be likely to be employed with Divisions or in Army Areas or on the Lines of Communication. The only thing to do was to try and make "soldiers" of the men and hope for the best. Of course tradesmen can fit in to any job.

Class of Work Done.—It may be interesting to jot down some of the more important jobs that an Army Troops Company actually did in 1916:—

Hutting (very various)
Water supply
Settling in a Corps H.Q.
Laying out and initial work on an Army Defence Line
Work on Corps Defence Line of all descriptions (dugouts, m.g. empts. wiring &c.)
O.P.'s for Field Survey Coy. and for Artillery
Preparation of positions for Heavy Artillery
Trench tramways.
Laying Decauville lines for ammunition supply to Heavy Artillery battery positions
Road screening
Running a Corps R.E. dump & workshops
Road work
Forestry work
Assistance to Field Coys. when pressed
Pipe pushing demonstrations

A somewhat varied collection!

Administration of.—For about 18 months after their first appearance in the field Army Troops Companies were very much "on

their own." The units working in Corps and Army areas were usually administered for purposes of leave &c., by Camp Commandants of Corps and Armies, but for disciplinary purposes O's C. Coys. had the powers of C.O's. About March 1917, C.R.E's Corps Troops and Army Troops were instituted, and usually administered all R.E. Coys. in Corps Troops or Army Troops respectively. In fact the C.R.E. Corps Troops stood or should have stood in just the same relation to the Army Troops Companies working for the Corps as the C.R.E. Division stood to his Field Companies. The fact that Corps Troops are very often as strong numerically as a Division is often lost sight of. Occasionally the Commandant Corps Troops may administer as many as 28,000 all ranks.

Allotment to Corps, &c.—This being the case it is strongly urged for consideration that definite Army Troops Companies should be allotted to Corps, and *never* changed except for the most urgent reasons. It is an undoubted fact that very considerable waste of power was occasioned in the war owing to companies being shifted hither and thither from one Corps or Army to another. It is of course fully recognised that some areas, owing to their features, or the situation, required more R.E. work than others. This difficulty can be met to some extent by allotting a small reserve of companies to Armies, and these could be used for reinforcing any Corps that is hard pushed. One cannot get perfection in this respect, and quiet sectors will always have to be "bled" in all arms to reinforce a "push." Still the above principle should be adhered to as far as possible.

The question then arises of how many companies should be allotted to a Corps. Experience in the war points to two on an increased establishment as a minimum. Mining and E. and M. work would be dealt with by other units. While every company should be prepared to go anywhere and do anything, it is thought sound practice to employ one company on water supply work, another on roads and bridges, and so on, each company making a speciality of a particular class of work. This is probably better than allotting all the work in a particular area to one company. It must always be borne in mind that owing to its lorries an Army Troops Company has a wide "radius of action," as a party can always be put into a lorry or motor van with their tools and can work usefully up to a dozen miles from their headquarters. The reason why this method could not often be put into practice during the war was due to the constant shifting of companies from Corps to Corps, which it is hoped may not occur again in the future.

Name.—The name Army Troops Company has led to a great deal of misconception, and would be better altered; Corps Troops Company would be more accurate. If it is necessary to classify companies at all, (Works) Company or (Heavy) Company are suggested as

possibilities. The Army Troops Companies, being a creation of the present war, have now practically disappeared for the moment, but it is hoped their equivalent will be preserved when things have settled down, as in any future war of any magnitude, companies of this kind will undoubtedly be required. It should be quite practicable to maintain one or two Army Troops Companies at Aldershot and other large military centres and earmark *personnel* to form cadres of other companies in the event of mobilization.

In conclusion it may be said that the normal round of an Army Troops Coy. provides probably more scope for varied engineering work than that of any other unit. With an improved establishment it would be an excellent unit to serve in.

INTERNATIONAL COMMUNICATIONS.

By BRIG. GENERAL H. O. MANCE, C.B., C.M.G., D.S.O.
(*British Representative on the Provisional League of Nations Committee for Communications and Transit*).

AT the meeting of the Council of the League of Nations on the 18th of February, a resolution was adopted, at the instance of Senor Leon, the Spanish representative, inviting the International Commission of Enquiry on Freedom of Communications and Transit to act in an advisory capacity to the League of Nations, and particularly to prepare drafts of Conventions (international agreements) regarding transit questions, and to frame the scheme for a Permanent Organisation, which should eventually replace it, as an organ of the League.

The Organs of International Transit.—It is necessary to distinguish between the various bodies which have been concerned with international transit questions since the Armistice. First there was the "Commission of Ports, Waterways and Railways," which was part of the Peace Conference. When the work of this Commission was drawing to an end the French Government, anxious to secure continuity of collaboration by experts who had acquired a special knowledge of international problems, invited the Governments concerned to nominate these experts as their representatives on an "International Commission of Enquiry on Freedom of Communications and Transit," on which certain neutral states—Argentina, Holland, Spain and Switzerland, in the first place—as well as the Allies, were represented. This body has now, at the invitation of the League, been re-christened the "Provisional Committee for Communications and Transit" for the League of Nations; and it will, as mentioned above, be replaced by a Permanent Organisation of Transit for the League.

In an entirely separate category is the Communications Section of the Supreme Economic Council. This body deals mainly with reconstruction in Central Europe in contrast to the above-named bodies, which are more immediately concerned with matters arising out of the Peace Treaty, and with future international relations regarding Communication and Transit.

The Provisional Committee Begins Work.—The International Committee of Enquiry lost no time in giving effect to the request of the League of Nations Council. A special meeting was held on March 17th to consider the matter. M. Claveille, who was in the

chair, in opening the sitting, thanked the Governments who had recently accepted the invitation to associate themselves with the work, now in hand, of elaborating the new Charter, which will guarantee, in the League of Nations, Freedom of Communications and of Transit to the common benefit of all. He expressed his entire confidence that the United States of America, which had participated in the Commission at its commencement through so eminent a representative as the Hon. Henry White, would not fail shortly to resume its place on the Commission.

The Commission unanimously decided to accept the invitation of the Council of the League of Nations and to consider itself, from that date, as a Provisional Committee of Communications and Transit of the League of Nations.

The Commission then examined the draft report to the Council of the League on the permanent organisation of Communications and Transit in the League of Nations which was presented by the Secretary-General in the name of the Sub-Commission of Enquiry; and after a long discussion they unanimously adopted the recommendations, which will shortly be transmitted to the Council of the League of Nations.

In addition to the above report on the permanent organisation of Communications and Transit in the League of Nations, draft International Conventions on the subjects of "Freedom of Transit," "International Rivers" and "Ports" are under consideration, and will be submitted to the Permanent Organisation for Transit as soon as the latter is constituted.

The "Provisional Committee," as at present constituted, is an essentially expert body. M. Claveille, the former French Minister of Public Works, who acts as chairman, is a man of European reputation. The other members are all public officials of high standing, Ministers, Directors of Waterways and of State Railways, and legal and other technical experts. The countries represented on the Committee at their meeting on March 17th were: Belgium, British Empire, China, Czecho-Slovakia, Denmark, France, Greece, Holland, Italy, Japan, Jugo-Slavia, Norway, Poland, Rumania, Sweden and Switzerland.

*The Need for a Liberal Régime.**—The Charter of the League of Nations in questions of Transit is to be found in Article XXIII (e) of the Covenant, by which the Member States undertake to "*make provision to secure and maintain freedom of communications or of transit, and equitable treatment for the commerce of all Members of the League.*"

* The word *régime* is used by the French in this connection in a sense slightly different from its ordinary employment in English. It implies a policy as well as an administrative system.

It is, perhaps, not widely enough recognised how important it is to establish a liberal policy in this matter of "Freedom of Communications and Transit" from the point of view of world peace, and therefore of the League. Before the war this free régime existed, in a large measure, by general usage, and we had perhaps taken it for granted, and assumed that it would always continue. The war introduced new conditions. The needs of security and economy of rolling stock resulted in the imposition of a number of severe restrictions, which have not in all cases disappeared with the conclusion of peace.

Again, the war has created new States in which it is most desirable from the first to encourage an enlightened and uniform Communications and Transit policy, not only in their own economic interests, but to avoid conditions intolerable to their neighbours. If the members of the League recognise the importance of a liberal régime in these matters it will eliminate many potential causes of friction. It must, however, be admitted that these restrictions—vexatious though they may be—cannot all be entirely removed, at present, without inflicting hardships of another kind. The disrepair of the railways and rolling stock are so serious in some of the countries devastated by the war that Article XXIII (e) of the Covenant recognises exceptions in the interests of their own reconstruction. That is, however, a transitional state of things, and it in no way affects the principle that a liberal régime in transit questions is one of the chief interests of Europe; and hence, that the drafting of the International Conventions which are to establish such a régime is a primary need.

In addition to the general duty of encouraging Freedom of Transit, the League of Nations has specific duties laid on it by the Peace Treaties in regulating disputes as to the interpretation of the Articles of the Treaties dealing with ports, waterways and railways. The League may also, in this connection, recommend the revision of stipulations relating to a permanent administrative régime; and the Council of the League may revise certain of the stipulations at any time after five, or in some cases three years. The questions which may arise under these provisions are likely to be of a highly technical nature, and the League, therefore, needs the services of an expert advisory body.

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

PART IV.

WORK IN THE FIELD UNDER OTHER BRANCHES OF THE STAFF.

SECTION 5.

METEOROLOGICAL SECTION.

Formation and Organisation.—Different Natures of Work.—Forecasts for the General Staff.—Examples of actual forecasts.—Forecasts to R.F.C.—Rules for probability of fog.—Special wind reports for Night Flying and Bombing.—Gas operations.—Information for the Artillery.—Records.

1. *Formation and Organisation.*—The Meteorological Section, R.E. was formed on September 28th, 1915, in order to develop and co-ordinate the provision of scientific meteorological measurements and of weather forecasts, whose value had been proved in the Battle of Loos.

The Section as originally constituted, included a total *personnel* of 8 officers and 28 other ranks (of whom—2 officers were held in reserve in England).

Additions were made from time to time and in 1918 the total establishment was 16 officers and 82 other ranks (including 2 officers and 7 other ranks of the detachment with the Independent Air Force) : in 1918 also a Kite Balloon Section and an Aeroplane Flight were set aside by the R.A.F. solely for meteorological work under the direction of the Commandant of the Section : and 5 officers and about 20 other ranks *personnel* were attached from the Sound Ranging Section solely for Meteor work. In the Autumn of 1918 further additions, doubling the effective strength of the Section, were recognised as necessary to meet the increased demands for meteorological information, but before the necessary arrangements were completed the Armistice was signed.

2. *Different natures of Work.*—The work of the Section falls into 5 principal divisions :—

(*a*). Forecasts for the General Staff, and for all Formations, and the preparation of memoranda in the different meteorological questions arising in the War.

(*b*). Provision of forecasts, warnings and measurements of upper wind for the Royal Air Force, and to supply any reports or statistical information needed in connection with flying operations.

(*c*). Provision of observations and forecasts in connection with

offensive and defensive gas operations, and the preparation of memoranda on the conditions favourable for such operations.

(*d*). Provision of accurate values of wind and temperature for Artillery, due account being taken of the variations with height throughout the layers of the atmosphere traversed by shells.

(*e*). Establishment of observation posts for use in the reports referred to in (*a*)—(*d*), and for maintaining at the same time a record of the meteorological conditions in the British Army Area during the War.

3. *Forecasts for the General Staff.*—Rain was forecasted in the Battle of Loos, but at that time interest was concentrated on the wind owing to the vital importance of the latter for the use of gas in connection with the attack.

In June 1916 the importance of weather as distinct from wind was more definitely recognised, and throughout the Battle of the Somme personal advise was given regularly by telephone from the Meteorological Section Headquarters at Hesdin, and by the Meteorological Officer at Fourth Army Headquarters.

Charts were prepared daily in 1916 for the information of G.H.Q. and Armies, and from the beginning of 1917 similar charts were distributed to Corps so that Commanders could see for themselves what the general meteorological situation was, and how, in the opinion of experts, it was likely to develop during the ensuing 24 hours or more. These charts were supplementary to the ordinary forecasts sent by telegram three times daily, and normally referred to the period of 24 hours from the time of issue.

In addition to forecasts and advice about the weather of the immediate future in connection with operations, reports were also prepared of the average conditions of the different months of the year, and a set of monthly rainfall maps showing the normal distribution of rainfall in N.E. France and Flanders was made at the end of 1915, and copies of these maps were included in monthly reports subsequently issued. Copies of a section of each monthly map are attached. It may be noted that the renewal of the Battle of Ypres in September 1917, after its temporary cessation, was accelerated on account of such a report.

4. *Examples of Actual forecasts.*—A full account of the Meteorological advice given in connection with all the battles of the War would exceed the limits of space available, but the following may be noted.

July 19th, 1916.—"2 or 3 days fair weather anticipated and perhaps a week." The subsequent weather was rainless until August 9th or 10th: though the first week of the spell was mainly cloudy or overcast.

September 21st, 1916.—"Conditions on the whole favourable for fair weather continuing for 2 or 3 days."

September 22nd.—" Fair weather likely to last over 24th."

September 24th.—" Fair weather likely to last into 26th but doubtful if it will last over 26th." Actual fair weather lasted into 27th.

October 12th, 1916.—" To-morrow will probably be better than to-day: there is just a risk of overcast skies as the type is Westerly but indications are more favourable than they have been, and there will probably be very little rain." The next day was rainless, but there was much low cloud which interfered with aeroplane cooperation.

November 8th, 1916.—" Temporarily improved and quieter weather likely."

November 9th.—" Fair weather likely to last for a day or two."

November 10th.—" Indications more favourable for fair weather continuing."

November 11th.—" Quiet rainless weather likely to last over to-morrow."

November 13th.—" Probably no appreciable rain for another 2 or 3 days, and a fine day or two likely before quiet conditions break up."

November 16th.—" Fair weather probably continuing, but a risk of rain or snow is developing."

November 17th.—" Some rain or snow likely to-morrow." Rainless but mainly overcast, misty weather lasted from the 11th to the 14th: on the 15th the weather was brighter and on the 16th and 17th cloudless. Snow came on the morning of the 18th.

April 8th, 1917.—" Strong or high winds, and unsettled weather after to-day." The subsequent week was one of changeable weather with rain, sleet and snow, and fair intervals.

April 19th.—" Ridge of high pressure developing across France will probably bring fair weather, and perhaps a spell of it."

April 20th.—" A spell of fair weather is likely with North to East Winds, and a gradually rising temperature." Fair weather lasted from April 20th to May 4th.

July 30th, 1917.—" The anticyclone is advancing slowly, and will bring better weather, but the Northerly current in front of it is likely to maintain generally overcast weather with showers, perhaps thunderstorms, at least over to-day though a short bright interval is likely towards night." On this occasion the forecasts for the 24 hours were generally correct, but the outlook beyond 24 hours was wrong. The better weather did not come until after August 4th, after 4 days of heavy rainfall in the Northern Section of the British Army Area.

September 19th, 1917.—" Conditions are not settled, and there is a risk of thunderstorms: but apart from that the weather will probably be mainly fair in the immediate future. As regards the further outlook, the indications are not very definite one way or the other,

but as far as they go they are 10 to 9 in favour of fair weather." On the whole fair weather lasted from September 20th to October 3rd, though there was some rain on the night of September 19th—20th, and on the night of September 26th—27th: (less than 5 mm. in each case).

October 3rd, 1917. (*Morning*).—"The indications for the immediate future are not for much rain, but rather for cloud and drizzle or mist. Indications for the further outlook are against generally good weather: 10 to 8 against."

October 3rd, 5.30 *p.m.*—"Developments are not going favourably: I do not anticipate much rain before to-morrow, though the risk of it is rather bigger and high winds or gales are probable, sufficient to interfere with aeroplane work." The rainfall the next day amounted to about 6 mm.

