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CONTENTS.

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CONTENTS.

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SUGGESTIONS FOR CARRYING OUT FIELD COMPANY SCHEMES.

1. *Preparing a "Locality" for Defence.*—This includes :—

(*a*). Reconnaissance of locality.

(*b*). Placing look-outs.

(*c*). Bringing up first-line transport under cover to nearest point to scene of work.

(*d*). Marking trenches on ground, including dug-outs, communication trenches, etc.

(*e*). If locality has to be prepared entirely by R.E., placing the men at their tasks with proper tools.

(*f*). If infantry working parties are sent, allotting sappers to the more technical tasks, arranging N.C.O.'s or sappers to show the infantry what to do, etc.

(*g*). Making a plan on such a scale (at least 40 in. to 1 mile : 1 in.=50 yards being convenient) that an infantry subaltern would be able to carry out the preparation of the defence if the R.E. are called away.

(*h*). Should the locality consist of buildings, the loopholing of walls, barricading of windows, and destruction of outbuildings and trees, etc., interfering with field of fire, must be included in the work and shown on plan and sections.

(*i*). Bold freehand sections should be plentiful—not cramped, indecipherable drawings. N.C.O.'s should be taught to make these.

(*j*). The scheme will comprise in all cases a rough but clear table showing how all the men in the Field Company Section are utilized, and the responsibility allotted to the N.C.O.'s.

2. *Obstacles and Clearings.*—When the scheme includes the above, follow out generally the instructions in paras. (*a*) to (*c*), (*e*) to (*f*), (*i*) and (*j*).

3. *Pontoon Bridging.*—When this is ordered, carry it out actually.

4. *Trestle and Other Bridging.*—When this is ordered, all that is required is a section and a statement showing where materials are available, and the working parties and transport can be found. Do not forget that local wagons, with the horses from the tool carts, will often be found convenient for transport, local horses also if obtainable.

5. *Diary of Work.*—A diary of the day's scheme, including times, will invariably be kept. The record of *times* is most important. Use the *Field Pocket Book* (AB 153) for diaries.

6. *Communication with C.O.*—This is of all importance. Acknowledge all messages. The C.O. will always tell you where to find him. On reaching the scene of work, send a cyclist to the C.O. This cyclist will be kept by the C.O., and, knowing the way back to his section, forms a most valuable link between the various parts of the company.

7. *Roads, etc.*—When the scheme includes the construction of roads, mark out the road on ground, state where materials are available and what means are at hand for transporting them, and how you allot your N.C.O.'s and sappers to superintend working parties of infantry. Plans and sections showing how the road is made must be provided. These instructions also apply to the improvement of existing communications, *e.g.*, the improvement of a country lane or farm track into a motor road, etc. Do not forget the value of bricks, planks, etc., from buildings, the use of hurdles, brushwood, tree trunks, etc., for improving roads on soft ground.

8. *Approaches.*—Do not forget that every bridge needs an approach.

9. *Trenches, etc.*—When not ordered to be actually made, must be traced, and working-party tables drawn up. Plans and sections on suitable scales.

10. *Topographical Sketches.*—When a sketch is required, enlarge the ½-in. map to 4 in.=1 mile and put in all detail useful for military purposes. Insert approximate contours, figured.

11. Hand in full reports at conclusion of operations.

12. Carry out all schemes under active service conditions.

13. *Bivouacs and Water Supply.*—When equipment is available, actually carry out the water supply. When not available, draw clear plans and sections, and show details on a table with distinguishing letters.

14. Do not forget that these schemes are for your own instruction and that of your N.C.O.'s and men. It is only by constant explanation to them that you will get the fullest value out of the training. It is of the greatest value to all ranks that they should find out in peace training as many as possible of the small practical difficulties that will occur in war.

F. G. GUGGISBERG.

ELECTRIC REMOTE INDICATORS FOR RIFLE RANGES.

(Reproduced with the kind permission of the Editors of "The Electrical Review").

ATTEMPTS have occasionally been made to employ electrical apparatus in rifle ranges for signalling the value of each shot, but the arrangements so far devised have usually been of a rather rudimentary description, and could be used only in conjunction with the usual mechanical indicators.

The Marksmen's Society, of Spandau, near Berlin, just before the outbreak of war, took a decisive step in this direction by having

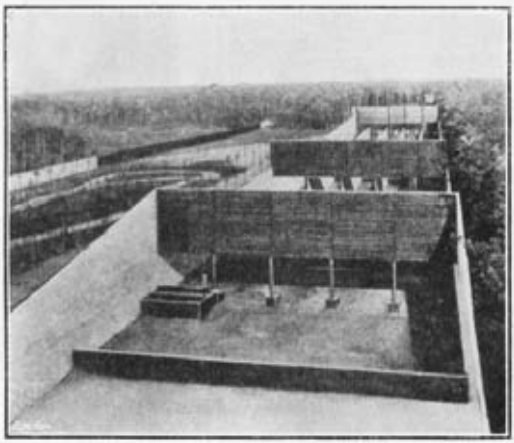


FIG. 1.—*Rifle Ranges at Spandau.*

all its rifle ranges fitted with electric remote indicators on the Siemens system. The installation, which was supplied by the Siemens Co., offers a number of novel features, and may be briefly described.

The Society owns extensive shooting grounds, comprising three 300-m., 12 175-m., and two 100-m. ranges, and one of 35 m. Each range is fitted with a transmitter and a receiver, serving to signal the number of the rings hit each time. Each of these apparatus, connected together by electric cables, possesses a scale, the 23 divisions of which bear the inscriptions 0, 1, 2, 3, . . . 20,

Electric Remote 1

"telephone" and "stop." The transmitter is installed to the left of the target, between the guide bars of two contiguous targets (*Fig.* 2), there being no need to provide any special room for it, as in connection with previous installations. The receiver is arranged at the firing point, to the left of the marksman (*Fig.* 3), and is readily read and checked by the latter, as well as by the secretary seated immediately behind him. Each transmitter and receiver comprises an index fitted with a handle, which is easily adjusted by hand, the pointer and handle of the transmitter being connected, in the interior of the casing, with an adjusting arrangement resembling a small

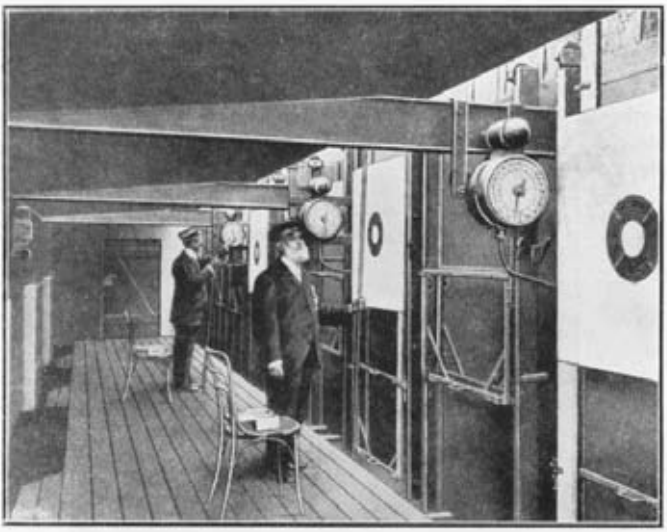


FIG. 2.—*Transmitters at the Butts.*

electric motor (*Fig.* 4), which ensures perfect agreement in the readings of the two apparatus. The index of the receiver is shifted by a similar system, and, being protected by a glass plate, cannot be interfered with by the marksman.

With each new reading marksmen are advised by a short acoustic signal given by an electric buzzer, at the transmitter and receiver, which is readily distinguished from the bell signals employed for other purposes. At the marksman's post and on the desk of the secretary seated behind him, there are push buttons actuating simultaneously the buzzers of the transmitter and receiver, which are distinguished by their different timbre.

Electric Remote 2

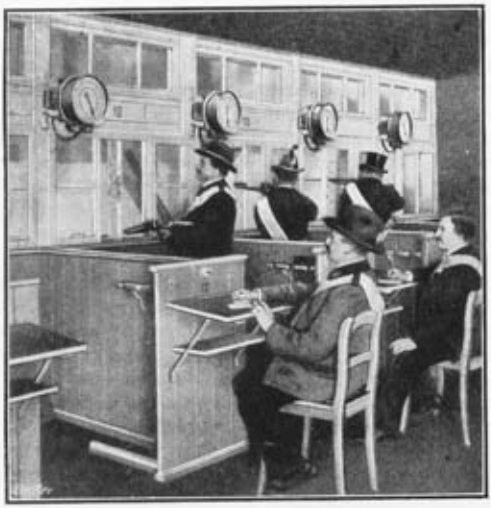


FIG. 3.—*Firing Point, showing Receivers.*

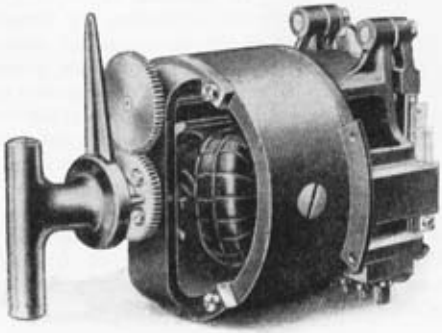


FIG. 4.—*Mechanism of Transmitter.*

Electric Remote 3

The installation further comprises a telephone plant. Water-tight telephones, arranged in the passage-way of each range, are connected up to an indicator switchboard installed in a special cabin, whence each telephone is readily called. In order to get a connection with his marksman, the man entrusted with the operation of the transmitter has only to adjust the index of the latter to the division "telephone," thus causing the receiver index to take up immediately the same position, and advising the marksman that he is wanted on the telephone. The telephone plant has been designed on the central-battery system, the battery being installed so as to be protected against atmospheric influences. The telephone apparatus are joined together by means of armoured cables.

The installation works as follows:—After taking up his post at the firing point and firing his shot, the marksman presses down the push button on his left, thus actuating the buzzers of his receiver and transmitter and calling the attention of the operator. The latter looks for the mark left on the target by the shot just fired, pointing out with a small rod the section in which this mark is found (top, bottom, right or left). Having then taken down the target, he adjusts the transmitter index to the number of the ring hit by the marksman. While he is shifting this index, the electric buzzers of the transmitter and receiver are sounded simultaneously, and the receiver index takes up the same position as that of the transmitter. The operator finally pastes some paper on the mark made by the bullet, after which the target is ready for another shot.

The first cost of this electrical outfit is in most cases more than made up for by the saving of ground and accommodation. Operating expenses are extremely low. At Spandau, three-phase current at 220 volts, 50 cycles, is available for feeding the apparatus, thus allowing a very simple type of alternating-current indicator to be used. The 18 shooting ranges are arranged in six groups each of three, and as each group has an armoured underground cable of its own, any breakdown in operation will be limited to the three ranges of a given cable. Each group communicates with the electric mains through a transformer stepping down the pressure from 220 to 55 volts. The consumption of power of each transmitter-receiver set is about 28 watts.

An additional advantage of the electrical indicator is the possibility, as brought out by actual experience, of shooting at a rate 50 per cent. higher than usual, which is especially important on the short winter afternoons.

THE PRACTICAL PROBLEM OF TELEGRAPH TRANSMISSION FROM A NEW ANGLE OF VIEW.

By MAJOR W. A. J. O'MEARA, C.M.G., *p.s.c.*

THE theoretical aspects of the problems connected with the transmission of electric currents for telegraph purposes have been closely studied by eminent mathematicians and physicists from the earliest days of the development of electric means of communication ; one of the first of the important contributions to the science of telegraphy was the paper by Lord Kelvin (then Professor Wm. Thomson) "On the Theory of the Electric Telegraph," published in the *Proceedings of the Royal Society of London* in 1855, and much information of practical value in relation to this subject has been published since that date.

The telegraph engineer of pioneer days, as does his successor of modern times, utilized for the transmission of telegraph signals a source of energy the use of which was intended to cause a current of the maximum amplitude required in a given circuit to flow from the moment that the transmitting device was operated ; that is to say, an effort was made to send out square-topped electric wave impulses, and this was the case both for the purposes of ordinary land as well as long-distance cable telegraphy. There was, and still remains, this difference between the systems of signalling in the two cases, namely—whereas in the case of the former the elements of a letter were, and are still, formed by current impulses of the same sign but of unequal durations of time, on the other hand in the latter case these elements were, and are still, formed by current impulses of opposite sign but of equal durations of time ; the two systems of signals are shown side by side in *Plate* I. In Lord Kelvin's paper, to which reference has been made, mathematical data were provided which enabled the telegraph engineer to calculate, for the different conditions of electric circuits, the ordinates of the "curves of arrival" of the current impulses used in telegraph signalling. Since the form of the "curve of arrival" practically determines the number of decipherable signals which can be sent in unit time along the conductor forming a telegraph circuit, the subject was of immense importance in connection with the design of long submarine cables. The "curve of arrival" is obtained by plotting, as ordinates, the

various amplitudes of the received currents to some scale calculated in relation to the intervals of time reckoned from the instant of applying the battery at the sending end, these intervals of time being plotted as abscissæ; "curves of arrival" enable an engineer to visualize what is taking place, instant by instant, at the receiving end of telegraph circuits, and the characteristics of conductors can thus be studied in relation to their electrical constants. Since the early days of the electric telegraph other means have been discovered for ascertaining the nature of the "curve of arrival"; of these means the oscillograph is perhaps the most useful for practical purposes. The use of an oscillograph permits a photographic record of the current fluctuations, at any accessible point of a circuit, to be made instantaneously, and the necessity of making tiresome mathematical calculations to determine what may be taking place in a conductor, from point to point, is thus entirely obviated. The ordinates of a "curve of arrival," based on the data contained in Lord Kelvin's paper, have been calculated and the curve has been plotted (*vide Plate* I.); its form shows that the current takes quite an appreciable time, after the battery is applied, to rise to its maximum amplitude, and that, indeed, for a short interval after the current is started, known as the "silent interval," no measurable current reaches the receiving end of the circuit. Telegraph engineers have made considerable use of the scientific data placed at their disposal; they have, however, concentrated their attention on the improvement of line conditions and the designing of extremely sensitive apparatus for operating the devices installed at the receiving end of a line, but have, to a great extent, neglected the study of the source of energy question.

Without a doubt, marvellous progress has been made during the past 70 years or so; improved types of transmitting and receiving apparatus have been designed; a machine has been constructed for automatically recording received messages at high speed (100 to 120 words a minute) type written in page form; another machine has been constructed in which the spark from the discharge of a condenser is employed to photograph on to a moving band of sensitized paper, which is automatically fed into a fixing bath, the images of letters and other symbols cut in stencils fixed to the periphery of a rapidly revolving plate: this band of photographic paper is delivered ready for use almost immediately after the completion of the message. But in all these cases the source of energy, almost universally employed for transmitting the signalling wave impulses, is the constant potential type used from the earliest times: the only changes which have been made in this part of the telegraph circuit, consist in the substitution of secondary cells for the primary batteries, the utilization of direct current lighting installa-

tions in connection with telegraph signalling, and the use of specially designed dynamos (confined almost entirely to the United States of America), that is to say, the square-topped wave impulse has been retained in use for telegraph purposes in spite of its patent defects. The curve representing the square-topped telegraph signalling wave impulse is, after all, merely a type of complex periodic curve, and, as is well known, Fourier showed that any periodic curve, as long as it nowhere goes to an infinite distance from the axis of X, can be built up by compounding together a finite number of harmonic curves, the periods of which are commensurate. Nowadays, the analysis of a complex periodic curve for the purpose of determining the amplitudes and phase angles of the different harmonics of which it is compounded can be effected either mechanically by means of machines specially constructed for the purpose, or mathematically.