November 18th, 1917.—"The anticyclone holds and will probably maintain rainless weather over Monday (20th). No indications yet of a break up."

November 19th.—"A depression in the N.W. is moving East and spreading: it will bring unsettled weather certainly in the North of England, probably in the South, and perhaps to-morrow here too. Instead of all the indications being favourable for quiet rainless weather as they have been for the past few days, this morning about half the indications point one way and half the other, though they are still against heavy rain for the next 24 hours." The wind forecasted for dawn on Nov. 20th. was W.S.W. 8 m.p.h. Actually the mean of measurements for 5 places from Ecurie to Roisel was between W.S.W. and S.W. by W. 8½ m.p.h. The weather was overcast and misty.

November 20th, 1917.—"The deep depression of yesterday has moved to the north of Norway, and its influence here will diminish. There are no indications of immediate stormy weather, but conditions are now favourable for depressions moving East from the Atlantic to affect this area so that the continuation of rainless weather is unlikely. It will be mild." It rained at night on the 20th, and slightly during the day and night on the 21st: in all about ¼ in.

August 6th, 1918.—"The depression will probably move E.S.E. and a Northerly type set in behind it. The weather is likely to continue generally unsettled with occasional rain, and perhaps hail, during the next 24 hours, though brighter intervals are probable." Also discussed weather of August with Fourth Army Commander, and added that it was not possible then to say if there would be a new depression following the receding one: that until definite indications of a general improvement came, it was not possible to say even that we should not have a generally unsettled August."

August 7th. 9.15 *a.m.*—"Conditions favourable for fair weather for a time: unless there is a marked fall in Western Ireland on the

next chart I think we shall probably get 2 or 3 days fair weather. I do not expect a marked fall."

August 7th, noon.—" Things look less favourable : more risk of a new depression bringing rain here : we expect generally fair weather for next 24 hours and the rain may not come at all : some indications are against its coming : the upper air has become warmer and that means that we cannot get heavy rain unless we get hot."

August 10th.—" Fair weather probably continuing over Monday (August 12th)." The weather continued fair until the night of August 16th.

November 12th.—" The anticyclone now centred over the British Isles will move further East and maintain moderate N.E. or East Winds, and generally fair weather. It will be mild in the day, but inland fog and frost are likely at night. The fair weather will probably continue at least 2 or 3 days." The weather continued fair until the 18th.

5. *Forecasts to R.F.C.*—At first reports consisted of forecasts twice daily and warnings of line squalls, *i.e.* storms which travel across the country like a wave with winds generally S.W. in front and N.W. behind. They are accompanied by a sudden rise in the barometer, a sudden fall of temperature, heavy squalls of wind, and rain or thunderstorms.

As most of the hangars faced towards the North, warnings of anticipated Northerly gales or even of a risk of Northerly gales were also issued.

The forecasts also included a statement of the anticipated direction and speed of the wind at 6,000 feet.

Early in 1916 a forecast of the anticipated amount of low cloud (cloud below 8,000 feet) in the ensuing afternoon was included in the forecasts issued in the morning to enable Squadron Commanders to make their arrangements accordingly. Arrangements were also made for the warning of all Units when thunderstorms were anticipated as they affected both aeroplanes and kite balloons, the latter even more than the former.

Warnings of fog were also issued.

The principal difficulty was to get the warnings in time to the Units concerned. For example, in August 1916 a thunderstorm warning was issued at 4.58 p.m. and a flight of 8 aeroplanes set out about 5.15 p.m. before the warning reached it. A heavy squall came up from the S.W. and 5 of the aeroplanes failed to return through it. The squall on this occasion was accompanied by thunder.

Again on August 29th, 1916, thunderstorms occurred in some places, and warnings were sent out at 3.30 p.m. From the evening chart it was seen that the stormy conditions were not over, and the following forecast was issued at 9.10 p.m. (Summer Time). " Urgent

and Important: Wind S.E. or South 15 m.p.h., probably changing to S.W. 25 m.p.h. with gusts of gale force: but risk of a brief Northerly gale in early morning. Mainly overcast with rain squalls: improving later." The gale came later in the night, and at one place did 50,000 francs' worth of damage to hangars and aeroplanes.

6. *Rules for Probability of Fog.*—An investigation of records for Kew Observatory had shown a relation between the difference between the dry and wet bulb thermometers and the subsequent development of night fog (as distinct from drifting fog). The records in Flanders were examined and the following rules deduced :—

The readings from wet and dry bulb thermometers can be used for indicating the probability of fog at night by means of the table below. For the six months April—September the following conclusions apply to the British Army Area :—

(*i*). Considerations apply only to nights when the sky is clear or not more than half-clouded.

(*ii*). Readings taken before 9 p.m. Summer Time are not of much value.

(*iii*). If the wind at 9 p.m. is above 8 m.p.h. at 5 feet above the ground, there is little risk of fog or mist.

(*iv*). If the wind at 9 p.m. is *nil, i.e.* dead calm, there is considerable risk of fog or mist whatever may be the thermometer readings.

(*v*). For winds above zero and below 8 m.p.h. at 9 p.m. the risk of fog is considerable if the temperature readings give in the enclosed diagram a point which comes below the red line.

(*vi*). Fogs are about twice as frequent between 2 a.m. and dawn as they are before 2 a.m.

(*vii*). These readings do not help to foretell fog which drifts over from the sea or the south; that can only be done by means of synoptic weather charts—when it can be done at all. The readings help only in the case of fogs which develop through the cooling of the lower air by radiation at night.

At 9 p.m. (Summer Time).

Dry bulb in degrees F.	Dry bulb minus Wet bulb in degrees & tenths.	Remarks.
40	0·8	Considerable risk of fog if the observed
45	1·1	difference dry minus wet is less than the
50	1·4	corresponding difference in this table.
55	1·8	Small risk of fog if the actual difference
60	2·1	is greater than the corresponding difference
65	2·5	in this table.

At 9 p.m. (Summer Time).

Dry bulb in degrees F.	Dry bulb minus Wet bulb in degrees & tenths.	Remarks.
70	2·9	*Example* 1.—At 9 p.m. sky nearly clear. Wind 5 m.p.h. Dry bulb 54°·6. Wet bulb 53°·4. Difference 1°·2. Difference from table for dry bulb 55 is 1°·8. Therefore as actual difference is less than tabular difference and wind is light and sky clear there is considerable risk of fog developing. *Example* 2.—At 9 p.m. sky clear. Wind 12 m.p.h. Practically no risk of mist or fog, wind too strong. *Example* 3.—Sky half clouded. Wind 4 m.p.h. Dry bulb 58°·3. Wet bulb 53°·7. Difference 4°·6. This is well above the tabular difference and there is little risk of fog.

7. *Special Wind Reports for Night flying and Bombing.*—With the development of night flying it became necessary to navigate aeroplanes by compass, and due allowance had to be made for the wind at the height at which the flight was made. Reports of wind for this purpose began to be sent to night-flying squadrons in August 1917, and continued until the end of the War. They came to be known as "Sleep-wind Reports." They were obtained in the same way as the winds for the Artillery, by the use of pilot balloons, and in fact the observations for the hours common to both sets of reports served both purposes.

Some indication of the accuracy with which the average wind over distances up to 50 miles can be obtained is furnished incidentally by quite a different operation which was carried out in June 1918. A man-carrying balloon started from near Verdun and landed at Grosbous near Luxembourg, 50 miles away in a direction N.29°E.: the forecasted wind at 3,500 feet based on pilot balloon observations was S.30°W., *i.e.* the balloon drifted to within 1° of the forecasted direction.

It is therefore clear that for night flights over short distances there need be no error due to the wind if pilot balloon ascents are possible to the height at which the flight will be made, and if they are coordinated and due allowance made by an expert meteorologist for impending changes.

With the development of night flying it also became necessary to issue special forecasts for short periods to enable the night flying squadrons to take advantage of all favourable opportunities and to avoid sending out the aeroplanes when fog, low cloud or storms are likely to develop before the completion of the raid. At first a special forecast was issued by priority telegram about 5 p.m. but in

1918 it was arranged to issue forecasts in code by wireless at 5 p.m. and 7 p.m. These forecasts combined with the 'sleep-wind' reports, and combined too with the personal advice of Meteorological Officers given by telephone direct to the Squadron Commander contributed considerably to the success of the night bombing operations, and the comparative freedom of the night flying squadrons from untoward accidents.

As day bombing developed too during 1918 arrangements were made for issuing regularly 3 or 4 times each day reports of the wind at greater heights up to 20,000 feet. Direct observations were often not possible to that height but on such occasions the Meteorological expert at Headquarters is in a much better position than the local Unit Commander to estimate from charts and from the information available for England and France what the wind at the greater altitudes will be.

As the wind at 15,000 or 20,000 feet may reach 70 or 80 miles per hour when the wind at the surface or at 1,000 feet above it is only 20 to 30 m.p.h., it is readily recognised how important a knowledge of the upper wind is both for estimating the distance which the aeroplane can fly and return in the time available, and for enabling bombs to be dropped from great altitudes with reasonable prospect of falling near the targets.

NOTE.—If an aeroplane speed is V miles per hour, and the speed of the wind is W miles per hour in the same direction as the objective, then a total time t hours is available for going and returning and the distance which can be reached is—

$$t\ (V^2-W^2)/2V.$$

For example if $V = 100$ m.p.h.

$W = 0$.

$t = 4$ hours.

then— $d = 200$ miles,

but if instead of being zero, $W = 70$ m.p.h.

$d = 102$ miles,

or just about half the distance for no wind.

It is of course, a matter of indifference whether the wind is with the pilot on his outward or on his return journey, if the flight is made at one height. But if the flight can be made at different heights going and returning, advantage can be taken of this.

8. *Gas operations.*—In gas operations, meteorological advice is essential if the operations are (1) to be carried through without avoidable risk to our own troops (2) to secure maximum effectiveness.

The advice given is based partly on general charts which indicate the general changes likely to occur in the wind for a period of about 24 hours, and partly on local observations and a knowledge of the orography of the region concerned.

Meteorological advice for offensive gas operations was first given in connection with the Battle of Loos in September 1915. Prior to the battle a forecast based upon the general chart of observations at 1 p.m. had been made each afternoon about 6.30 p.m. stating whether the wind next morning would be favourable or unfavourable: and the degree of confidence of the forecast had also been indicated; the forecast was corrected or confirmed about 9 p.m. by another based on the chart of 6 p.m. observations.

In the afternoon of September 24th, 1915 the indications were rather for a wind on the unfavourable side of the limiting direction; although the changes expected would be generally towards the favourable; "just a chance" expressed things briefly.

The later chart was much more favourable for the change to a favourable direction to come in time. Actually the wind changed to West in the night of the 24th—25th September but backed again to S.W. after midnight, and after 8 a.m. changed to south and slightly to the east of south.

Gas attacks in 1915—1916 were made chiefly by discharging cylinders so that the gas started on its course from our own lines. This naturally involved more risk of accidents and a steady wind was required to ensure the gas getting away without temporary eddies back to our trenches. It also made it very difficult to have gas attacks in connection with pre-arranged operations.

With the system of projectors used subsequently much lighter winds could be used: the culminating point being reached in March 1918, when projectors were discharged on Third Army front with a generally unfavourable wind which was turned into a calm or slight favourable wind by the gravitational effect of the night cooling on the eastern side of the Boulogne—St. Quentin Ridge.

During 1917—1918 also gas shelling was much used, and special forecasts were made each afternoon and evening to indicate what the wind conditions would be near the surface at 7 p.m., midnight and 4 a.m.

On occasions too, cylinders were run up in railway trucks and discharged without being unloaded, the forward trenches being cleared for the discharges. For such cases a steady wind was required rather stronger than for the earlier less intense discharge. On one occasion in 1918, 6,000 cylinders, 190 tons, were discharged in a single night on First Army front.

Early in 1918 too, statistical reports were prepared at the request of the Director of Gas Services for the information of the Ministry of Munitions.

Already in 1916 diagrams had been prepared showing for each month of the year the frequency of winds from different points of the compass, the winds selected being those above 4 and under 15 m.p.h. These diagrams were printed on the back of the daily

weather charts. Similar diagrams were prepared for 1915—1917 and tables showing the number of spells of favourable and unfavourable winds lasting for 2 days, 3 days, 4 days, up to 9 days. The tables were accompanied by diagrams and notes explaining the conditions under which favourable winds occurred and the method by which these conditions were foreseen.

9. *Information for the Artillery.*—The wind for the Artillery has been obtained primarily by the observation of small free balloons ascending at a known rate. The altitude and azimuth of the balloon is read every minute and the position of the balloon calculated therefrom. The horizontal drift gives the wind in the layer passed through. For occasions when the weather does not permit of observation, the wind is computed from the general charts of pressure distribution, allowance being made for the effect of the distribution of temperature on the normal wind arising from the distribution of pressure; this allowance is estimated from the general charts, as the temperature distribution at different heights is rarely known with sufficient detail to permit of routine numerical calculation. The motion of the clouds is also taken into account.

In 1918 supplementary methods were used.

(*a*). Observations from a kite balloon: the importance of making wind measurements at a distance below the balloon greater than its diameter was established in these observations.

(*b*). Observations of the drift of smoke bursts from anti-aircraft shells bursting at known heights. The drift is observed in a mirror and a simple calculation gives the wind at the height of the burst.

(*c*). Observations of the drift of balloons rising at a known rate and carrying charges bursting at known times. The observation is made by sound ranging on the burst. This method is due to the French Military Meteorological Service.

Initially the winds at different heights were telegraphed to the Artillery, but as the total effect of the wind on a shell is a complex sum of the winds at all heights up to the top of the trajectory it was arranged in January 1917 that the necessary computation should be made by the Meteorological Section—all trajectories with the same time of flight have also approximately the same weight, and approximately also the same effective wind—the winds issued by the Meteorological Section were computed for a series of times of flight, at first up to 50 seconds and later up to 70 seconds.

Improvements in the fundamental constants, on which the computations are based, were made in 1918, and for centrally issued information applicable to varied guns and ranges the method now in use leaves little to be desired. But ultimately improvements will be effected by each battery using its own fundamental constants

and computing the effective wind from the actual wind in the different layers. This will permit of allowance being made for the two principal effects at present disregarded, viz. the difference between the fundamental constants for cross winds and head winds, and the effect of the change in the position of the "velocity of sound region."

Put briefly the present practice is for the meteorologist to perform essentially Artillery computations on the results of his meteorological observations. The ideal plan would be for the meteorologist to confine himself to the meteorology, and leave the Artillery *personnel* to deal with all the Artillery computations.

Temperature.—The fundamental values are obtained partly from Aeroplane and Kite Balloon observations, and partly by estimation taking into account the results of experience, and the well established physical conditions governing the rate of decrease of temperature with height in a turbulent atmosphere.

The values of the temperature at different heights are used by the meteorologist to compute equivalent temperatures for different times of flight, directly applicable by the Artillery to the range tables.

In computing the approximate temperature allowance is made for the effect of temperature on the pressure at different heights; this was done in France in July 1917, and is believed to have been the first application of this method in any of the Allied Armies. It simplifies very much the application of the meteorological facts.

Barometer.—As this varies rapidly with height and in a definite way, the scientific method is to use an instrument at the battery or group headquarters. The aneroid barometer is quite suitable for all practical purposes if it is properly treated, and is compared regularly with the corrected values of a mercury barometer. If readings of the aneroid are taken at fixed times the height above M.S.L. noted, and the results forwarded to a meteorological headquarters, the comparison can be made with the usual charts of pressure distribution. This method was used for some time, but was ultimately replaced by the existing practice which is for the mean sea level value of the barometer to be furnished every 4 hours in the Meteor telegram, and for the batteries to deduce the value appropriate for their shooting by the approximate rule: "If the height of the battery above mean sea level is 'Z' metres, then $\frac{Z}{3}$ is the number of hundredths of an inch to be subtracted from the sea level value of the barometer to give the value at battery level."

The actual practice of the meteorologist at Army H.Q. is to correct his barometer reading for the average diurnal variation to get a value applicable 3 hours later: and he superposes on that any changes in time which he anticipates from his charts and barograph.

Information as to the upper wind was also supplied regularly to

Sound-ranging Sections from the beginning of 1917: this was practically discontinued temporarily at the beginning of 1918 owing to the establishment of special wind sections for sound-ranging purposes. But after the German offensive in March, 1918, the practice was resumed and hourly reports were issued whenever conditions were favourable for sound-ranging. Values of temperature were also added because the effect of temperature upon the "location" of a gun deduced from the sound-ranging records, though considerably less than that of wind, is still appreciable.

Experience in 1918 showed that by a proper use of the meteor values, results could be obtained as accurate as those found by the use of the special Sound-ranging wind sections.

It should be added that the proper use of meteor values for sound-ranging was due to the work of the "Wind Sections" of the Field Survey Battalions R.E. Without the large amount of data collected by these Sections it is probable that we should still be ignorant of many facts affecting the *effective* wind and temperature as regards the behaviour of sound waves.

10. *Records*—In the Summer of 1915 regular observations were made 6 times daily at St. Omer of barometer, wind, temperature, weather and humidity: rainfall was measured twice daily.

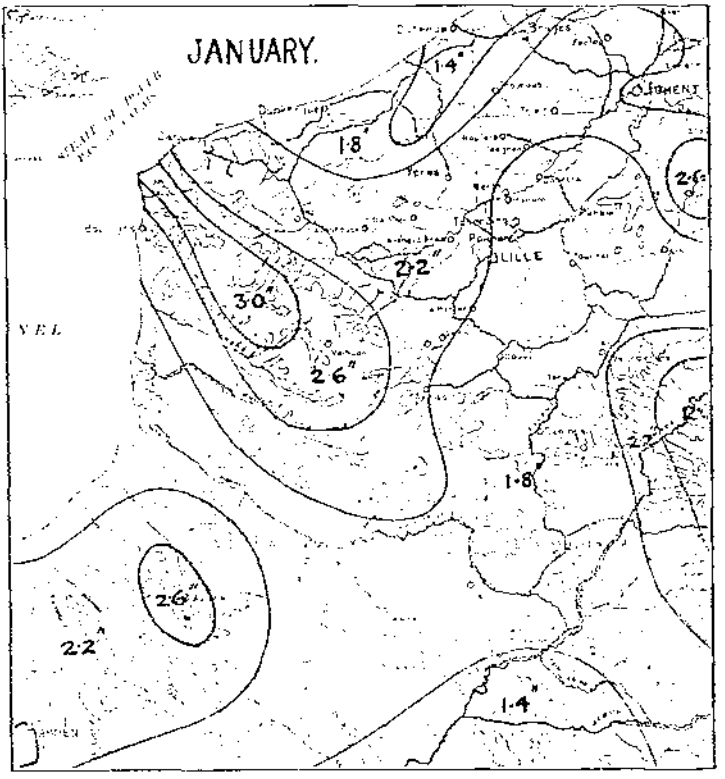
At the forward stations the observations were at first only of wind and weather but barometers and thermometers and rainguages were placed at 3 selected places and gradually the number of places with thermometers and raingauges was increased to give a more accurate representation of the variations over the area occupied by the Armies.

The results of the observations at the four principal hours 1 a.m., 7 a.m., 1 p.m., 6 p.m. were charted daily, and these charts constitute a readily accessible source for information about the wind and weather.

As time went on the number of reports was increased and information about the form of cloud, the amount of cloud, the visibility and the humidity was included for approximately every two hours day and night. Also the whole of the information was used in the preparation of a brief statement of the wind and weather of each day in the form of a weather diary. This diary was supplemented by tables giving detailed values of temperature and rainfall and was issued at the end of each month.

Pilot balloon ascents also became more numerous, and the records of these constitute a valuable source of information for all researches into the conditions prevailing in the upper air.

In addition to the use of the records for reference and research, they were also used from time to time for the supply of information as to rainfall for the guidance of those in charge of mining operations: for information about frost and its effect, in conjunction with wind,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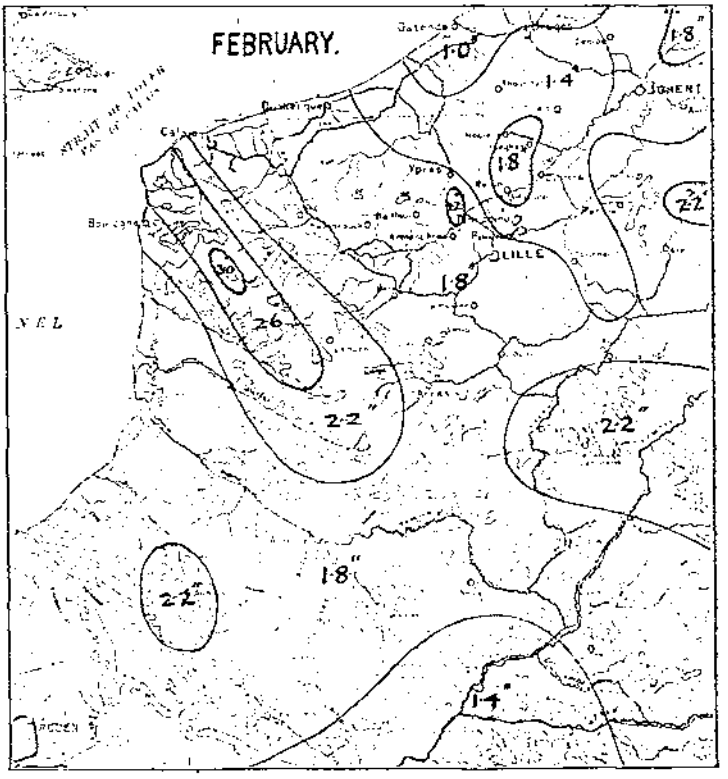
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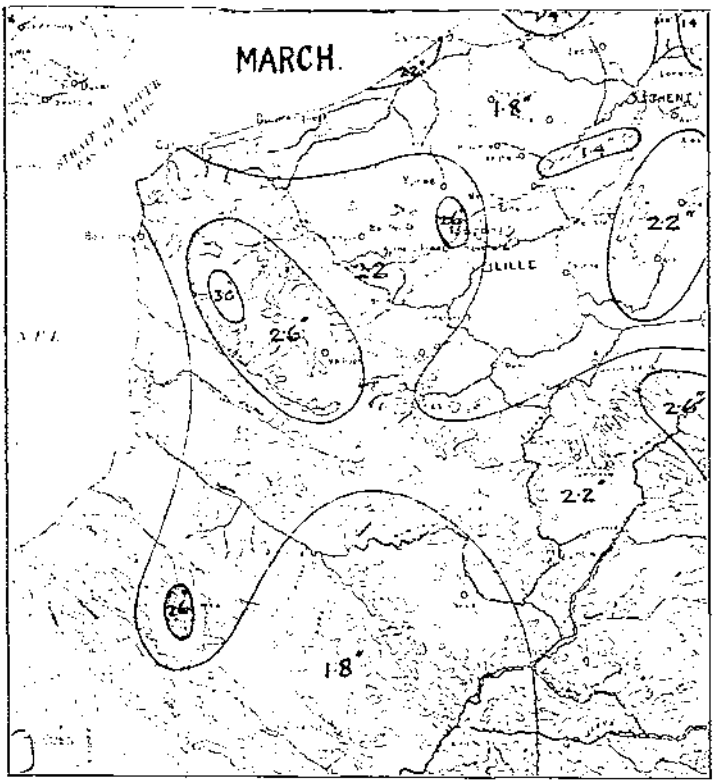
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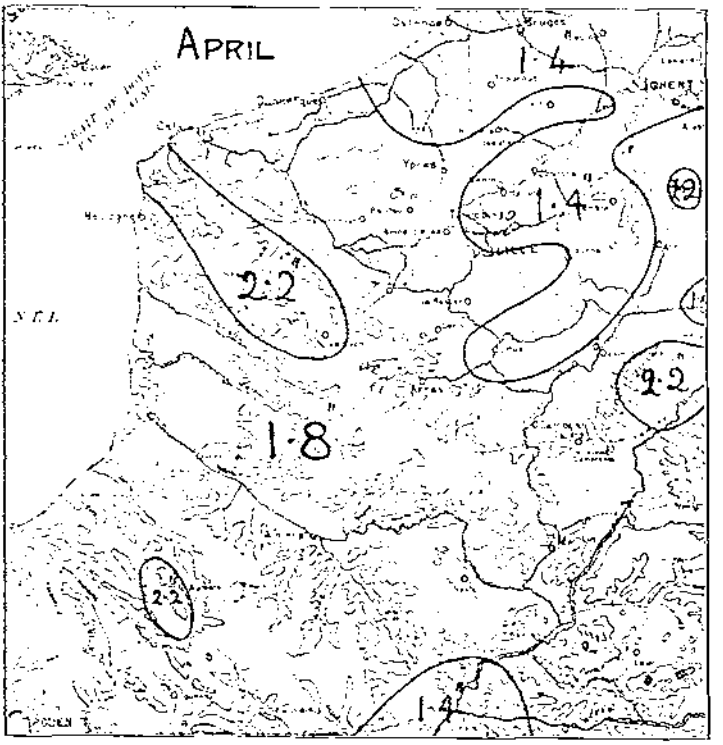
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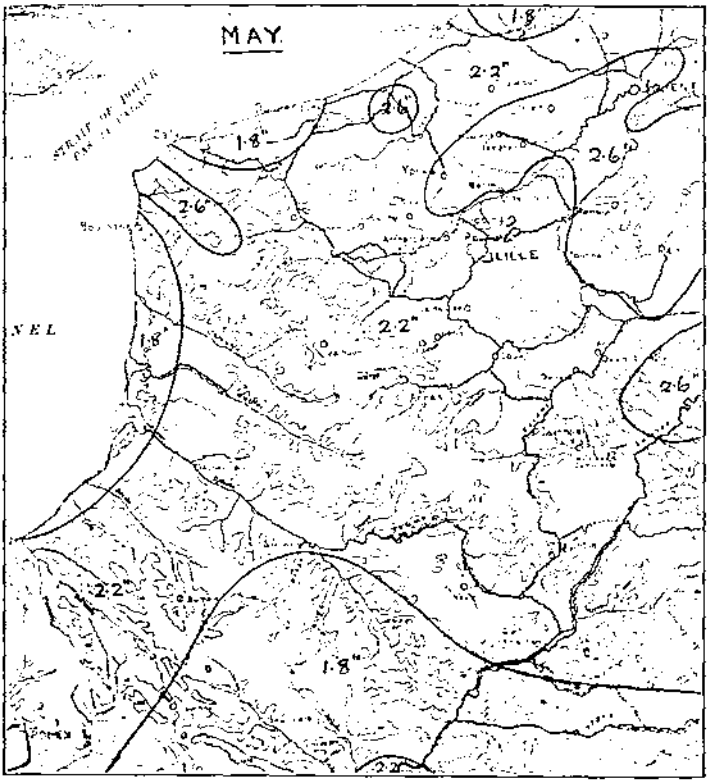
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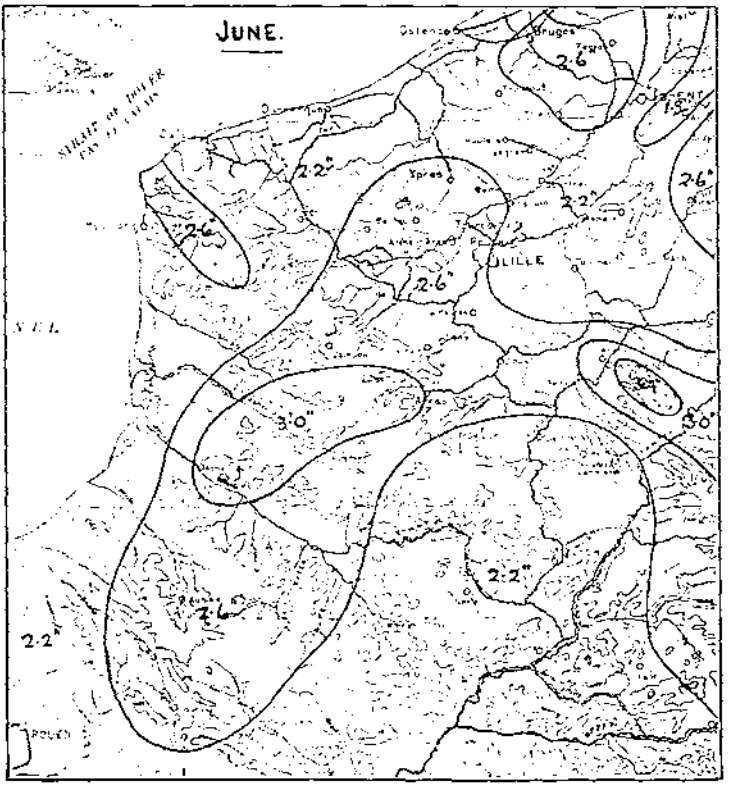
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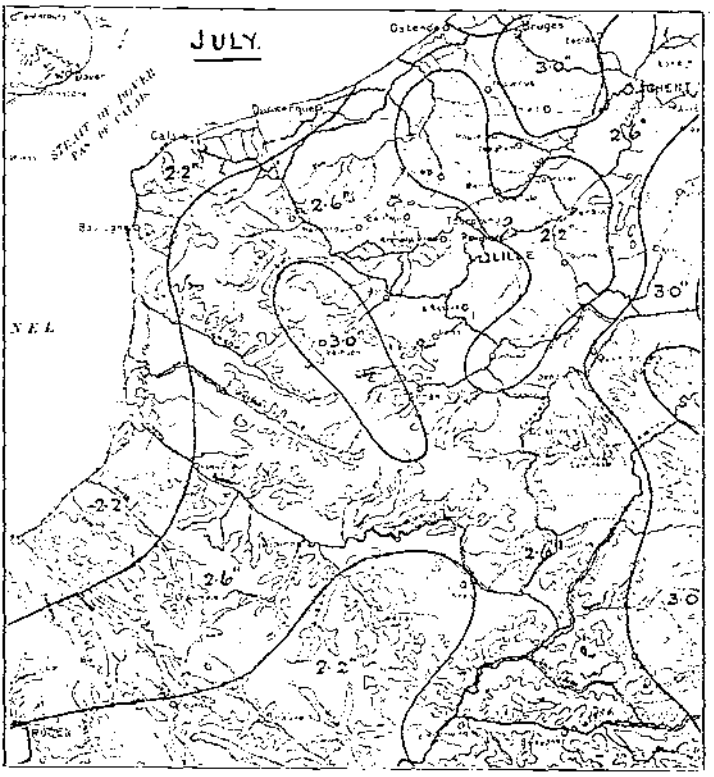
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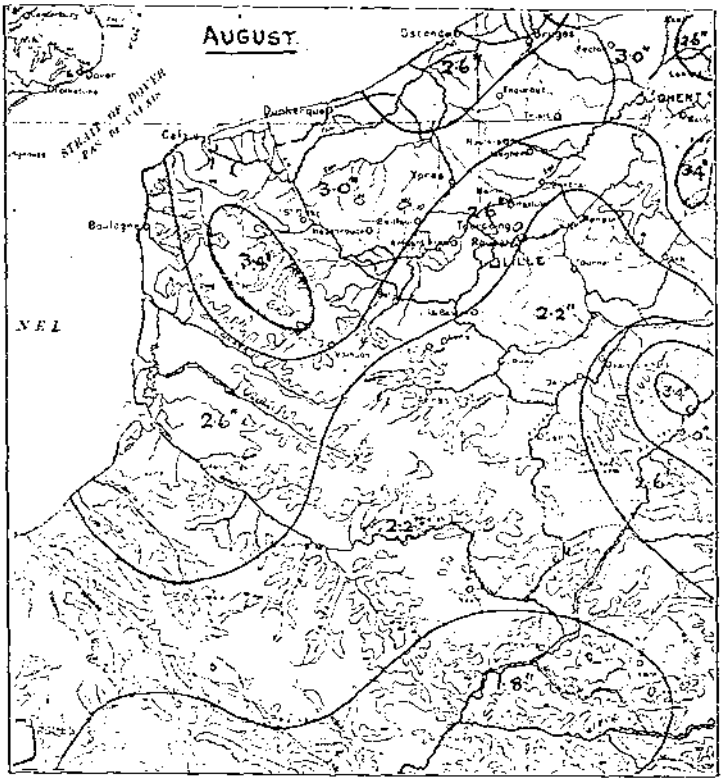
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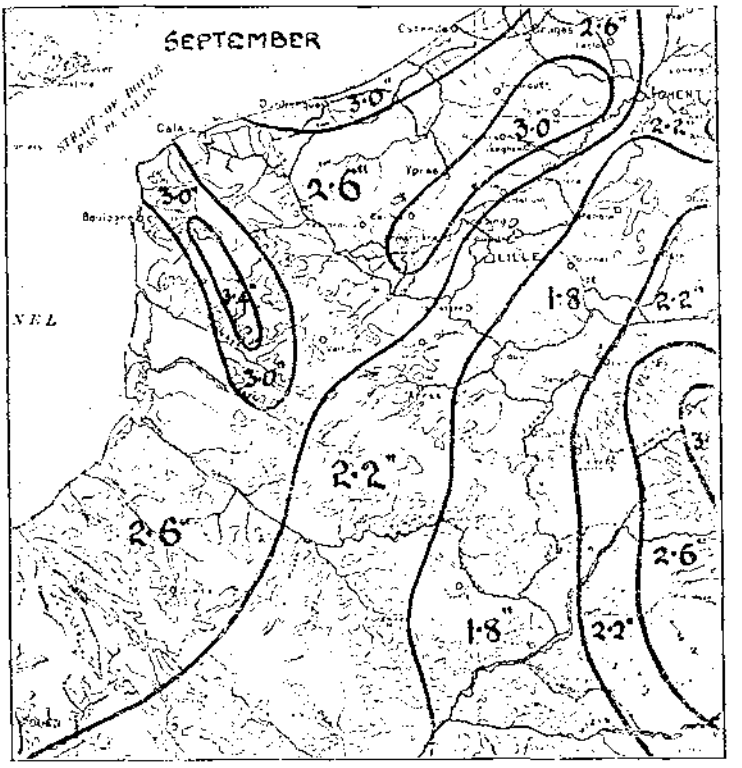
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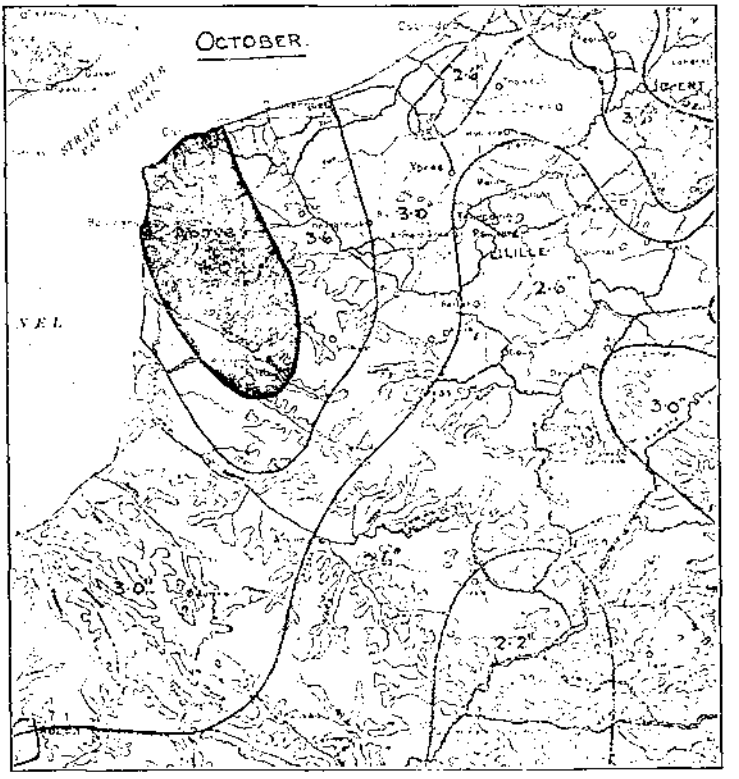
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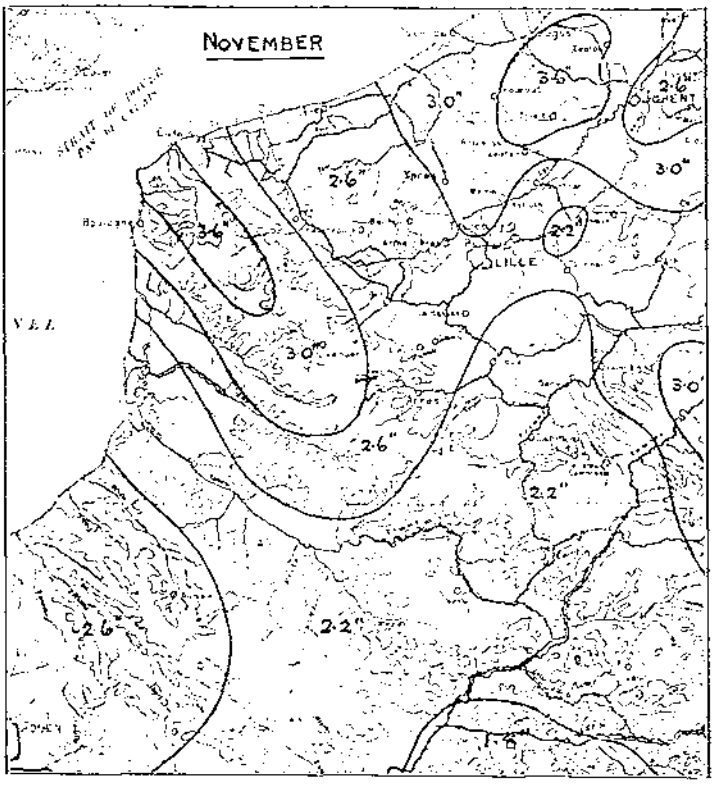
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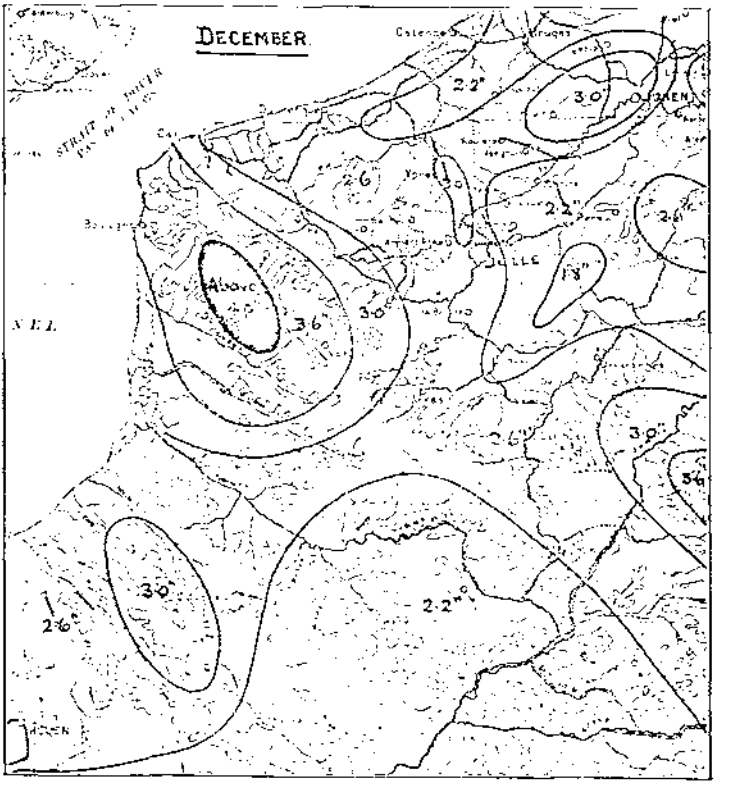
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upon radiators and machinery for the guidance of Transport and other officers: for information about gales in connection with claims for damages.