The mathematics of the theory of electric wave transmission discloses the fact that, in the case of the propagation of electric waves along certain classes of conductors, the waves of different frequency or wave length travel at different speeds and attenuate at different rates, that is to say, in such cases a complex periodic wave impulse undergoes *distortion* during transmission. The above theory shows that in the case of the transmission of telegraph signals along aerial conductors of low electrostatic capacity β, the attenuation factor is independent of n, the periodicity of the signalling wave impulses, but that in the case of transmission along conductors in cables, whether subterranean or submarine, this is no longer so. In the latter case β is theoretically proportional to $\sqrt{n}$, although tests show that this relation is not always obtained with strict accuracy in practice. The amplitude of an electric current along any conductor, as is well known, decreases during propagation in the ratio of $1 : \epsilon^{-\beta l}$, where β is the attenuation constant per unit length of conductor (per mile or per km.), and l is the distance, in the same unit of measurement, from the end at which the potential is applied and ϵ is the base to the Naperian system of logarithms. How very great is the difference in the rate of attenuation of the different harmonics of a complex periodic wave impulse may be seen from the figures relating to a particular copper conductor in a cable, certain data regarding which are available for the purpose of making the necessary calculations. The constants of this conductor are as follows :—

Diameter	= 2·55 mm.
Electrostatic capacity	= ·07 mfd. per km.
Inductance	= ·0004 henry per km.
Resistance	= 3·322 ohms per km.

The measured values of β for this conductor, at certain periodicities, were ascertained to be as follows :—

$n=400$ ($\sqrt{n}=20\times 1$).	$n=1000$ ($\sqrt{n}=20\times 1\cdot581$).	$n=2000$ ($\sqrt{n}=20\times 2\cdot236$).
·023	·033	·041

Utilizing the above values of β, the amplitudes of the received current of an initial amplitude of 100 milliampères have been calculated, for the frequencies stated above, in respect of certain lengths of the above conductor, the results obtained are as follows :—

Length of Circuit.	Distance between Towns Named = Length of Circuit.	$n=400$.	$n=1000$.	$n=2000$.
10 km.....	--	79·453 ma.	71·892 ma.	66·365 ma.
100 km.....	London—Portsmouth ...	10·026 ma.	3·688 ma.	1·657 ma.
150 km.....	London—Birmingham ...	3·1745 ma.	·7083 ma.	·2133 ma.
300 km.....	London—Plymouth	·10077 m a.	·00502 ma.	·00045 ma.
700 km.....	London—Perth	·000010185 ma.	·000000009 ma.	·00000000003 ma.

The above values demonstrate that a wave impulse of a given amplitude transmitted at the lowest of the frequencies for which calculations have been made, even in the comparatively short distance of 300 km. from its origin, decreases in amplitude to nearly the one-thousandth part of its initial value, whilst the same current transmitted at the highest of the frequencies given above at the same distance of 300 km. decreases to approximately the 200-thousandth part of its initial value, that is to say, in this particular case the fifth harmonic decays 200 times as fast as its fundamental sine wave in the short range of 300 km. The other values given in the table speak for themselves.

The fact that current impulses of different frequencies are propagated at different velocities along any given circuit results in the displacement of the phase angles of the various harmonics composing a complex periodic wave impulse in relation to its origin or starting point, and hence relatively to one another; for instance, in the case of the 2·55-mm. conductor, already referred to, under certain conditions of dielectric conduction (leakance) the lag is only 2 degrees per km. in the case of the sine wave having the frequency $n=400$, whereas in the case of the harmonic having the frequency $n=2{,}000$, the lag increases to 4·5 degrees per km. This phenomenon of different phase-angle displacements which occurs in the case of the several component waves of a complex wave impulse is analogous to the phenomenon of refraction when white light passes obliquely from a medium of one density into that of a different density; and the displacements of the phase angles of sine waves of the different periodicities can, in relation to any known distance from the transmitting end of a conductor, be represented diagram-

matically to scale in a manner similar to that employed to depict the refracted positions of light waves of different frequencies in a diagram of the solar spectrum. For instance, if a line YZ be graduated in electrical degrees, there can be marked along it the displacements of the phase angles of the sine waves of the various frequencies arising in connection with the transmission along any particular conductor of a complex periodic wave impulse compounded of the sine waves in question. If normals to YZ be drawn in appropriate colours (shading into one another) to mark the positions of the displacement of the phase angles of each of the sine waves present in any complex periodic impulse a coloured spectrum scale is obtained; so that if such spectrum scales be suitably drawn in respect of electrical circuits of the same length, but of which the electrical constants differ, means are obtained for a rapid visual comparison of what may be termed the dispersion properties of the conductors under investigation. The general idea of the spectrum scale method of representing the transmission properties of a conductor is shown in skeleton diagram in *Plate* II., in which the comparison of two conductors, of which the constants are given, can be made at sight. This diagram can also be utilized for reading off the lag of the phase angle at any intermediate point of the conductor, thus: erect a perpendicular YX to YZ and make XY equal, to some scale, to the length of the conductor in respect of which the spectrum scale has been constructed, join X by straight lines to the points along YZ representing the displacements of the phase angles. Then, if XY be graduated to represent intermediate distances between XY. the points of intersection of a line drawn through the appropriate mileage graduation with the lines from X to the phase-angle markings along YZ (the spectrum scale) will give the displacement of the phase angles of the several harmonics at the intermediate distance in question as shown in the figure.

Unfortunately, it has not been possible to find time to make the complete calculations necessary for the determination of the amplitudes and phase angles of the sine waves from which the ordinary square-topped telegraph wave impulse is compounded. However, the ordinates of a complex periodic curve compounded of 100 pure sine waves having frequencies in the ratio of 1, 3, 5, 7, 9, etc., to 199 and amplitudes relatively proportional to 1, $\frac{1}{3}$, $\frac{1}{5}$, $\frac{1}{7}$, $\frac{1}{9}$, etc., to $\frac{1}{199}$ have been calculated. It is assumed for present purposes that all these sine waves start from the same zero, with the same sign; the complex curve obtained by plotting the ordinates calculated on the foregoing assumption, and also the fundamental sine wave of the above series are shown in *Plate* I. The former of these two curves, it will be seen strongly resembles the shape of the square-topped telegraph curve.