Among other miscellaneous purposes for which meteorological information was supplied may be mentioned:—

(*a*). Warnings of frost or snow for the information of Transport Services.

(*b*). Warnings of thaw, for the guidance of those responsible for the issue of regulations about traffic, known as "thaw precautions."

(*c*). Information about upper wind in connection with the dispatch of pigeons and literature by balloons drifting over the enemy lines; on two or three occasions also similar information was supplied for use with man-carrying balloons.

(*d*). Forecasts of weather and visibility as regards fitness for photographic work.

(*e*). Information as to the probable weather conditions present and future over Belgium, Heligoland, Lower Rhine and Upper Rhine, for the guidance of the Intelligence Branch of the Staff.

(Previous articles under the heading of "The Work of the Royal Engineers during the European War, 1914—19" appeared in the *R.E. Journals* of September, 1919 (Introduction p. 105; Anti-Aircraft Searchlights, France, p. 106; Postal Section—Army Postal Services, p. 114), October (Bridging, Chapter I., p. 162), November (Bridging, Chapter II., p. 200), December (Bridging, Chapter III., p. 261), January 1920 (Bridging, Chapter III., *concluded*), p. 13), February (Bridging, Chapter IV., p. 61; Organization of Engineer Intelligence and Information, p. 79), March (Bridging, Chapter V., p. 149), April (Bridging, Appendix—Formation of R.E. Bridging School. p. 189), May (Work in the Field under Various Branches of the Staff—Forestry, p. 247). Copies of these Journals may be obtained through the usual channels.)

DESCRIPTIVE RECORD OF WORK DONE BY 85th FIELD COMPANY, R.E. DURING RECONNAISSANCE IN FORCE ACROSS THE STRUMA IN SEPTEMBER, 1916.

DURING the month of September 1916 several reconnaissances in force were made across the Struma and in almost every case boat-rafts made and worked by R.E's were used.

The first reconnaissance in which the 85th Company took part was on the 15th of the month.

The 31st Brigade were to cross at Zouave Ford and 29th Brigade at Chasseur Island, and a small flank force at Gudeli Ferry.

At Zouave Ford four boat-rafts were constructed about a mile back from the river so that the sound of hammering would not carry to the Bulgar lines. These boat-rafts were simply wooden frame-works, 16 feet by 12 feet and 3 feet deep, which were covered by 30 feet by 30 feet tarpaulins, the flooring being made of corrugated iron. During the night they were carried down to the river, and in the early morning two men swam across with a cable and put in an anchorage about 50 yards up-stream. The four rafts were fastened in a tail and the whole party, about 600 strong, was got across in two trips without a hitch.

At Chasseur Island one boat-raft had been constructed and was similarly worked by an upstream rope. This raft carried over roughly 400 men in an hour.

At Gudeli Ferry a small raft, about six feet square, was constructed, which also operated successfully.

The Bulgar artillery searched for these crossing places but never got within 200 yards of the crossing until about an hour after all the troops were safely back, when a barrage was put down on Zouave Ford.

On the 23rd, a reconnaissance was made on the right by the 180th Mounted Brigade in co-operation with the French. The main crossing was made at Suha-banga, the French crossing being made at Fitoki.

Two sections of 85th Field Company were lent to construct and work raft-boats in conjunction with the 1/2nd Wessex Company. Four boat-rafts 16' by 12' were constructed on the 22nd at Suha-banga, about two miles from the river, and carried down on wagons during the night.

During the early morning four parallel cables were run out across the stream, about ten yards apart, and one boat was connected to each cable by a ring, two tow ropes being used to pull the rafts to either shore, and by midday everything was ready, landing stages

having been made at each bank for all the boats. Two of the boats were handed over to 1/2nd Wessex Company to operate and the other two were worked by 85th Field Company. By 1.30 p.m all the troops were across, each boat having carried over about 200 men. The position of the crossing place was not located by the Bulgar artillery and not a single shell landed in the vicinity.

About 3 p.m. the river started to rise rapidly, and by 6 o'clock it had risen about three feet, making the landing places inaccessible. This was overcome by cutting large quantities of brush-wood and constructing a floating platform. All the cables held in spite of the very considerable extra strain put on them, caused by the increase in speed of the current, and all troops had been safely brought back by 9 p.m., by which time the river had risen nearly five feet.

During the night of the 24th word was received that the rafts of the French had been swept away, leaving a hundred men on the far side of the river, and, that two men had been drowned in trying to swim across, having got caught up in the barbed wire, which had been put in the bed of the river at the ford some time before when the river was low. As they had no engineers they called upon the 85th Field Company, who were nearest to them, to help. A small detachment was sent down with materials for a boat-raft and at the same time a message was sent informing them that the rafts at Suhabanja would be put in operation if they could work up to that point.

On arrival at Fitoki it was found that a large backwater about half-a-mile wide had been formed by the rise in the river, and this had to be crossed to get to the bund on the bank which was still above water. A cable was run out across the backwater, and communication established with the bund by means of a small boat.

A small raft-boat, six feet square and three feet deep, was constructed, covered by a tarpaulin, and this was towed out to the bund. The distance to cross to the other bank was about 80 yards and the current was running about nine knots. Fortunately a telephone wire left by a F.O.O. on the previous day was found about three hundred yards upstream and by means of this a cable was got across. As there was only one other long cable left the boat had to be pulled across by the crew on this cable. As the space in the boat-raft was very limited only four could haul on the rope, and it took two hours to get the boat to the other side, the second cable being paid out behind. Once across the matter was more or less simple, the boat being connected to the main cable by a snatch block and the second cable tied at its centre to the boat was long enough to allow for a hauling party on both banks. The French were brought back twelve at a time and the cable at the far bank was released and tied to the boat on the final trip, which was safely accomplished, the last load arriving at the bund just before dark.

BOOKS ON ENGINEERING, TELEGRAPHY AND TELEPHONY, AND RAILWAYS.

ENGINEERING.

The following may be added to the list of Books on Engineering recommended to officers in the *R.E. Journal*, November, 1919 :—

STRUCTURAL ENGINEERING.—By J. Husband, Assoc. M. & Watts' Medallist Inst. C.E., etc., etc., Head of the Civil Engineering Department of the University of Sheffield, and W. Harby, sometime Assistant in the Civil Engineering Dept. of the University of Sheffield. Published by Longmans, Green & Co.

This is one of the best books of its kind that we have seen. Without being too bulky or detailed, it contains in readily accessible form, a great deal of valuable information. The methods of design are modern and are treated in a very thorough and practical way, and are easy to follow.

Chapter I. deals with Materials. Chapter II. with Loads and Working Stresses, and includes Tables of Traffic Loads on Highway Bridges, and equivalent Distributed Loads on Railway Bridges for varying spans; Table of Stones' "Range" Formulæ, etc. Chapter III., Bending Moments and Shearing Force. Chapter IV., Beams. Chapter V., Columns and Struts. Chapter VI. gives the design in detail of a Plate Girder. Chapter VII., Lattice Girders. Chapter VIII., Deflection, including the deflection and horizontal deflection of braced girders by the method of "Work." Chapter IX., Roofs. Chapter X., Miscellaneous and Tall Buildings. Chapter XI., Masonry and Masonry Structures, Foundations, Gravity Dams, Arches (rigid and hinged), and Tall Chimneys.

MATERIALS.

JOHNSON'S MATERIALS OF CONSTRUCTION.—Rewritten and edited by F. E. Turneaure. 1919. 5th Edition. Published by John Wiley & Sons, New York (Chapman & Hall, London).

The authors aim to provide essential information concerning the sources and manufacture of the principal Materials of Construction; to give carefully selected data covering the more important mechanical and physical Properties and the influences of various factors upon these properties; to show the causes of defects and variations and how they may be discovered; to furnish an acquaintance with the technique of testing materials; and to present some of the more general uses of the materials.

Chapter I. gives a synopsis of the Principles of Mechanics of Materials. Chapters II. and III. deal with Machines and Appliances for Testing, the Technique of Testing and the Utility of the various Tests. Chapters IV.—VI. consider the Characteristics, Methods of Identification, Properties and Uses of the more Important Woods, also Causes of Decay and Means of Preservation. Chapter VII. treats of the Important Stones, their Constitution, Durability, and Properties. Chapter VIII. covers the Manufacture and Testing of Structural Clay Products, together with their Mechanical Properties and Uses. Chapters IX.—XII. deal with the Nature, Manufacture, Methods of Testing and Properties of Hydraulic Cements, Limes and Plasters. Chapters XIII.—XV. fully describe Methods of Making Mortar, Concrete, and Concrete Products, also the Properties and Uses of these Materials. Chapter XVI. provides a brief summary of the Utility of the Principal Metals, their Ores, and Fundamental Considerations governing their Extraction. Chapters XVII. to XIX. treat of the Reduction of Iron from its Ores and subsequent Purification and Fabrication. Chapters XX. and XXI. deal with the Formation and Structure of Alloys in general, and the Constitution of Iron and Steel. Chapters XXII.—XXIV. are devoted to a discussion of the Properties and Uses of Wrought Iron, Steel, and Alloy Steels. Chapter XXV. takes up the Manufacture, Moulding, Constitution, and Properties of Cast Iron and Malleable Cast Iron. Chapter XXVI. treats of the Production, Properties and Uses of Copper, Zinc, Aluminium, Lead, Tin, Nickel and their alloys. Chapters XXVII. to XXIX. cover the effects of Temperature on Metals, the Causes and Effects of Fatigue, and the Corrosion and Protection of Metals.

The book is thoroughly up to date and contains much valuable information on the latest processes, tests, and specifications applied in the U.S.A., and is strongly recommended *for study* and practical reference.

FOUNDATIONS.

FOUNDATIONS OF BRIDGES AND BUILDINGS.—By H. S. Jacoby and R. P. Davis. 1914. Published by McGraw-Hill Book Co., New York (Hill Publishing Co., Ltd., London).

Chapters I.—III. deal very fully with Timber Piles, Pile Driving and Bearing Power. Chapter IV. describes various types of Concrete Piles, their Relative Advantages, Cost, Bearing Powers, and Method of Driving. Chapter V., Metal and Sheet Piles. Chapter VI., Cofferdams. Chapter VII., Box and Open Caissons. Chapters VIII—X., Pneumatic Caissons for Bridges. Chapter XI., Pier Foundations in Open Wells. Chapter XII., Ordinary Bridge Piers. Chapter XIII., Cylinder and Pivot Piers. Chapter XIV., Bridge Abutments. Chapter XV., Spread Foundations. Chapter XVI., Underpinning Buildings. Chapter XVII., Investigation of Subsoil and Loading Tests. Chapter XVIII., Pneumatic Caisson Practice. Chapter XIX. References to Engineering Literature.

The theory given in this book is everywhere very fully supported, or its limitations shown, by records of experience and observations of engineers and contractors representing the best American practice. The subject of timber piles is especially fully treated on the grounds of their extensive use in the U.S.A. for rapid and economical construction chiefly in connection with railway and marine work. The great change in the design of foundations, piers and abutments, effected by the application of reinforced concrete is well brought out and emphasized. Specifications, labour and cost analyses, in each branch of the subject, add largely to the value of the book. The book is strongly recommended to any officers who may have heavy or difficult foundations to deal with.

FOUNDATIONS AND MACHINERY FIXING.—By F. H. Davies, A.M.I.E.E. Constable & Co. Price 2/-.

Deals with the Design and Construction of Foundations for Machinery of various types.

Chapters I. and II., Foundations Generally. Chapter III., Design. The Proportion of Foundations for Engines, Turbines, and Dynamos. Chapter IV., Materials for Foundations. Chapter V., Holding-down Bolts and Anchor Plates. Chapter VI. and VII., Practical Construction. Chapter VIII., Vibration, its causes and effects. Chapter IX., Methods of Isolating Machinery, to prevent the Vibration affecting the neighbourhood. Chapter X., Fixing of Electric Motors.

ROADS.

HANDBOOK FOR HIGHWAY ENGINEERS.—By W. G. Harger, C.E. and E. A. Bonney, Supervising Engineer, N.Y. State Dept. of Highways. Published by McGraw-Hill Book Co., New York (Hill Publishing Co., London). 1919.

Part I.—Principles of Design:—Grades and Alignment; Sections; Drainage; Earth, Sand-Clay, and Gravel Roads; Gravel and Stone Foundation Courses; Macadam Top Courses and Rigid Pavements; Maintenance; Minor Points; Materials.

Part II.—Practice of Design and Construction:—Preliminary Investigations; Survey; Photography, Notes on Camp Equipment, etc.; Office Practice; Cost Data and Estimates; Notes on Inspection.

Part III.—Specifications:—General Outline; Examples of Current Practice; Materials; Construction Methods; Road-bridge Specificatinns.

Part IV.—General Tables and Formulæ.

The purpose of the book is to collect in a compact and convenient form (pocket size), information ordinarily required in the field and office practice of road design and construction. The book is designed to meet the requirements of both experienced and inexperienced road engineers. The possibilities of economy without impairing the efficiency of the road are emphasized.

The authors are not advocates of rigid concrete surfaces, and consequently the subject is only briefly dealt with, the latest practice in concrete road-making being omitted. With this limitation (omission to deal fully with concrete roads), the book is recommended as providing much useful information.

TELEGRAPHY AND TELEPHONY.

The best books at the moment on Telegraphy, Telephony and construction, etc. are published by the Post Office. The following have recently been presented to the Corps Library by the Engineer-in-Chief, G.P.O.:—

CONSTRUCTION OF AERIAL LINES ON ROADS AND RAILWAYS. 1911.

TESTING AND JOINTING OF CABLES REQUIRED FOR SUPERPOSED TELEGRAPHIC WORKING. 1919.

CONSTRUCTION OF UNDERGROUND TELEGRAPH AND TELEPHONE LINES. 1919.

WIRING OF BUILDINGS. 1912.

Other good books are:—

Herbert's TELEGRAPHY (revised edition).

J. G. Hills' TELEPHONE TRANSMISSION.

WIRELESS TELEGRAPHY.

The following books on Wireless Telegraphy and Telephony are recommended :—

HANDBOOK OF WIRELESS TELEGRAPHY AND TELEPHONY.—By Dr. W. Eccles.
TEXT BOOK OF WIRELESS TELEGRAPHY. Vol. I., General Theory and Practice. Vol. II., Valves and Valve Apparatus.—By Rupert Stanley, B.A., M.I.E.E. (Longmans, Green & Co.).
TELEPHONY WITHOUT WIRES.—By P. R. Coursey, B.Sc. (The Wireless Press).
THE ELEMENTARY PRINCIPLES OF WIRELESS TELEGRAPHY.—By R. D. Bangay (The Wireless Press).
THE WIRELESS TELEGRAPHISTS' POCKET BOOK.—By J. A. Fleming, M.A., D.Sc. (The Wireless Press).
THE PRINCIPLES OF ELECTRIC WAVE TELEGRAPHY AND TELEPHONY.—By J. A. Fleming, M.A., D.Sc. (The Wireless Press).

RAILWAYS.

The following is a list of books on Railway Engineering, Operating, Goods Working, Locomotives, and Railway Signalling. The list is obviously by no means exhaustive, and there has only been included such a selection as is most likely to be of use to R.E. Officers. It should be noted that no books on Machine Tools, or Machine Shop Practice (in connection with locomotive construction and maintenance) have been included, as these apply generally to all forms of mechanical engineering :—

TEXT BOOKS ON RAILWAYS.

PERMANENT WAY MATERIAL.—By W. H. Cole. Spon, 1915. 7/6.
RAILWAY CONSTRUCTION.—By W. H. Mills. Longmans, 1898. 18/-.
RAILROAD STRUCTURES AND ESTIMATES.—By J. W. Orrock. Wiley (N.Y.), 1909. $3.00.
RAILROAD TRACK AND TRACK WORK.—By E. E. R. Tratman. "Engineering News" (N.Y.), 1908. 14/-.
RAILROAD CONSTRUCTION.—By W. L. Webb. Wiley (N.Y.), 1908. 21/-.
ECONOMIC THEORY OF THE LOCATION OF RAILWAYS.—By A. M. Wellington. Wiley (N.Y.), 1903. 21/-.
FIELD ENGINEERING.—By Searles & Ives. Chapman & Hall (Wiley), 1881. 14/6.
TRACK FORMULÆ AND TABLES.—By Roberts. Chapman & Hall (Wiley). 13/6.
ECONOMIES OF RAILWAY OPERATION.—By M. L. Byers. "Engineering News" (N.Y.), 1908. 21/-.
WORKING AND MANAGEMENT OF AN ENGLISH RAILWAY.—By Sir G. Findlay. Whittaker, 1894. 7/6.
EFFICIENT RAILWAY OPERATION.—By H. S. Haines. Macmillan Co. (N.Y.), 1919. $4.00.
RAILROAD TRAFFIC AND RATES (2 Vols.).—By E. R. Johnson and G. G. Huebner. Appleton (N.Y.), 1911. 21/-.
RAILROAD ADMINISTRATION..—By R. Morris. Appleton (N.Y.), 1910 7/6.
PRACTICAL RAILWAY WORKING.—By C. Travis, D. R. Lamb, and J. A. Jenkinson. Boswell, 1915. 3/6.
FREIGHT TERMINALS AND TRAINS.—By J. A. Droege. McGraw-Hill (N.Y.), 1912. 21/-.
RAILWAY GOODS STATION.—By F. W. West. Spon, 1912. 4/6.
RALWAY STORES MANAGEMENT.—By W. O. Kempthorne. Spon, 1907. 10/6.
LOCOMOTIVE OF TO-DAY.—Locomotive Publishing Co. 3, Amen Corner Paternoster Row, E.C.4. About 3/6.
LOCOMOTIVE PERFORMANCE.—By W. M. Goss. Wiley (N.Y.), 1907. 21/-.
THE RAILWAY LOCOMOTIVE.—By V. Pendred. Constable, 1908. 6/-.
MANUAL OF LOCOMOTIVE ENGINEERING.—By W. F. Pettigrew. Griffin, 1909. 21/-.
MODERN LOCOMOTIVE PRACTICE.—By C. E. Wolff. Sc. Publ. Co., 1903.
LOCOMOTIVE OPERATION AND TRAIN CONTROL.—By A. J. Wood. McGraw-Hill (N.Y.), 1915. 12/6.
FIRST PRINCIPLES OF RAILWAY SIGNALLING.—By Byles. Railway Gazette, Queen Anne's Chambers, S.W.1.
MECHANICAL RAILWAY SIGNALLING.—By Reynar Wilson.
POWER RAILWAY SIGNALLING.—By Reynar Wilson.
RAILWAY SIGNAL ENGINEERING.—By Lewis. Constable, 1912.

CORRESPONDENCE.

ORGANIZATION AND EMPLOYMENT OF ENGINEERS IN WAR.

To the Editor of the R.E. JOURNAL.

In the issue of the *R.E. Journal* for May a footnote asks for views on the subject of the lecture delivered at the S.M.E. in March last by Major General H. F. Thuillier, C.B., C.M.G. This is my excuse for the following remarks.

If the strength of the R.E. in a Division is taken at 1,600 to 2,000, as suggested by the lecturer, the unsolved problem is, how to best combine these troops into suitable units for all purposes, based on the section formation. The solution would appear to lie in a consideration of what work is likely to be done, and what size of unit forms the maximum and minimum for administrative convenience and economy.

It may be taken for granted that the command of a R.E. Major would be from 200 to 600 men. The minimum size of a unit is governed largely by economy in administration, and in addition by the disadvantage of increasing in number the already numerous small special R.E. units. The obvious solution of three double-companies of approximately 600 each of all ranks, would leave out that small but essential unit, which is called by the lecturer the headquarter company. Also it must be remembered that future wars will probably not be on the same lines as the late war. Consequently the possibility of having to detach a R.E. unit from the Divisional area, for a long or short period, must not be overlooked. With three double-companies, such a detachment would either be a whole double company, which would seriously deplete the strength of the Divisional R.E., or a portion, say half a double-company. This can hardly be an entirely self-contained unit. However closely the organization of a double-company is made to allow of each half being self-contained, it must be impossible to make it entirely so without, in normal times, an extravagant employment of administrative *personnel*.

The larger form of unit, exemplified by the double-company, has obvious advantages when the nature of employment of the R.E. is considered. For example the laying of pipe lines, the construction of trenches, road construction and repairs and the numerous small tasks, all interdependent and collected in a circumscribed area. These require one directing head and many willing hands, to carry them out. On the other hand, bridging, concrete work, workshops, construction of artillery O.P's, and battery positions, camouflage, etc., will frequently require small and scattered parties, which could best be provided from a unit of about 200 strong, a unit in which the O.C. can find time to visit every party daily, however widely they are scattered within the Divisional area.

With the above in view, would not the case be met by arranging

the strength of the Divisional R.E. in two double-companies and two single companies? The double-company could be organized on almost the same lines as two single companies, with the obvious administrative modifications which the advantages of the double-company system imply. This would give four R.E. units, a feature of which is worthy of notice, namely that the number is not the same as the number of Brigades, but is a multiple of the number of units normally operating on a Divisional front. This might overcome the tendency in Brigades of looking on a certain field company as their own property, and would seem to give the C.R.E. a very flexible command. As an example of a possible form of employment of these four units, either in open or trench warfare, one might consider the two double companies as permanently employed in the forward area, carrying out their own reliefs between half companies. The O.C. alone would be permanently in touch with the front line, a condition of affairs which would hardly be looked on by the O.C. himself as a disadvantage, and which, from the point of view of efficiency and continuity of policy has many features in its favour.

One of the single companies could then carry out the duties of the headquarters company with a proportion of its strength. The remainder say one half, could meet the probable requirements of the artillery. The second single company, which would relieve the first company mentioned above from time to time, would be available for the multifarious duties necessitated by the nature of R.E. work and the many special requirements emanating from the Divisional Commander and his staff. It would also meet probable requirements for a R.E. detachment outside the Divisional area. An obvious case of the utility of such a unit is in a retreat. It would be at hand for demolitions, a work which was not always thoroughly carried out, owing to the R.E. units being otherwise employed. The only other feature involved in the above proposal is that of the more highly skilled tradesmen and the more highly technical tools, which it is suggested should be provided for the headquarter company. The more highly skilled men could well be duplicated in the two single field companies without any disadvantage, and so be available to double man a task in an emergency. The men would run scarcely more risk of being wounded or killed, than if they were employed further behind the line in units which would certainly be well bombed. The more highly technical tools could also be duplicated in the same way in view of the conditions obtaining in modern warfare, and the fact that tools are not infallible, they sometimes break or get out of order and require immediate replacement. Naturally there would be some few machines which would not be supplied to a greater extent than the essential minimum, but presumably a C.R.E. is not going to be entirely denuded of transport in the future, as he was in the past, and these machines could be on charge to headquarters and travel in the H.Q. transport.