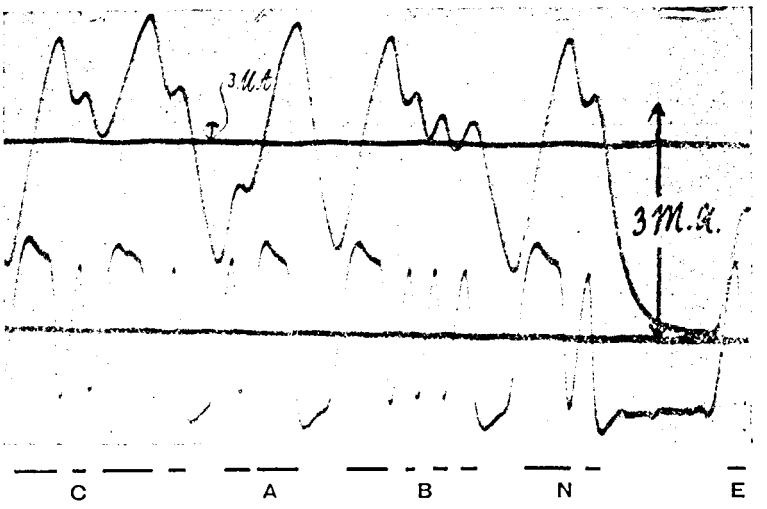
The speed of signalling on land lines varies considerably, according to whether manual or automatic machine transmission is employed. At one time Morse telegraph operators were expected to signal, by hand, at the rate of from 32 to 36 words a minute; it is believed that 28 words a minute is now considered a sufficient output per operator in this country. In the case of the automatic Wheatstone apparatus from 200 to 600 words per minute can be transmitted, by the use of a punched tape; the length of the conductor and its characteristics largely determine the maximum number of words per minute which can be transmitted in any particular case, but practical considerations often dictate that the output arrived at shall be much below the maximum obtainable. In the international Morse code four elements are, on an average, employed to form the letters, signals and symbols in use; the average number of letters in the words employed in the text of telegrams in the English language is approximately five, and, therefore, including the spaces 20 alternations are employed, on an average, to transmit each word in a telegram. Therefore in the case of hand signalling, at the rate of 30 words per minute, a train of complex periodic wave impulses, whose fundamental wave has a frequency $n=10$ per second, is propagated along a conductor. In the case of transmission by the automatic Wheatstone apparatus at the rate of 300 words per minute the fundamental wave has a frequency $n=100$ per sec. An inspection of the complex periodic wave shown in *Plate* I. creates an impression that higher harmonics than those of which it has been compounded enter into the composition of the square-topped telegraph wave impulse; so that in the case of hand signalling at the rate of 30 words per minute sine waves having frequencies exceeding $n=1,990$ per second are probably propagated at the transmitting end of a telegraph conductor, and in the case of transmission by automatic Wheatstone apparatus at the rate of 300 words per minute frequencies exceeding $n=19,900$ per second are probably present at the transmitting end of the line.

In the case of long-distance submarine telegraphy, the speed of signalling is naturally much lower than in the case of land lines. The formula sometimes used to ascertain the maximum speed of transmission on a submarine cable is $N=\frac{2700}{CR}$ per minute, where N represents the maximum number of decipherable signals which can be transmitted and CR is the product of the total capacity and resistance of the conductor; for example, the Brest-Dakar cable has a constant of $CR=7$ seconds, and therefore, the maximum speed of transmission on this cable is:—

$$N=\tfrac{2700}{7}=386 \text{ legible signals per minute.}$$
$$=19 \text{ words per minute.}$$

The speed of transmission on long submarine cables has been much increased by the adoption of the method of "curbed" signalling which is analogous to double-current sending on land lines, but even with this method of cable transmission when signalling at high speeds is resorted to, the elements composing the letters are apt to run into one another, and this is particularly the case with letters like "S" or "H" which are formed by three or four square-topped waves of the same sign, that is to say, even the delicate forms of receiving apparatus used in cable telegraphy are unable to resolve the separate impulses, and hence it is that highly expert operators are required to handle the received slips or tapes on which the incoming messages are recorded. Some idea of the degree of *distortion* which signals undergo during the process of transmission along a submarine cable can be gained from the accompanying oscillograph record which represents a few of the letters of the alphabet signalled

AS RECEIVED.



AS SENT.

according to the method adopted in land telegraphy. These signals were transmitted along one of the Anglo-German cables between the Norfolk coast and Borkum during some experiments carried out in 1910; unfortunately, details of how the circuit was made up are not available. It will be observed that the dash element of the letter which has a distinct squareness at top at the sending end has lost this characteristic by the time the wave impulse reaches the receiving end, where it arrives in the shape of an ordinary sine wave; whilst in the case of the dot element the very appreciable diminution

in amplitude which this element undergoes in its journey can be clearly traced. The scale of the diagram is somewhat too small for utilization in connection with accurate calculations; however, it is possible to ascertain the difference in phase of the sent and received currents therefrom, thus the zero points of the dash elements of the letters A and B are found by measurement to be $\frac{30}{60}$ in. apart; if these zero points of the sent signals be projected on to the centre line of the received signals it will be found that the corresponding zero points of the same elements on the latter centre line are, on an average, $\frac{5}{60}$ of an inch apart; therefore the received current lags in phase in relation to the sent current by $\frac{5}{30} \times 360° = 60°$.

Recently a paper "On an Unbroken Alternating Current for Cable Telegraphy" was read before the Physical Society of London by Lieut.-Colonel Squier, PH.D. In this paper the practical problem of telegraph transmission is treated from a new angle of view. The telegraph engineer of pioneer days was restricted to the use of the source of energy which causes square-topped wave impulses to be propagated along a telegraph conductor; it is otherwise to-day. The author states: "If an engineer were required to design a system for operating an electric motor through an Atlantic cable, no form of generator could be proposed at present, other than a single-phase alternating current of the sine-wave type. This form, we know, will deliver power at the receiving end of the cable more efficiently than any other shape wave." In the paper in question attention is called to the fact, already referred to earlier herein, that in the case of long submarine cables "no matter what the shape of the alternating current transmitted, approximate sine waves are received at the distant end of the cable. Battery reversals produce just as accurate sine-wave signals on the receiver as does the alternator itself." It is urged that since both theory and experiment show that a sine wave is the only one which can pass through the cable without changing its characteristic form, it is most desirable that steps should be taken to alter the typical telegraph circuit so as to admit the employment of pure sine waves for telegraph signalling purposes; the harmonic waves, required to build up the square-topped wave, impressed at the transmitting end are absorbed in the cable itself, and never reach the receiving end, they represent merely a superfluous electrical charge which must, for each signal, be got rid of before the succeeding signal can be sent into a cable. Colonel Squier also points out that: "The opening and closing of an alternating current circuit is well known to produce disturbances of a more or less pronounced character, depending upon the angle of phase at which the current is opened or closed." And it may be remarked here that under present-day conditions, which render it necessary to place conductors for important telegraph and telephone

circuits in close proximity to one another along the same routes, the disturbances of the nature referred to have been responsible for the rejection of more than one invention in the field of high-speed telegraphy; inventions, moreover, which otherwise possessed most desirable features.

The author of the paper in question advocates that the practice in regard to telegraph signalling should be put on a rational basis and with this object in view discusses the merits of a system of transmission in which it is proposed to utilise an uninterrupted alternating current of pure sine-wave form for telegraph purposes, this current being operated upon by the ordinary punched transmitting tape in such a manner as to alter the impedance of the transmitting circuit at the instants *when the current is naturally zero*. By this means the amplitude of the current flowing in the circuit can be varied in any manner desired at the most appropriate moment. In the system here advocated, each semi-wave of either sign represents the dashes, dots, and spaces: each of these elemental signals is formed by a current of different amplitude, the amplitude of the dot being made twice that of the space semi-wave, and that of the dash double the amplitude of the dot semi-wave; the semi-waves constituting a few of the letters of the alphabet are shown diagrammatically in *Plate* I.: in the diagram in all three cases the same letters of the alphabet are shown in the same sequence, but whereas the letters as signalled in the land and cable telegraphy systems occupy practically the whole interval equivalent to 50 units, it is possible to repeat the letters on the sine-wave system in the interval equivalent to 42 units on the same scale.

For purposes of comparison the methods of signalling in Morse Code on land lines and on long submarine cables are shown on the same Plate as the system of signalling proposed by Colonel Squier, and it will be readily recognized from an inspection of these diagrams that in addition to the other advantages likely to accrue much economy of time will also be gained by the use of pure sine-wave signals, as compared to that consumed in signalling with the square-topped wave signals.

The alternating currents received may be utilized either to trace the message on a tape by employing a siphon recorder or these currents may be employed to operate a siphon Morse printer, by means of an adaptation of Muirhead's gold-wire relay, or a Huntley magnifier and a local relay. The question of the "resolving power" or definition, in relation to the legibility of the letters signalled, is discussed in the paper in question; in it is also developed the fundamental principle of never metallically "breaking" the transmitter circuit; and a special form of dynamo, to operate at frequencies of from 4 to 10 per sec., which was used in carrying out experiments on an Atlantic cable is described.

Although the problem of telegraph transmission is treated by Colonel Squier from the standpoint of long submarine-cable circuits, nevertheless he recognizes that the employment of the pure sine-wave impulse could, with advantage, be employed for signalling on land lines; not the smallest of these advantages would be the removal, in the case of the automatic Wheatstone system, of the making and breaking of the circuit at comparatively high voltage; the effect of its adoption would be, at a single stroke, to reduce very largely the inductive disturbances produced by high-speed telegraph circuits on neighbouring telephone and telegraph circuits, effects which often cause not only annoyance and trouble but also give rise to unnecessary expense. Another of the advantages would be that the possibilities in connection with the working of *superimposed* telegraph circuits on long-distance telephone trunk lines could be enormously increased.

In conclusion Colonel Squier points out "that certain characteristics are very desirable in any cable system, such as

(*a*). All signals should represent equal lengths of time.

(*b*). No two consecutive signals should be of the same sign.

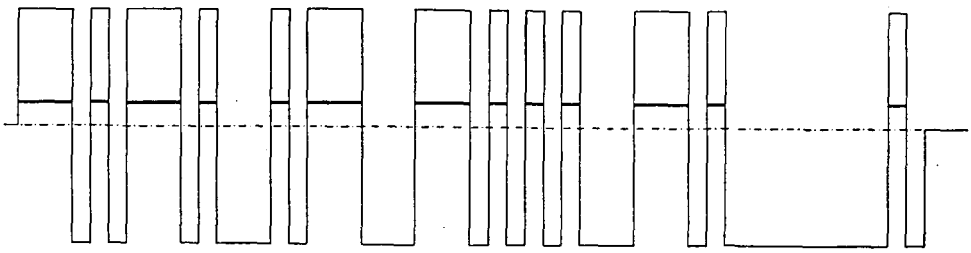
(*c*). The resolving power or definition of each letter of the alphabet should be as nearly as possible the same.

(*d*). The total quantity of electricity measured in coulombs impressed upon the cable should be as nearly as possible equal to zero for any two consecutive signals."

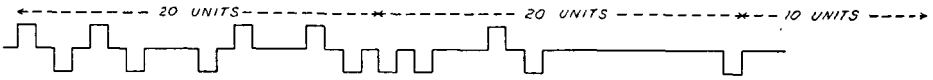
Finally, attention is drawn to the fact that "the ideal solution for power transmission automatically comprises each of these conditions, and, in addition, has other advantages in safety to the cable property from undue electrical strain throughout every centimetre of its length." It is undoubtedly the case that the system of signalling by alternating currents proposed above goes far to meet the above-mentioned requirements.

The angle of view from which the subject of telegraph transmission has been considered here provides, it is thought, a strong argument for the abandonment of the arbitrary square-topped wave impulse hitherto in use for telegraph signalling purposes, and for the adoption in its place, both in the case of land lines and in that of submarine cables, of the more scientific, and therefore more efficient, pure sine-wave impulse.

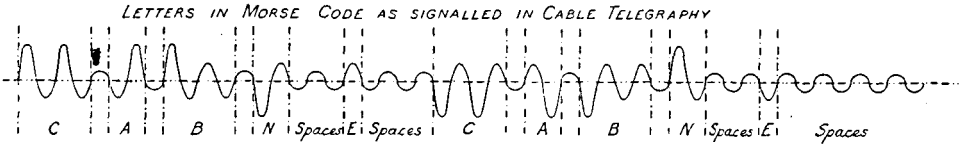
TELEGRAPH TRANSMISSION.