The lecturer's remarks on allocation of responsibility would appear to meet the views of all field company commanders. But one reason for the past faults and mistakes should not be overlooked. This reason was that both senior officers of the R.E. and commanders of formations

did, in fact, blame the executive R.E. officer for anything that went wrong in those features which might conceivably be included under the heading of engineering. The R.E. officer was the easiest to get at, and it was not difficult to find his name. The responsible officer of another arm was often difficult to locate, as, after completing his task he was absorbed back into his unit for ordinary duties and left no trace of his indentity. In consequence the R.E. officer got accustomed to expect blame for any slackness or mistakes occurring in the area in which he was working, and consequently took charge, for his own sake, when it was unnecessary and incorrect for him to do so. The solution of the difficulty by the inclusion in the orders of the staff the name of the commander or formation responsible for any particular work, would appear to radically alter this state of affairs for the better.

The only other point which I would wish to emphasize, may perhaps not be considered as covered by the field of the lecture, but is closely connected with its subject. This is the question of equipping the Divisional R.E. with machinery, such as a lathe, portable saw mill, mechanical pumps, acetylene metal cutting and welding plant, and also water supply tools and fittings. This equipment need be no more liable to destruction with a Division than in a Base Park where it would be certainly bombed. Nor would the few skilled men required to work them, seriously deplete the working strength of the Divisional R.E. The correspondence and rail transport saved, the convenience and more rapid execution of work, and the more complicated technical problems to be met with on the modern battlefield, would more than justify this innovation.

Yours faithfully,
A. T. SHAKESPEAR, *Capt., R.E.*

To the Editor R.E. JOURNAL.

SIR,

As you and Major General Thuillier invite discussion of the lecture delivered by the General and published in the *R.E. Journal* for May 1920 I venture to contribute some remarks to the discussion.

Five Main Factors.—The lecturer began by stating that he could deal with only a portion of such a big subject and I must do the same, referring however to some matters not touched on in the lecture.

An Engineer in War, as in Peace, must keep constantly in mind five main factors when preparing for or executing work.

(1) Time.
(2) Skilled Labour.
(3) Unskilled Labour.
(4) Material and Plant.
(5) Transport for Material and Working Parties.

I have not attempted to place them in order of importance because all are equally important and the absence of any one will wreck the whole. The proportion of each varies with every work and a skilful balancing of proportions ensures rapid, efficient and successful work.

In my remarks I propose to keep constantly in mind all the five factors and I would ask the reader to do the same.

In peace time an Engineer does not attempt to begin work until he has arranged for all the five factors to be duly proportioned, but I have yet to meet the happy Engineer who was able in war to secure all five to his satisfaction. Perhaps the skilled labour has been with difficulty collected and at a moment's notice is sterilised by the unskilled labour being swept off by a higher power, or the material was not available, or the transport was switched off to ammunition and supplies, leaving his labour idle. These are difficulties with which the Engineer in war of any rank from N.C.O. to General has to contend and surmount and by the side of which the most abstruse Engineer problem seems comparatively simple.

Doctrine.—A great deal can be done by organisation in peace and as General Thuillier says by the establishment of a universally accepted "Doctrine" to make things easier in this respect in the next war for our successors, or possibly for ourselves!

For instance, take "War Establishments." If an individual, a vehicle, an animal, an article of store, or a unit is in "War Establishments" it is comparatively easy to get it. It may be forced upon you whether you want it or not, but if it is not in "War Establishments," one or two disasters must occur before it is put there. Hence the importance of getting "War Establishments" thoroughly complete and right. Never mind if there is no immediate chance of getting the men or the articles. Get them into the book and some day they will be thrown at us.

Skilled and Unskilled Labour.—General Thuillier has emphasised the necessity for the C.R.E. (whether of a Divn. or on Communications) commanding and administering the unskilled as well as the skilled labour to be employed on work for which he is responsible, and we may hope this is now established "Doctrine," but I venture to ask why put them in the same unit? In asking this I see that I am questioning what the General says is the second point on which there is universal agreement, and I must give reasons for my heresy.

The proportion of skilled to unskilled labour varies with the job. For trench work, for roadmaking, for what I may call heavy labour jobs it will vary from 1 to 5 up to 1 to 10. For bridging, for building and for skilled jobs it will vary between 1 to 2 and 1 to 4.

If you have your skilled labour in companies and your unskilled also in companies but the latter grouped into battalions all under the C.R.E., the proportion of skilled to unskilled labour is easily altered without dislocation of units. One or more sections or companies or battalions of unskilled labour are detailed to work with one or more sections or companies of Engineers.

On a bridging job a Company of Engineers may perhaps have two companies of labour while on the bridgehead defences another Engineer company has two labour battns.

Compare this elasticity with laying down for all time in immutable "War Establishments" that the skilled *personnel* will be "25% to 30% of the whole."

No man should be called or dressed as an Engineer unless he is a

"skilled tradesman." I maintain that this principle is a veritable sheet anchor in the Corps organisation to which we should hold regardless of the temporary difficulties which prevent us getting tradesmen. We are organised for war, and temporary peace difficulties are beside the question, apart from the possibility of overcoming them. When we see a man in the field dressed as an Engineer let us know at a glance that in him we have a skilled tradesman and not discover by his work that he is a labourer dressed as an Engineer.

Again if we adhere to this principle we are protected during the rush of hasty organisation in war from being swamped with unskilled men. Will even the 25% to 30% of skilled men be worked up to when any man can be enlisted as an Engineer? We all know how drafts and reinforcements are sometimes collected and rushed up. When all are dressed alike who is going to prevent a unit being swamped with unskilled men?

Yet another point. We fight in many countries where the local inhabitants can be organised in companies and battalions of unskilled labour and where on account of climate he can carry out labour jobs better than the English labourer. Some units of British labour must always be available for the front line work on which the inhabitant of the country can be employed to a limited extent only, but the units of skilled men must still bear the same proportion to unskilled. On the Western Front during the war the proportion of unskilled British labour in the forward zone was necessarily much higher than was practicable or desirable in Macedonia, Palestine, and countries where the native labour was suitable, but skilled British labour was as necessary in every theatre of war. Again compare this elasticity in organising skilled and unskilled in separate units with combining them in one immutable War Establishment.

We must recognise that we shall never be allowed the monopoly of unskilled labour. Wars are unfortunately not got up in order to enable C.R.E's to carry out perfect Engineering work. Other inconvenient people come butting into the War. All we can hope for is to get a certain number of units definitely enlisted as Engineer labour units, commanded and administered by C.R.E's and always working with Engineer units. For every company of Engineers we may hope to have an Engineer labour battalion, but as already shown this proportion of unskilled to skilled labour will not always suffice. The remainder must come from the Army "Pool" of labour battalions and infantry working parties from which all the other inconvenient people also draw their labour and join with us in the scramble to get it. If only we can get it laid down as part of the "Doctrine" that for every R.E. Coy. about 250 strong, we are to enlist command and administer and permanently retain one Engineer labour battalion 1000 strong then this combination would have no difficulty in absorbing on occasions and efficiently directing much larger quantities of unskilled labour temporarily allotted from the "Pool."

Space forbids me giving reasons for the opinion that every R.E. unit should be a company not less than about 250 strong, with 6 officers, and that units much smaller than this whatever the nature of their work or speciality tend to be inefficient and uneconomical.

A great advantage that would follow from organising Engineer labour battalions in peace and in war commanded by Majors (who on the work would rank junior to Majors of R.E. Companies), is that we at once open up a fine career for our N.C.O's and sappers who could exclusively provide the officers for these Units.

Transport.—Next as to Transport. The same principle applies. We want it established in the "Doctrine" that with every R.E. Company and with every Engineer labour battn. there is an irreducible minimum of transport (quite apart from what is required for moving their equipment and food) which is definitely allotted for works transport to carry material and stores to the working parties and into the work *and to move working parties* from place to place. This latter point is often overlooked, but in moving warfare either in advance or retreat is especially essential. The Engineers with advance guard settle down to a job and before it is finished are passed by the rear guard. Another party leap-frogs over them carried forward in lorries. The original party finishes its job, thanks to the transport which brings it material, then gets into the transport and catches up the advance guard. To this irreducible minimum, without which each unit is helpless for work, a further quantity of transport, varying with the nature of the job and with the C.E's or C.R.E's capacity for scrambling, is added from the Army "Pool."

In this connection I remember the "hue and cry" after six lorries which had completely disappeared. When a certain C.R.E. had arrived at the Danube it was considered politic to ask if the lorries he possessed could by any chance be the missing ones.

Incidentally I submit that Engineer units allotted to cavalry should have four-fifths of their *personnel* in Ford cars and one fifth on horses.

Stores and Material.—Our organisation for stores in war and in peace also requires thorough overhaul. As War Establishments ignored the subject, every C.R.E., every C.E., every A.D.W. improvised Stores Establishments by taking away valuable tradesmen from R.E. Companies that could ill afford to lose them. The establishment and the unskilled labour they require for loading and off-loading must make its appearance in War Establishments, likewise the Establishment of clerks and draughtsmen of C.E's and C.R.E's requires overhaul.

Doctrine Again.—I make no apology for returning to the subject of "Doctrine" because General Thuillier has emphasised the importance of our knowing our own minds, firstly as to how we wish to be organised and secondly how we can best assist the army to accomplish its work, and then coming to an understanding with the Staff upon this "Doctrine."

There seems now to be considerable unanimity on these matters in the Corps. I have not met any R.E. who would not welcome the clear exposition given by the lecturer of the "Functions of C.R.E." "Employment in the Field" "Allocation of Responsibility" "Duties of C.R.E." &c., &c., to the end of the lecture. Many difficulties will be cleared away, on the day when the rule is laid down, and observed by all, that all works are divided into two categories.

(1) Those for which the R.E. are responsible.

(2) Those for which the Infantry and other arms are responsible.

Before the war we really did not know ourselves what our "Doctrine" should be. Now we do, and are ready to discuss it with the Staff and get them to lay down a "Doctrine" which all will adhere to. That at present remains to be done. We must cease to be a mystery box that no fellow can understand. The principles of the employment of R.E. in different phases and operations of war should be as widely known and adhered to as the employment of other arms.

I attended a Staff Ride two months ago at which all were veterans of the war whose knowledge of every principle and detail gave me a valuable education, and yet in the attack of a position several of them allotted each section of a Field Company to each battalion to accompany it in the assault without a defined mission, and I know my remonstrance was not popular.

In this connection I would urge that it is most necessary that officers of other arms, and particularly Staff College students should be attached to us during the training season and also to our works offices. Why are we left out when they go for attachment to other Arms? Brigade Majors and Staff Captains work in the very closest *liaison* with field company commanders, G.S.O. (I.) and A.Q.M.G. with C.R.E., B.G.G.S., and D.A. and Q.M.G. with C.E., &c. I doubt if any other arm is in closer connection with the Staff. Why then are the Staff students not attached to us to learn our methods and our difficulties, and particularly to realise how we must balance the proportions of the five main factors referred to at the beginning of this effusion? I do not think anyone who has not been responsible for works can realise the quantity of material required for quite small works and the transport to bring it there. The timber used in quite a small bridge when stacked in a heap looks incredible. If the Staff will lay down a doctrine, preferably that expounded by General Thuillier, and insist on Commanders adhering to it during all training, and if we are attached to other arms and they to us, the doctrine will eventually be established and universally accepted so that we all work on the same lines for the same object.

I am, &c., &c.,

H. L. PRITCHARD, *Brevet Colonel, R.E.*

REVIEWS.

ELEMENTARY AERONAUTICS

By A. P. THURSTON, D.Sc., late Captain, R.A.F. (Sir I. Pitman, Ltd.). Price 7/6 net.

This is the second edition of this little work, the first having been published a few years ago. It is a useful book and particularly suited to those who wish to get a good general idea of the subject. In the

first two chapters, the general theory of plane and curved surfaces is discussed and the usual formulæ for air pressure, centre of pressure, etc., are given in some detail. Stream lines, and the formation of surfaces of discontinuity are clearly explained and the resistances of bodies of different kinds are also given. In the next two chapters the principles of "stability" and "control" are described, in a clear and simple manner—In a future edition it would be advantageous to discuss "Yawing" in detail.

In *Chapters V. and VI.* the general theory of air screws is explained and there are some notes on the "Helicopter." The curious application of this latter apparatus to an aeroplane, suggested by Bleriot is commented on.

Chapter VII. is of interest, as it describes one of the earliest attempts to calculate the forces, etc., acting on an aeroplane in flight. The necessary details are well shown in the diagrams. An account of laboratory instruments follows, and a brief description of some of the earlier aeroplanes is given.

Chapter X. describes some of the aeronautical engines in common use. The illustrations are good.

Chapter XI. on the methods of stressing aircraft structures, is important, as it explains the system used by the author in his official work. The final remarks on design will be found useful by constructors.

In *Chapter XII.* "Air Friction" is fully gone into. The author says truly that "more controversy has raged round this question than around any subject in aeronautics"—The reason for this is, that in the experimental work, it seems to be impossible to separate "form resistance" from "frictional" resistance and it is extremely doubtful whether any of the experiments described really do this. The author's idea of using glass plates, so as to ensure a smooth surface was a very good one, but probably better results would have been obtained, if they had been "fair shaped" in section. The whole subject is a very difficult one and a great many points have to be considered in connection with it; for instance, the probability of a particular air velocity giving the minimum resistance, and so on.

There is an interesting chapter on "Pressure Distribution," and the tables regarding strength of timber, etc., will be found useful by constructors.

J. D. FULLERTON, *Colonel, R.E. (ret.).*

PAGES D'HISTOIRE, 1914—1918.

(Librarie Militaire Berger-Levrault, 5—7 Rue des Beaux Arts, Paris).

(*Continued from R.E. Journal for May*, 1920).

The 165th number of this series is entitled *Le Bolchevisme en Russie*; the volume is a translation into French of the White Paper presented to the British Parliament in April, 1919, on the situation in Russia,.

and covers the period August, 1918 to March, 1919. In addition to the correspondence between the Foreign Office and various diplomatic, and consular officials and military officers, the volume contains a number of important memoranda dealing with different aspects of the situation arising from the state of anarchy prevailing in the erstwhile Russian Empire. In an Appendix to this volume will be found extracts (in French) from the Russian Press covering the period September, 1918, to February, 1919. They disclose the unhappy state of the country and what the people are suffering from the reign of terror that prevails therein.

The 166th number is entitled *Paris pendant la Guerre* and is from the pen of M. Gaston Cerfberr. The vicissitudes through which the inhabitants of the French capital passed from the time of the declaration of war in the autumn of 1914 to the joyous days in the summer of 1919, when fêtes were organised to celebrate a glorious peace, are briefly described. Owing to its geographical position in relation to the contending forces, the Parisians were made to feel the full effect of what a modern war means; they accepted their trials in a spirit of fortitude and made the best of an anxious and uncomfortable situation. M. Cerfberr touches upon practically every aspect of life in Paris during the great struggle; *e.g.*, the mobilization of the troops; the requisitioning of horses, etc.; the approach of von Kluck's Army to the defences of the French capital; the Zeppelin raids; the bombardment by "Big Bertha"; the exodus of 1918; the introduction of rationing; taxation; the difficulties of obtaining supplies; the economic situation, etc. References are also made to the visits of the British Sovereign, of the King of Belgium, of the Italian King, and of President Wilson.

The 167th number contains the official communiques issued by the Central Government to the Provincial Authorities during the period October—December, 1918; it is the XXXIX. volume of the series dealing with such matters.

W. A. J. O'MEARA.

THE BATTLE OF THE MARNE.

By G. H. PERRIS (Methuen). 10/6.

The author, who was war correspondent with the French armies, gives a clear and detailed account of the various phases of the great battle, well supported by plans and numerous references. But the account is almost entirely from French sources, and the student, who begins to know something of what occurred on the other side, will look in vain for a description of the mistakes made and difficulties encountered by the Germans, which had such a far-reaching influence on the results of the battle. The book has been placed in the Corps Library.