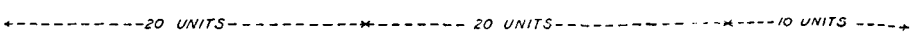
LETTERS IN MORSE CODE AS SIGNALLED IN LAND TELEGRAPHY

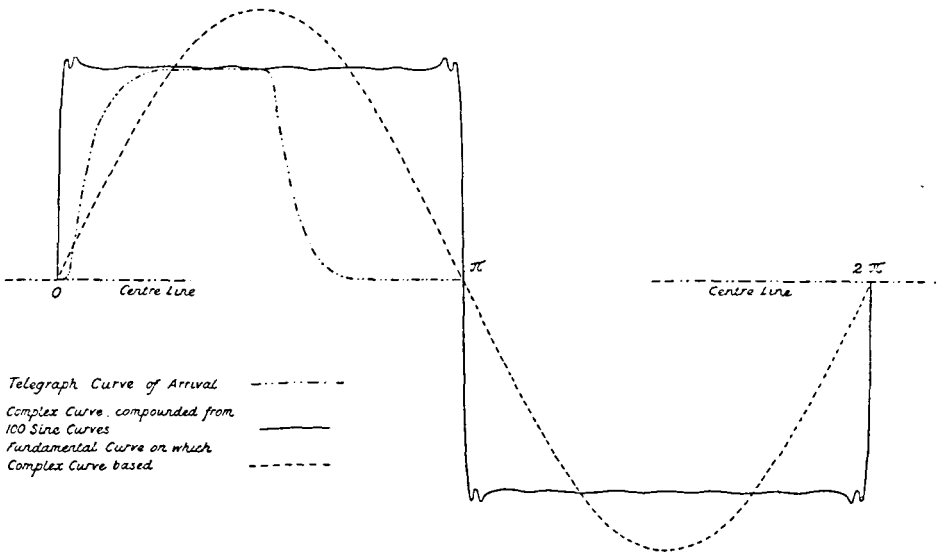


LETTERS IN MORSE CODE AS SIGNALLED IN CABLE TELEGRAPHY



LETTERS AS SIGNALLED BY THE SINE WAVE SYSTEM





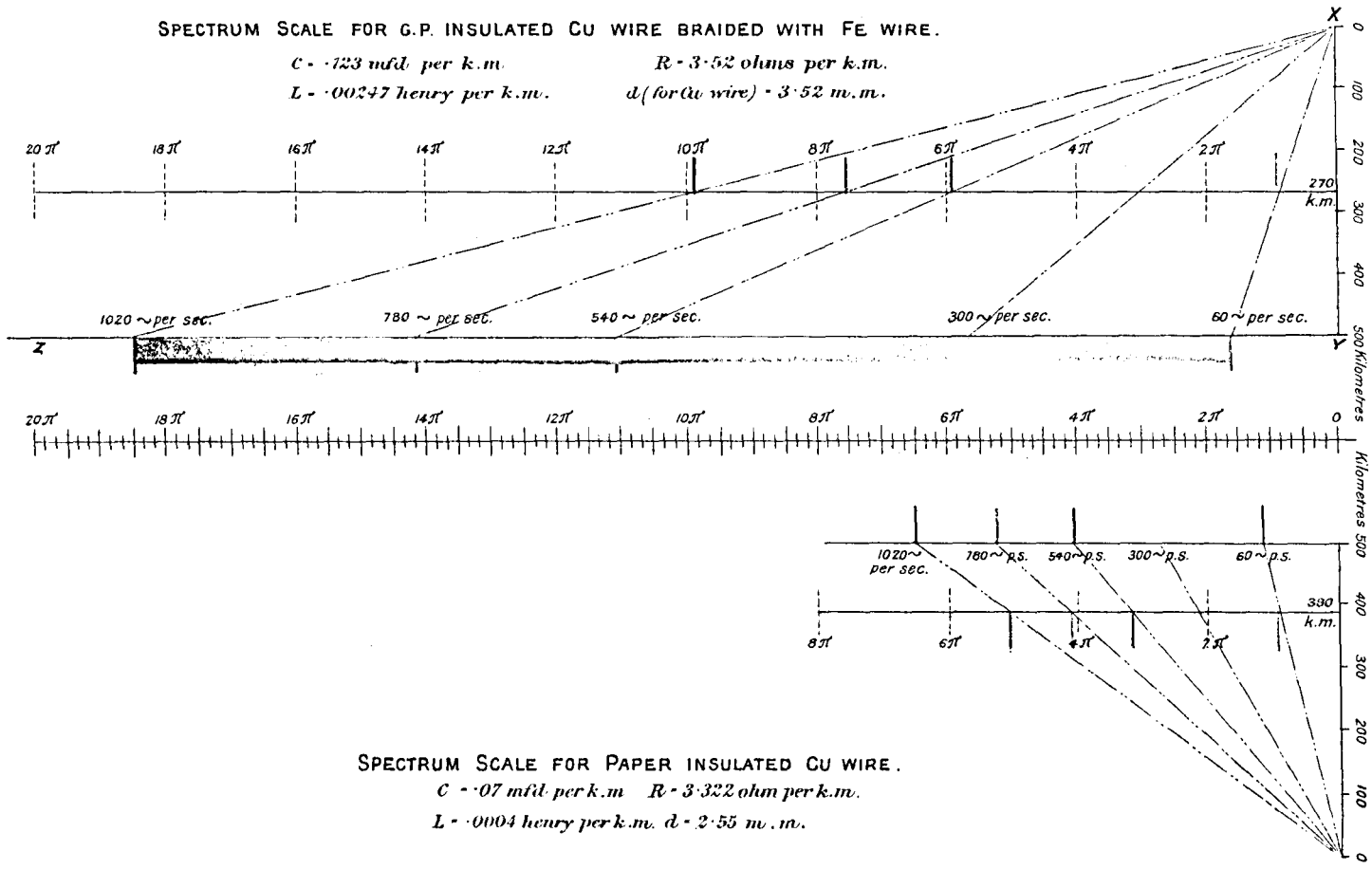

SPECTRUM SCALE FOR G.P. INSULATED CU WIRE BRAIDED WITH FE WIRE.
C = ·123 mfd. per k.m.
R = 3·52 ohms per k.m.
L = ·00247 henry per k.m.
d (for Cu wire) = 3·52 m.m.
20π 18π 16π 14π 12π 10π 8π 6π 4π 2π
270 k.m.
1020 ~ per sec.
780 ~ per sec.
540 ~ per sec.
300 ~ per sec.
60 ~ per sec.
X
Y
Z
0 100 200 300 400 500 Kilometres
20π 18π 16π 14π 12π 10π 8π 6π 4π 2π 0
Kilometres 500 400 300 200 100 0
1020 ~ per sec.
780 ~ p.s.
540 ~ p.s.
300 ~ p.s.
60 ~ p.s.
330 k.m.
8π 6π 4π 2π
SPECTRUM SCALE FOR PAPER INSULATED CU WIRE.
C = ·07 mfd. per k.m
R = 3·322 ohm per k.m.
L = ·0004 henry per k.m.
d = 2·55 m.m.

PLATE II.

SOME FUTURE DEVELOPMENTS IN HEATING AND VENTILATION.

By A. H. BARKER, ESQ., WH.SC., B.A., B.SC.

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IT is somewhat surprising, in view of the immense importance to mankind of the twin sciences of Heating and Ventilation, that the amount of attention hitherto paid to the scientific aspects of these subjects, both on the part of the scientific man and of the engineer, should have been so small. The subject, indeed, is hardly seriously regarded as capable of scientific treatment by the average engineer, who probably looks on it as a branch of plumbing or building, calling for a certain knowledge of rule of thumb and a certain amount of practical experience, but at the same time hardly a fit subject for the scientific engineer. Although the science of this subject is yet in its infancy, the author is anxious to secure a more just recognition of its position as a serious branch of engineering, and takes this opportunity to explain to his brother engineers how and why this view is a totally erroneous one, and to discuss the general nature of some of the problems yet unsolved. It may safely be said that there are more unexplored problems of science and greater difficulties attending their solution in the case of heating and ventilating than in almost any other branch of the profession, and the author has had some experience of a good many. In Germany, that uninspired land of detail, where the minutiæ of the subject have been thrashed out with a meticulous care which seems to us to be almost absurd, the real essence has been entirely missed.

This erroneous view of the science as a mere matter of rule of thumb has been fostered in the past by the extremely unscientific manner in which the subject has been treated by writers of technical books in America and England. Any educated engineer studying some of this literature must be driven to the conclusion that there is really no science whatever in the subject.

The reasons why it has failed hitherto to come up to the standard attained in other branches of engineering are not difficult to understand. They are the immense complexity of the factors which go to make up any given result, the difficulty of defining in terms of exact science what that result is or should be, the fact that the

criterion of success up to the present has, of necessity, been the feelings of individuals rather than the readings of scientific instruments. Added to these is the immense power of adaptability of the human organism to varying conditions, which tends to make actual variations of conditions appear unimportant in practice. The circumstance which differentiates this branch of engineering from almost all others and at the same time introduces difficulties unknown in all other branches is that we have here to take account of the variable human factor, both as to its physiology and its psychology, as an essential part of the problem. In this sense we trench on the domain of the physiologist and hygienist to a degree unknown in any other branch.

It is easy to understand that this combination of difficulties tempts the busy practical man to be satisfied with any sort of result, and to leave to Nature the task of adapting the organism of the sufferer to the conditions produced by the engineer—a task which she can often accomplish, but often not without injury to the individual. The present lack of exact knowledge makes it difficult or impossible to hold the practical man to any precise standard of accomplishment. In other words the practical man can get along somehow, with a very small modicum of knowledge. It is the general attempt to do so which has led to the undoubted state of discredit in which this branch finds itself to-day.

All engineering is merely glorified common sense. The training of an engineer leads him to try to deal in a commonsense way with objective facts as he finds them. In this branch the first obstacle is the great difficulty of finding what are the facts.

Consider for instance the first problem which would meet a scientific engineer endeavouring, without previous experience, to arrange a satisfactory scheme of ventilation for a building. He would commence with the assumption that the artificial ventilation of a building consists in forcing in a calculated volume of air, a task which, if he were familiar with fans and the laws of the flow of air in ducts, he might think he could easily accomplish. After he had made one attempt to satisfy the occupants of the building by proceeding on the assumption that this is the only requirement, he would find out that one essential factor in the problem was to study the distribution of the air currents in the building itself.

Even in a small building, this is in itself a problem of very great difficulty. Although each one of these currents obeys laws of nature as rigidly accurate as any other laws of nature, yet the number of influences having an effect on the air currents is so enormous that the complexity of the result is almost immeasurable. In the attempt to lay down in terms of exact science the laws which govern this result, any person might well be baffled and unable to trace with any clearness the operations of any law at all. The reason is, of

course, not that the law is not there, but that it is so complex that it would take almost a superhuman intellect to analyze it completely.

Further, who can say what system of air currents in a room—say a theatre—is to be aimed at? We all know that complaints of the ventilation of almost every public room are universal. Yet there is no general agreement, either what is wrong or what is needed to put it right. How is it possible to hold the ventilating engineer responsible for a poor result when no one can specify what the result ought to be?

I have made reference to the complexity of only one of the constituents of ventilation. Those of heating are no less complex. We have two totally distinct forms in which heat is delivered into the room, namely, convection currents of heated air and radiant energy. These are as distinct from one another as light is distinct from sound. Yet, up to the present, no formal recognition of their entire separation from one another has been recognized in current literature. The cause for this is easily seen to be that, different as these two forms of what for convenience we call heat are from one another, yet they can be instantaneously transformed from one to the other and back again. Their measurement, again, is not a problem to be easily solved. No sooner does one measure the amount of radiant energy than the mere act of measuring it turns it, or part of it, into convected heat.

The difficulty, however, which is the most baffling in the attempt to reduce this subject to an ordered science is the fact that the object of both heating and ventilation though primarily physiological, is also to some extent psychological. The primary object is to keep the inhabited rooms healthy; of almost equal importance is the necessity to keep them comfortable. The effect of any given condition on the human body is, if possible, more complicated than the laws which govern air currents and heat flow. The physiologist cannot yet tell us in exact terms what are healthy conditions for inhabited rooms. He can give us generalities only, and the experiments on which even these generalities are based are far from convincing. He cannot even, for instance, tell us what is a healthy temperature for human beings to live in, nor does he seem to realize that when he speaks of "the temperature of a room" he means merely the temperature of a thermometer suspended in the room.

Some physiologists say (and the author agrees) it is desirable in the interests of health that the temperature maintained should be as low as a human being can endure without real discomfort. Yet others will say this is nonsense, that the room should be so warm that the man feels comfortable without any effort. Neither can anyone tell us within 300 per cent. how much fresh air per head per hour is the minimum consistent with health. Indeed, as a fact, such a crude statement would have no meaning in the real

science of the subject. It depends on the temperature, humidity, and a score of other things. Physiologists cannot agree as to the chemical nature of healthy and unhealthy air. Books on the subject of climate do not give any explanation of what physical conditions constitute a bracing or a relaxing climate. Indeed most of the hygienists do not seem to realize that such words need any further description.

The matter is yet more complicated when we consider that one object the heating engineer has in view is to make persons comfortable. We here come across the baffling fact that a man is comfortable when he thinks he is comfortable. If we can make him imagine he is comfortable without the alteration of any single condition, we can make him feel comfortable. Make a man imagine he is cold or feels a draught, and he will at once want to shut all the windows. Convince him on the other hand that to shut the windows is unhealthy and stuffy, and the same man will not be comfortable unless the windows are open. One can train oneself to feel comfortable in anything.

In further illustration the author will refer to a psychological experiment he made on a medical man who was a guest at his house some years ago. We were sitting in a room which had a thermometer suspended on the wall. The visitor made some remark about a "shoemaker's wife" and complained of the room being cold. It was freezing outside: the thermometer on the wall read 54 degrees, and was a correct one. The author's view is that such a thermometer reading is quite consistent with health and comfort, when it is freezing outside. We fell to a discussion of temperatures, and it was suggested, as an experiment, that the temperature of the room should be gradually raised until the guest felt comfortable, to ascertain whether he found a temperature of 60 degrees too high. The room was provided with a fairly powerful heating apparatus. The author went into the cellar, pretended to stoke up the boilers and to turn the radiator full on. As a fact, nothing was done either to the boiler or the radiator, though the doctor was allowed to hear the clattering of the fire-doors and fire-irons. After a short interval the thermometer was changed unobserved by the visitor, for another precisely similar in appearance which read 6 degrees too high. When it had been placed on the hook without his seeing the change, it was shown to him, and he was asked whether that temperature made him more comfortable. He said the temperature was then just right for him, neither too hot nor too cold, although the real thermometer reading was precisely the same as it had been in the earlier part of the evening. That little experiment is most illuminating as showing the extraordinary difficulties attending an attempt to treat this subject scientifically.

It is an undeniable fact that a room filled with air which, so far

as chemical analysis can detect, is absolutely pure may *feel* very stuffy. For instance, the House of Commons, on the ventilation of which the author has experimented for many months for the Committee of the House, the air in the Debating Chamber is, chemically speaking, as pure as in any room in the world. Fresh air simply pours into it in extravagant volumes. In a moderately full house there are no less than 13,000 cubic feet of air supplied per head per hour. Yet it produces, without any possible doubt, the effects which we are accustomed to think of as associated with defective ventilation—lassitude, sleepiness, infection and so forth. Complaints are loud and quite general.

A room may, on the contrary, feel fresh and sweet in which, judged by chemical standards, the air is very bad. The author has analyzed air containing 25 volumes per 10,000 of CO_2 which felt as fresh as a spring morning, although 10 volumes is regarded as the extreme allowable impurity in current science. There must be some combination of chemical or physical conditions which accounts for the effect so far as it is objective—when it is purely subjective, of course, it is impossible to analyze the effect. Nobody up to the present has ventured to specify what is that combination.

Now the future of the sciences of heating and ventilation depends, on the scientific side, on the further analysis of the conditions which produce the feeling of comfort and other effects. On the practical side they consist of the application of those discoveries so as to bring under control each of the conditions, and on the further developments of economy of construction and transmission and the better control of the forces we bring into play. Before we can get a step further we must be able to express, in exact terms, each of the chemical and physical conditions which go to make up the sum total of the room condition.

The criterion of our success, as I have said, is, and must be the effect on the feelings of an individual. But, we must, in order to give this subject a scientific basis, be able to translate the feelings of an individual into terms of measurable physical conditions, and this is our first difficulty. We may lay down certain physical conditions which we conceive to be necessary to the production of comfort and health, and we may direct all our attention towards producing those conditions. We may succeed completely in doing so, and find that when we have done it that some individuals will find that those conditions are not such as are necessary for their personal comfort. We may then get other bases to work upon and still find that the new bases themselves are not any more suitable than the first.

It is clear that the only legitimate function of the engineer as such, is to produce and control certain specified conditions. The criterion of his success must not be the self-contradictory feelings of the occupants of a building, but they must be the exact readings of

well-defined measuring instruments, such as radiometers, hygrometers, air meters of various kinds, apparatus for the analysis of air, dust counters, thermometers and other instruments.

The other half of the problem is for the physiologist and the hygienist, viz.: to specify what are the conditions which will be regarded as healthy and comfortable. It involves essentially experiments on human beings, which are in their very nature illusory and extremely difficult. In essence they are, in reality, so many attempts to calibrate human beings. The science of the subject is only in its infancy as yet. The instruments brought for your inspection to-night have been designed mostly by the author in an effort to arrive at a clearer basis for analyzing these problems, for future developments depend on this analysis to no small an extent.

Let us consider first the problems of heating stated in general terms. The practical problem before the engineer is to introduce heat into a building in such quantity and in such form as to make the building comfortable. It will be evident that as heat can be introduced in two different forms, namely by convection currents and by radiation, there will be at least two corresponding conditions as to temperature in a room which must be observed by the heating engineer. The very existence of these two conditions has received no recognition in any of the classical literature on the subject. Indeed, as has been previously remarked, it does not seem generally to be clearly understood what is the meaning of the expression "temperature of a room."