F.E.G.S.

THE THEORY AND PRACTICE OF AEROPLANE DESIGN.

By S. ANDREWS & S. BENSON. (Chapman & Hall). 1920. Price 15/6 net.

This book is one of the "Directly Useful" series, and as the publishers state, "occupies a midway position between purely theoretical and purely practical works." It is well and clearly written, and contains a good deal of useful information in a compact form, while the "worked out" examples will be found very useful by the student of aeronautics.

In *Chapter I.* the general principles of design are discussed, and the tables giving "weights and structural components, per centage resistances of aeroplanes, etc." will be found useful.—The "ceiling" of a machine is explained, and there is a brief discussion on stability and controlability.

Chapter II. deals chiefly with "Materials" and tables describing the principal ones in use are given—The "factor of safety" is dealt with in Table X. It should be noted that this is not the same factor of safety as that discussed on pp. 140, 141. The use of stress diagrams is clearly explained as also the "Method of Sections," which is recommended as a useful check on other systems of calculation.

In *Chapter III.* the properties of aerofoils are discussed in considerable detail. It begins with a very good description (well illustrated) of a wind tunnel and the method of using it to find the resistance of surfaces, bodies, etc.—Air data for aerofoils are next considered, and a large number of useful tables and diagrams follow. A great number of different kinds of aerofoils are examined and the effects of "gap," "decalage," "stagger," etc., are carefully gone into. The diagrams of R.A.F. wing sections No. 1 to 10 will be found useful. The Lift by Drag rates 17 in Nos. 9 and 10 is decidedly good.

In *Chapter IV.* stresses and strains in Aeroplanes are considered and much useful information regarding them is given in a handy form.

In *Chapter V.* there is a very detailed account of the "Design of Wings" commencing with a description of the different kinds of trusses used, various useful details of information such as, definition of tractor and pusher machines, the aeronautical factor of safety, etc., follow. The great importance of ascertaining the real stresses, to which a machine is subjected in the air, is pointed out, especially in the case of diving, when the mean overload may equal 12 times the weight of the machine. A good calculated example of the stresses in a certain biplane follows, and after this, the general procedure for the design of members of the wing structure is considered in detail. Useful practical examples complete the chapter.

Chapter VI. deals with "Resistances" and "stream lining." Commencing with a general description of the resistances, viz: the drag of the wings, and that due to the other parts of the machine, an explanation of "air pressure" and "skin friction" follows—The importance of making bodies, struts, etc., of fair shape is dwelt upon, and useful tables and diagrams give the resistances of such bodies in a convenient form. The usual explanation of "skin friction" is given, but there is no doubt that this subject requires a great deal of further investigation, as, up

to the present time no satisfactory experimental method of separating "form" resistance from "frictional" resistance has as yet been discovered.

Chapter VII. contains a very good account of the methods of constructing the fuselage of a machine—Examples of different types are given (very well illustrated) and the method of finding the stresses in the members is explained. The paragraphs on the gyroscopic action of a rotary engine, and the effect of the air screw, on the fuselage should be noted.

In *Chapter VIII.* chassis are discussed and the method of calculating the forces acting on them when a machine is landing, are clearly described. The account of "shock absorbers" and the methods of designing them is particularly interesting.

In *Chapter IX.* air screws are discussed. The author considers the "Blade Element Theory" the most satisfactory one, and describes it in detail. The experimental method of design, based upon wind tunnel experiments is explained, and a calculated example, showing the application of the method to a particular air screw follows. Stresses in air screws are next considered, and some notes on construction complete the chapter.

Chapter X gives a very full account of the "stability" question, and the worked out examples will be found very useful by students.

Chapter XI.—Design of control surfaces. This is an important chapter as the subject does not always receive as much attention as it requires. Very full details are given, and the account of "construction" of control surfaces is very good.

Chapter XII. deals with "Performance" of machines, and the practical methods employed in connection with this subject. Tables LX. to LXII. will be found interesting.

In *Chapter XIII.* the process of "laying out a machine" is described, and the authors very rightly insist upon this being done in a scientific way instead of by some vague rule of thumb method.

Chapter XIV. gives an account of "the general trend of aeroplane design." A number of well known machines are described and interesting details are given in Tables LXXII. to LXXIII.

The Tables and illustrations in this book are particularly good.

J. D. FULLERTON, *Col., R.E. (rel.)*

NOTICES OF MAGAZINES.

BULLETIN BELGE DES SCIENCES MILITAIRES.

May, 1920.

(Bruxelles, Libraire Albert Dewit, Price 1 fr. 50 c.)

The first number of this monthly publication has just been issued by the Belgian Army Staff. In an introduction it is explained that as no one can honestly believe that the great struggle which has recently

ended will be the last of all wars, and as the training of armies and the perfecting of new engines of war in peace time can only be tested on manœuvres, at military schools or in laboratories where the conditions are imaginary, this periodical has been initiated to furnish documents describing in detail both the large and the small episodes of the Great War, for the use of military students and for those whose duty it is to carry out the organization and preparation of the army. The articles in the present number cover 54 pages and include, among others, "The Operations of the Belgian Army during the Campaign of 1914–18" (unfinished), "The Conduct of Operations by the German Grand Staff up to the Battle of the Marne" (unfinished), "The inundations on the Belgian Front." Considerable space is devoted to aviation, and brief notes are published on organization matters in the German, Dutch and British Armies.

F.E.G.S.

THE MILITÄR-WOCHENBLATT.

No. 87.—*Through a peace of slavery to Bolshevism.*—Lt. General Von Altrock declares that the treaty condemns Germany to an existence as desperate for the present as it is hopeless for the future. He says that the only thing that can prevent Germany becoming a prey to Bolshevism is permission to increase her 100,000 strong army.

A meeting was held at Charlottenburg to protest against the reckoning of private means in assessing officers' pensions and a vigorously worded resolution passed.

Officers are beginning to ask when promotion will begin again. The *M.W.B.* says there can be none just yet as things are still too unsettled and promotion at the present juncture would only lead to greater evils than it is calculated to alleviate. It hopes however that the situation will soon improve.

Roll of Honour.—Berlin police officers—24 killed.

No. 88.—*England's Military situation and the reconstruction of the Territorial Army.*—This makes the most of the difficulties now confronting England and emphasises the danger that Bolshevism is to the British Empire, all due to a peace treaty in which ignorance and hatred were the ruling factors. The Indian Army awaits the deliverance which Bolshevism will bring it, when the British troops serving in India will barely suffice to hold the important centres. Churchill insisted on an overseas obligation for the Territorial Army because he knows it will very soon be wanted.

The new defence law includes a paragraph forbidding serving soldiers to take an active part in politics. This rule has been adversely criticised in some quarters, but General Von Linden-Suden supports it as only right and proper.

General Von Zwehl, in an article on Field Marshal Joffre's leadership up to the Battle of the Marne, says Joffre was quite right to assume that Germany would violate Belgian neutrality, as the question was openly discussed in German publications and equally wrong to suppose that Germany had any intention of crossing the Dutch frontier "we never

thought of doing such a thing!" Joffre's plan is described as a bold one, which, as it counted on irresolute leading on the part of the Germans and on good fortune, could easily lead to disaster. Von Zwehl says that it would have done so, but for the bad luck the Germans experienced on their right wing. The French success at Guise eased the situation to some degree, but it was still very critical and the deployment of the 6th Army was endangered until the Germans, already obliged to leave three Corps at Antwerp and Maubeuge, detached another two to East Prussia. This, Von Zwehl says, was a disastrous mistake. Maunoury wanted to attack the German right flank before his army was fully deployed. Joffre refused to allow this and his action is approved. Had he done so a decision would have been reached north-west of Paris, the German advance would not have penetrated so far south and the extension and the consequent weakening of the German front would have been avoided.

No. 89.—General Freytag-Loringhoven contributes a good article on the dangers of spasmodic and violent changes in national life. England, he says, owes her strength more to evolution than to revolution.

General Von Zwehl continues his remarks on Joffre's action before the Battle of the Marne. On the 1st September the French commander contemplated an extensive withdrawal of the whole of the line west of Verdun, pivoting on that point. Lord French, as we know, considered that if the English went back as far as Meaux it would be quite far enough, but Joffre indicated the line Juvizy—Melun as their position. However on the 4th September things began to look brighter for the Allies; Maunoury's Army was rapidly concentrating and word came of the German corps left at Maubeuge and Antwerp, and withdrawn from Russia. On the 5th the tables were turned. Von Zwehl comments on Joffre's good fortune in getting out of his plan to break through on the Luxembourg line so lightly. This, he calls Joffre's first great decision and declares that it was a most dangerous scheme and that if the 1st, 2nd and 3rd German Armies had only been under concerted and systematic leading, it would have resulted in disaster. It is all held to be further proof, if that were needed, that Schlieffen's project was a sound one, and, even when the French, through Italy's action, were so much stronger than had been contemplated, practically certain to succeed. Joffre's second great decision, as he characterises the formation of a shock group at Amiens, missed fire. The concentration area was too far advanced and his technical advisers should have pointed out to him the railway and entraining difficulties. This mistake however did not have very serious results. His third decision, to withdraw behind the Seine was not carried out because the offensive began, the impetus thereto being given by the voluntary withdrawal of the Germans. How the campaign would have resulted if the 2nd German Army had not started the retreat or if Joffre's plan to get behind the Seine had been carried out, opens endless problems for a strategic Kriegsspiel. Schlieffen's projects never extended beyond the frontier battle, which he thought would be decisive.

An Army Order defines the action to be taken to recover any non-public funds, such as those belonging to Canteens, Messes, Institutes, etc., which have been left behind in Poland.

Rolls of Honour.—General Staff—a list of 65 names including Generals Von Moltke, Von Lauenstein and Von Voigts-Rhetz and Colonel Hentsch. (Is the latter he who decided on the retreat of the 1st and 2nd Armies in 1914?) Pioneer Battalion No. 27—33 Officers killed.

No. 90.—The Battle of the Marne (1914) is being increasingly examined by German students. Some appear to be more concerned with the search for a formula which shall prove that black is white and failure success, than with the elucidation of facts, but in this number General Von Trossel makes a real contribution to the history of the campaign. He commends the books of General Von Baumgarten-Crusius and Field Marshall Von Bulow as the best hitherto published but indicates several points which still want clearing up. On the 28th August orders were received from G.H.Q., for the 1st Army to advance to the Lower Seine and the 2nd Army on Paris. The 1st Army accordingly moved in a S. Westerly direction and had heavy fighting at Proyart and Framerville. Prisoners taken there disclosed the arrival, near Amiens of the 7th French Corps from Alsace. On the 30th the 2nd Army struck the 5th French Army north of La Fere and, as Von Bulow did not know that the 1st Army had strong French forces before it, he asked it for help to exploit his success. The 1st Army informed him that it was going on the 31st to advance to the Oise between Compiegne and Chauny. Von Bulow states that G.H.Q. approved of this and ordered the 2nd Army to direct its left flank on Rheims, thereby giving up the plan indicated on the 28th (1st Army to Lower Seine, 2nd on Paris). Von Trossel asks why G.H.Q. changed its mind, and how it was that it had apparently no knowledge of important detrainments near and south of Amiens, as it is not conceivable that the 1st Army failed to report them. Also how the 1st Army appreciated the situation when, on 31st August, it determined to march south on to the Compiegne—Chauny line instead of keeping its south-westerly direction, and why, knowing that there were strong even if beaten hostile forces on its right flank, there was no order given to Von der Merwitz's cavalry corps to follow them up and discover their movements if not their strength. He next discusses the G.H.Q. intentions which, as received on the night of 2nd/3rd September, were "To press the French in a S.E. direction from Paris; 1st Army in echelon to 2nd Army and to become flank guard of whole German forces," and asks how it was possible to press the enemy from Paris if the 1st Army was to follow the 2nd in echelon. Even if the 1st went forward in line with the 2nd it was impossible fully to carry out this order. He considers the first part of the order impracticable, but the second not only practicable but in accordance with the situation and quite natural as the 1st Army was the flank guard, and would have to move in echelon to fulfil its rôle as such. The ordinary way to carry it out would have been for the 1st Army to mark time and advance in succession from the left as the 2nd Army moved forward. For some reason, which Von Trossel says he cannot explain, the 1st Army, so far from dropping back, actually advanced three of its Corps and only dropped two, the IVth Res. Corps and IInd Corps as flank guard. Von Bulow declares that so far from being echeloned in rear, the 1st Army was actually echeloned in front of his Army and Von Trossel enquires why G.H.Q.

did not interfere when they learnt that orders were not being carried out. On the 4th September, the 1st Army advanced still further. On the 5th, G.H.Q. issued new directions which were briefly, " The enemy has escaped from the encircling attack of the 1st and 2nd Armies. Reports show withdrawal of French forces from Toul-Belfort and from the front of the 3rd and 5th Armies towards the west. The plan of driving the enemy away from Paris in a S.E. direction must be given up. It is probable that he will concentrate strong forces near Paris and protect that city and threaten the German right flank. The 1st and 2nd Armies must therefore remain opposite the east front of Paris, 1st Army between Oise and Marne, 2nd between Marne and Seine in order to attack any movement from Paris." On the same day (5th September) G.H.Q. also began the formation of a new Army to strengthen the right flank. Von Trossel asks why this was not begun at the end of August. Von Bulow had ordered only a short march for the 5th September up to the line Montmirail—Vertus. On receipt of G.H.Q.'s orders he stopped the 2nd Army's forward move, merely advancing the left flank a little further up to Morains-le-Petit.

In an article on the surrender of war criminals it is asked " What will the French Army, which is alleged to be so chivalrous, think of the surrender of hundreds of our leaders who only did their duty? Will it and particularly the French Officers so far demean themselves as to agree to dishonouring their unconquered enemy, before whose sword France has trembled in hysterical terror for four years and to bringing the leaders of an Army which, even with the help of England and Russia it could not conquer, before a far from impartial tribunal? " and so on, a mixture of flattery and insults, boastings and whines, typical of a certain class of German writer.

Roll of Honour.—Bismarck Jaeger battalions (2)—62 Officers killed.

No. 91.—Von Trossel continues his remarks on the Battle of the Marne (1914)—On the 6th September the 2nd Army should have carried on its right wheel so as to form a front facing Paris, its commander assuming that the 1st Army would conform to the north of the Marne. The latter however thought it too late to hold up the moves already ordered, and also believed that, contrary to G.H.Q. orders, the pursuit should be pushed forward up to the Seine. In this respect it is important to know at what hour Lt. Col. Hentsch reached 1st A.H.Q. This could not have been before 10 or 11.0 a.m. (5th Sept.) and as the 1st Army had been on the move since 6.0 a.m. it could hardly have been possible to effect any substantial alteration in the dispositions already ordered. As G.H.Q. however knew about the forward push of the 1st Army it was essential to warn it early and a short order " 1st Army stand fast. Further orders on the way " should certainly have been sent out by wireless or telephone from far distant Luxembourg, where G.H.Q. was, in the night of 4/5th. The first part of the message from 1st to 2nd Army, that the forward movement could not be held up, appears justified. The second part to the effect that, contrary to G.H.Q.'s orders the pursuit must be pushed on to the Seine, remains obscure. Von Trossel then examines the actions which brought about the gap between the 1st and 2nd Armies and describes how it was hastily patched up by

Kraewel's Brigade and the cavalry, who held up the British for a time, but eventually strong forces of the 5th French Army, released by the action of the 1st German Army, compelled the 2nd German Army to withdraw. Von Bulow assumes full responsibility for having so described the situation on the evening of the 8th September, to the G.H.Q. plenipotentiary Lt. Col. Hentsch that the latter ordered the retreat. It seems to have been in consequence of these orders that the 5th German Division stopped, when, on the afternoon of the 9th September it was on the point of falling on the British left while Lord French was attacking the Kraewel Brigade at Montreuil-aux-Lions. Von Trossel speculates on the probable result if the attack, of which this was a part, had been pressed, but concludes that, though there was a big prize to be gained, the results of failure would have been disastrous to both the 1st and 2nd Armies, and that the reasons put forward by Von Bulow for his action are sound ones. We have but little information about Lt. Col. Hentsch. Von Trossel describes him as endowed with full powers, and owing to the distance and inaccessibility of G.H.Q. this must have been necessary, but it would be interesting to know more of this comparatively junior officer whose conference with Von Bulow led to one of the great decisions of the war.

Conditions of service in the National Army.—The national army will consist of volunteers who engage between the ages of 17 and 23 for 12 years' service. They must be of German birth, good character, physically fit for infantry and unmarried. After 6 years' service men will be entitled to live out of barracks. Promotion by selection after special tests. For commissioned rank, which is open to all volunteers, four years' instruction is necessary. Education for a career in civil life is given during a man's service. Officers serve to age of 45 and then on from year to year. Conditions of promotion and leave as for other ranks. Release before reaching the age of 45 can be allowed on application by an officer on the grounds of altered circumstances. He can be dismissed on account of unfitness or unsuitability. In the latter case the officer must be informed 3 months before his proposed dismissal of the reasons for it, and be allowed to appeal. Retiring pensions begin after 10 years' service. A selection board consisting of officers can pronounce the sentence of dismissal without pension "for conduct unbecoming an officer."

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

4th May, 1920.

REVUE MILITARE GÈNÈRALE.

December, 1919.

THE ARMY BILL.

A critical examination of M. Renaudel's scheme. The title of this bill is "Projected measure for a first military contribution of France towards the covenants of the League of Nations." It states explicitly

that this League should result in the disarmament of all nations, and in consequence that the military organisation of France should develop in accordance with international policy and with the development of the League of Nations itself. But this epoch has yet to come, and it is impossible to ask the country to abandon care for its safety and the execution of the legitimate clauses of the peace treaty. An army is therefore necessary, but should be reduced to a minimum, firstly on financial considerations, and secondly to set an example in reducing armaments. The measure rejects, in spite of the example of England and America, a regular army recruited by voluntary enlistment as "menace to democracy." Conscription, an expression of the equality of all citizens under the law, is therefore adopted, with safeguards against its assuming an aggressive character as it did before the war. This aggressive character is not inherent in the system, but, depends on the political system whose servant it is. If the government wishes it to minister to diplomatic violences and blood-thirsty designs and the vigilance of the people does not curb these desires; if the democracies cowardly surrender to such aims, and more so if they associate themselves with them to satisfy an imperialism which inevitably leads to war; if they do not insist that the instrument forged by conscription is used exclusively for the country's defence, and cannot be applied to projects of aggression, or possibly to the maintenance of distinctions of caste or class at home, then there is always danger. Democracies must always watch the development of their military administration. But such restrictions only apply to times of peace. In time of war industrial as well as military mobilization must be arranged. The above are the general considerations on which the measure is based. The following gives a clear idea of the spirit in which it was drafted "To-day it can be affirmed without fear of denial that if the nation had listened to the voices of those who counselled a defensive organization on a militia model, that is to say, if it had prepared for the methodical utilization of all its reserves, France would have victoriously resisted the blows of the enemy instead of suffering the disaster of Charleroi. Care must be taken that, as in the past, the fate of the country and of its military organization is not left in the hands of a few advisers, more or less well chosen and qualified, and of ministers more or less obliging. Democracies must not permit, in the sad and demoralizing life of the barracks, the isolation of the army or the constitution of a military caste. The army should be associated with the general life of the nation, soldiers as well as officers participating in the political and national activity of the country, and exercising all the rights of citizenship."

The characteristics of the measure are :—

Total service 28 years.
Classes called up at 20 years of age (two batches).
Practical Training 8 months.
Periods of 15 days subsidiary training—4.
No calling up of the last five classes.

Voluntary enlistment confined exclusively to the cavalry and colonial army. Suppression of any previous deduction from the number supplied from any contingent in favour of the colonial army or of crews for the fleet.

Leave during the training service—30 days.

For the first three months the recruit is trained near his home for the last five he is drafted into a unit approximately on a war establishment, and consequently available for any kind of duty.

Batches of 100,000 each are called up every April and October. The latter will then join their war stations from January to May, and the former from July to November. The four subsidiary trainings take place in June and December, and it may be reckoned that, omitting war losses, 700,000 men will be available annually for training near their homes, and to send to their war stations 400,000 will suffice, at the rate of 100,000 for each period of 15 days' training.

The bill is at once a measure for recruiting, for army organization, and for cadres and strengths. From a strictly military standpoint the following remarks arise. It is agreed that universal disarmament may be progressively realizable, and that the strength of the Army should be in inverse ratio to that of the League of Nations, that the present strength should be the minimum compatible with security and international obligations, and also that in case of a new war the whole nation should rise against the invader. The strength can therefore be reduced considerably below that of 1914, but must not be allowed to fall below that required to train the nation in arms, and eventually to organize it for war, and cover the mobilization. From this point of view the measure shows two defects, it does not admit of the effective embodiment of a nation in arms and does not ensure the permanent security of the frontier. For a nation in arms the essential condition is the pre-existence of formed bodies sufficient in number and skill as nuclei for training, and the more rapid the mobilization the greater the number of these nuclei required. It is for consideration whether it would be better to reduce the period of service of the ordinary soldier and apply the saving thus effected to forming and training cadres, which need not be composed entirely of professional soldiers, but Renaudel's proposal tends to place obstacles in the way of the formation of such cadres. It is considered also that the number of re-engagements allowed is insufficient—it is not possible to train a N.C.O. in eight months.—(*To be continued.*)

January, 1920.

Reply to "Deductions from the World War" of Lt. Genl. von Freytag-Loringhoven.—A translation of von Freytag's article appeared in the *R.M.G.* for October, 1919. "L'Hoplite," the writer of this reply, is described as a high military official. He asks von Freytag, who accuses the French of holding feelings of hatred towards Germany,

how he can expect it to be otherwise considering the way the latter treated them in 1870–71, and after all it is only a case of the pot calling the kettle black, and does not von Freytag's article justify the feeling? Again his explanation of the German atrocities in Belgium exceeds the bounds of impudence. He accuses the *Poilu* of having fought for France's future position in the world; he fought to escape from what he knew would be slavery. He complains of the French treatment of German prisoners, but how did the Germans treat the French civil population? He says that the beast in human shape always wakes with surprising suddenness in the French; if the German is different it is because the beast never sleeps, or only does so when one is strong enough to ensure his harmlessness. He states "We have had to do with an enemy endowed with the mental constitution of the lower orders. . . The vast difference between civilization and *kultur* is revealed." As Germany claims *kultur* for her own, France must represent civilization, but was it the French alone who were endowed with the "mental constitution of the lower orders," did they burn Louvain, lay waste Belgium and the North of France, massacre inoffensive civilians, strip houses and factories, and destroy the cathedral of Rheims? Finally, what strikes the French people in the writings of the Tirpitzs, Ludendorffs, Falkenhayns and Freytag-Loringhovens is that they never inquire if war is a wrong in itself, and an unjust war a crime. They look upon the late war as an industrial or commercial enterprise that has failed, and analyse the causes of the failure, without the slightest allusion to the terrible moral responsibility which the authors of the cataclysm have incurred.

The Army Bill.—Continued from the December 1919 number. It is argued that the arrangements for training the reserve of officers (*officiers de complement*) are absolutely inadequate, and certain facilities offered by the measure are palliatives, not remedies. Figures are given tending to show that the numbers of the annual contingents are insufficient to provide for the protection of the frontier during mobilization—including that of England and America. The numbers actually available at any time will be less than the 100,000 allowed to Germany, and there will be two periods, June and December in each year, when the only troops under arms will be the reservists doing their 15 days' training. The period of training allowed is too short for artillery, engineers, tanks, and aviation. Each chapter is criticized in detail. Chapter I. deals with recruiting. Chapter II. with training. It is noteworthy that the compulsory physical training of the youth of the nation, in order to improve the race, is provided for from 10 years of age, with preliminary military training from the age of 16. Chapter III. deals with organisation. The *Corps d'Armée* ceases to be a permanent formation. Chapter IV., Cadres and Establishments. Long service is limited, artillery and engineer staffs done away with and others reduced. Recruiting and administration to be done by civilians, all transport to be in the hands of the artillery. Alterations in the colonial forces. Higher courses in tactics, of a year's duration, to be given. Chapter V. Promotion. Chapter VI. Miscellaneous.

A. R. Reynolds.

RIVISTA DI ARTIGLIERIA E GENIO.

January, 1920.

THE EMPLOYMENT OF TANKS.

It appears clearly from the recent war that tanks can be pushed forward without artillery preparation, saving enormous quantities of ammunition, without mentioning the advantage of surprise.

The tank is also of great moral benefit to the troops, saving the lives of many combatants, while carrying devastation and terror in the enemy's ranks.

Another advantage rendered possible is the reinforcing of provisions and ammunition for the troops in the first line and during the battle. Previous to the use of tanks the troops engaged were deprived of almost everything, and had to cease fighting, the roads being broken up and the railways interrupted, and when victory seemed near it could not be realized owing to the impossibility of bringing up the necessary provisions.

The employment of tanks on the largest scale, for which all the armies are now preparing, may prove an efficacious means of reinforcement, and may be the cause of a radical reform in tactics and field fortifications.

There are two kinds of tanks which may be used in battle:—heavy cars for demolitions, and light cars.

Tanks of the first type are used chiefly against strongly defended positions, which artillery fire has not succeeded in destroying or at least in sufficiently disorganizing.

The light tank (Whippet, English, and the new type Renault, French) is designed to rapidly complete the initial success of the breaking of the lines, causing confusion and panic among the enemy's troops. The French light car is especially designed to operate in strict contact with infantry.

However, to render possible the advance of the infantry, it is necessary that all the enemy's machine guns should be silenced, and as the zone of action of the tanks becomes at once, after their entry into the lists, a zone of concentration for the enemy's fire, it is indispensable, as has been clearly shown from the experience of war, that the assaulting tanks should always be used in mass, and never isolated or in small groups; and on the other hand it is necessary that the accompanying infantry should be numerous.

It is important that there should be a distribution in depth of the assaulting tanks so that the infantry reserves should correspond with like reserves of tanks.

It is also necessary to take into account that during the battle many cars will be disabled by damage to the motors, or by the fire of the enemy's artillery.

In order to diminish as far as possible the losses, and to profit by surprise, the tanks should enter into action at dawn or at a time of mist or fog.

In cases of serious resistance the tanks should attack frontally, while the infantry manœuvre on the flanks. On gaining the established objective the cars should be ready to continue the action by guarding the ground to the front against eventual counter-attacks.

The preliminary operations previous to action are:—

(*a*) Reconnaissances in order to inform the command on the possibility of employing the assaulting cars on the ground to be traversed, and for establishing posts for assembling, waiting, and starting.

(*b*) Local reconnaissances to give to every unit the precise idea of the development of action, exploring the roads and the obligatory routes, and for determining the works required to be executed for the passage of the tanks across our lines, and studying minutely the organization of the enemy's defences. After establishing the data for action the tanks should be transported by railway or by ordinary roads, as near as possible to the scene of action, and afterwards to the position of departure, where they should arrive at least two hours before the commencement of the attack. All the movements should be made at night or in misty weather.

If the action is preceded by artillery fire of long duration, the tanks may be usefully employed against the enemy's second line, as it may be presumed that the first line has been completely destroyed.

If the attack is undertaken by surprise and always at dawn a short but violent fire on the enemy's lines should be required from the artillery. The fire should be transformed into a movable barrage, with an increase of range of 100 metres to the minute, and with a proportion of smoke shells, so as to create a smoke barrier between the tanks and the enemy. Field guns can eventually follow the attack in order to neutralize the enemy's artillery of small calibre in anti-tank positions. The infantry advancing in strict contact with the cars should protect them at all costs.

Aeroplanes flying low, besides deadening by their motors the noise of the tanks, should harass the enemy with smoke shells, attacking the batteries from time to time and furnishing information to the crews of the tanks on the general progress of the battle.

To give an idea of the organization of the assault we may quote the system established in the French army and which was adopted by other armies.

In France usually previous to an action there was assigned to each infantry division a battalion of assaulting tanks of three companies with three sections each.

The unit for manœuvres and the tactical unit was the section, composed of five cars (one command-car and two half sections—composed each of a cannon-car—and of two mitrailleuse-cars, whose duties were to work on the flanks and to co-ordinate their efforts according to the orders of the commandant of the section). The formations for battle are lines and columns.

The commandant of the section gives his orders by means of flags waved from the cupola of his tank.

The various means for communication are scrupulously attended to: they are essentially pigeons and small courier-cars equipped with wireless apparatus (one for each company).

It is evident from what has been said that every operation of war depends on the assistance of the accompanying infantry on whom depend the solution of the combat.

Every attack by combined tanks and infantry requires long and methodical preparation.

ANTI-TANK DEFENCES.

There are several methods of defence against tanks, the chief one being the posting of artillery of small calibre at short distances from the first lines so as to fire against them.

If isolated pieces of 37 to 50 mm. are employed in certain sectors, each field battery selects an advanced position for one piece, from which it can contest the probable passage of the enemy's assaulting tanks.

Besides shell fire it also may be useful to arrange for protection by means of smoke and asphyxiating gas, which would compel the crews of the cars to wear masks and thus harass the movements of their machines.

Infantry and machine guns are also supplied with small perforating bullets to fire against the armour of the assaulting cars. The ground over which the assaulting tanks have to pass should be mined. Deep pits may be dug covered with thin strata of earth in the vicinity of the more important centres of resistance, and near to which isolated quick-firing guns are placed so as to fire directly at short distances on the enemy's tanks, when the latter owing to having fallen into these pitfalls are put out of action and present easy targets.

SPECIAL USE FOR TANKS.

Tanks may be used in savage warfare, and in fact were used in Lybia, and would have been more largely used if the Arabs had not surrendered without fighting.

It can also be foreseen that they may be largely used and with good results, for public security, in repressing riots, a use for which they are far better adapted than unarmoured cars.

E. T. THACKERAY.

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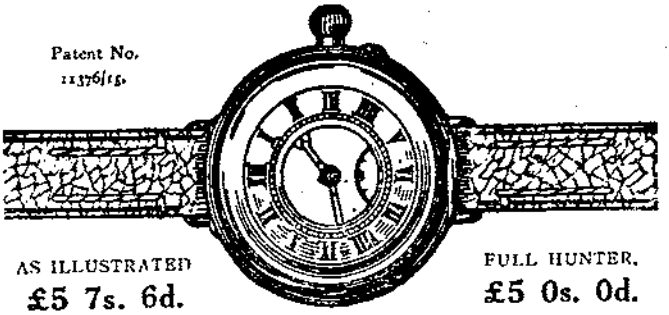

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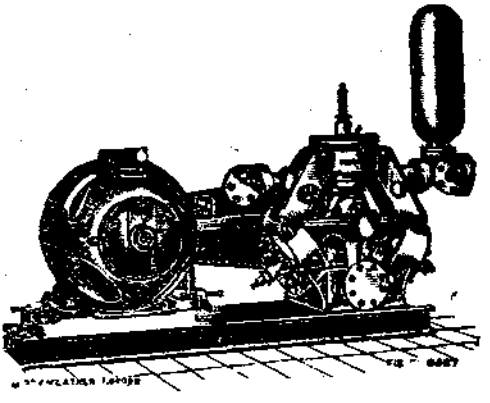

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