This expression is commonly understood to mean the reading of a correct thermometer suspended in the room. Now a thermometer suspended in a room does not indicate the temperature of the air surrounding it. It is also largely influenced by the amount of radiant energy impinging on the bulb, which has no connection with the air temperature. For instance, one sees in the winter time the caretaker of the tools used in road-mending operations seated in a sentry box before a coke fire quite comfortably, although the air surrounding the fire on all sides is sometimes far below freezing point. A thermometer suspended near the fire will obviously read fairly high, although the temperature of the air surrounding it on all hands may be far below freezing point. It is well known that the radiation passes through the air without warming it. This is an extreme example of this phenomenon, but it brings clearly into prominence the fact that a thermometer indicates its own temperature only, when it is hung up in a room. It clearly does not necessarily indicate the temperature of the surrounding air, neither does the reading of a thermometer form any reliable guide to the feeling of cold or warmth in a room or out of doors. The problem has been treated in the past as though all that was necessary was to introduce heat in any form sufficient in quantity to cause a ther-

mometer suspended in the room to read a certain figure say 60° or 65° F. There is no problem at all in that—anybody can do it. One can procure a radiator of suitable size, which is easy enough to calculate, and a suitable boiler, connect up with piping and there you are! It is true that there is a very great deal of calculation involved in so designing a large system of pipes that the flow to all parts of the apparatus shall be uniform and proportional. But even when this is done there are undoubtedly a great and increasing number of persons who say they cannot endure what they call "apparatus heat" in any shape. They cannot say why—and very few people can tell them why. Theories that the heat is a "dry heat" are absurd. Radiator heat is no more dry than any other form of heat. The heating engineer says: "There is your thermometer reading 60°—a beautiful moderate temperature—what more do you want?" The man says, in effect, "I do not know what I do want but I do *not* want to be stifled and I do *not* want to be cold. Can you not give me heat which keeps me warm without choking me?"

Now, that is a very real problem of which we must get to the bottom. Why is it that radiator heat is so distasteful to many persons? How far do imagination or psychological influences account for it? Obviously a careful analysis of room conditions must involve an investigation of all these matters.

It is evident that the first thing which should be analyzed in the endeavour to arrive at the actual temperature conditions of a room is both what is the temperature of the air itself and what is the temperature corresponding to the radiant condition. The author has introduced a conception which he has named the "radiant temperature." The idea of it is the temperature which a thermometer would register if there were no air in the room at all, a sort of mean of the temperature of the surrounding walls.

As an illustration, consider the following:—In an ice cave in a glacier, in Switzerland or elsewhere, on a very hot day, the radiant temperature in the cave is obviously 32° F., but the air temperature near the mouth of the cave will exceed 70° F., yet a thermometer at this point might probably read 56°.

Or again, conceive a room heated on a cold day by blowing hot air into it. Here it is evident that the hot air is the sole source of all the heat supplied to the cold walls. The air must therefore be hotter than the walls. The radiant temperature must be lower than that of the air.

On the other hand, when a man keeps warm while sitting in the cold open air in front of a coke fire devil, the radiant temperature must be higher than that of the air.

What is the nature of the physical effect of these two different conditions on the human body, and what is the effect on the sensa-

tions? Please note that the physical effect is a different thing from the sensations produced. It is necessary to investigate both. How far does the difference account for the complaints we hear of the stuffiness of radiator heat or of the lassitude produced by the plenum system. How far is either related to the rate of heat loss from the body of a human being? Does that rate of heat loss absolutely condition the degree of comfort experienced? If not, what other effect is there?

To make a systematic beginning of unravelling this tangle of questions we must first develop experimental means for recognizing and measuring the four different quantities, air temperature, radiant temperature, quantity of convected heat, and quantity of radiant energy.

Even before this is done it is necessary to determine experimentally what is the relation between the thermometer reading, the air temperature, and the radiant temperature. An extended investigation on this point has been made at the University College. We have also devised two instruments for separating the air temperature and the radiant temperature. These instruments are now on the table. They are far from being ideal instruments for the purpose, as they are both expensive and difficult and very tedious to manipulate. Something of a much simpler character will be necessary before we can say that this problem has been satisfactorily solved in a practical manner.

The principle of these instruments is comparatively simple. Essentially they are modifications of the same instrument.

The first (*Fig.* 1) has as its object to ascertain what is the mean temperature of the surfaces of the walls of the room and of the furniture and of all the exposed surfaces the temperature of which have an effect on the bulb of the thermometer. The principle of the instrument is to surround a delicate thermometer with air at the same temperature as that of the room, and also to envelop it on every side with a surface whose temperature can be adjusted to any degree and to an absolute degree of uniformity. This is secured by making a double-walled vessel, filled with water between the two walls, and providing means for heating it and stirring it powerfully. One delicate thermometer is inserted into the water-jacketed space and another into the water. The temperature of the water is then adjusted so that the inner thermometer reads the same whether it is surrounded by the water jacket or suspended freely in the open room. The temperature of the water is then clearly the "mean radiant temperature."

The elaborate parts of the apparatus are the means suggested by experience for ensuring that the thermometer is actually surrounded by air of the same temperature as in the room (for, of course, contact with the warm or cold sides of the apparatus will affect the tempera-

ture of the air) and for stirring up the water and for convenience of manipulation.

To take the reading of this instrument in practice is not so simple a matter as it looks on account of certain difficulties which need not be further discussed.

Air Temperatures.—The instrument for finding the temperature of air (*Fig.* 2) is similar in general principle, but is a direct-reading instrument. It is constructed on the principle that if a thermometer is surrounded not only by air at the same temperature as the air in the room, but also by double-walled surfaces at the same temperature as the air, the thermometer will read exactly the temperature of the air. That is, if the radiant temperature is artificially made identical with the air temperature, both will be the same as the thermometer reading. The identity of the temperature of the air in the instrument and the air in the room is obtained by measuring its density by a very delicate chemical balance. Any convenient method may be adopted for regulating the temperature of the water in the instrument, which is gradually raised until the density of the interior air is identical with the room air. The author claims to have proved by the aid of these instruments that the stuffy feeling which is often associated with systems of central heating is due largely, but not entirely, to the fact that the air temperature is too high and the radiant temperature too low. On the other hand, the freshness of a building depends on keeping the air temperature relatively low and the radiant temperature high.

It is fundamentally for this reason that a room warmed by an open fire is by many sensitive persons often felt to be much more comfortable than a room heated by a radiator. It is not necessarily due to the fact that the ventilation produced is more liberal except in so far as a continual inflow of cold air into a room tends to keep the air temperature low. If, for instance, we have in a room at the same time some means, such as an electrical stove, for generating a good deal of radiant energy, and at the same time in the room a coil supplied with a circulation of cold brine for keeping the air cool, we should get in the room conditions in some respects similar to those obtained by a warm fire and an inflow of cold air. It is the *temperature* and humidity of the air which are the important points, and not its chemical freshness or freedom from CO_2 or other organic products.

Dr. Leonard Hill has shown by experiment that physiologically speaking the chemical composition of the air has within wide limits no effects whatever on the human organism, and the author's experiments bear out that fact from another point of view. Dr. Hill believes that the effect of ventilation is so largely a question of the rate at which heat is abstracted from the human body that all other effects combined are of comparatively small importance. He has

devised two instruments to determine this rate of heat loss in any conditions.

The first of these is essentially a calorimeter consisting merely of a thermometer with a very large bulb. It is used by noting the rate of fall of temperature when raised approximately to the temperature of the human body and placed in the conditions which are under investigation. The rate of fall of temperature gives a measure of that at which heat is lost from the body.

A second and much more elaborate instrument is called the "calcometer." This is an electrical instrument which measures the rate of expenditure of electrical energy necessary to maintain a coil at the approximate temperature of the body. If Dr. Hill's view is correct, the indications of these instruments are practically all that is necessary to determine whether the point at which they are placed is in a satisfactory condition as regards ventilation. The author believes that though this rate of heat loss is no doubt of very great importance, yet there are many other conditions almost equally so. One of the chief is *the way* in which this surplus heat is abstracted. According to this view the proportion of the heat which is abstracted by contact of cold air with the body is of vital importance to the nervous sensations produced. It causes a great difference in effect whether the heat is abstracted by radiation or by contact of cold air. This, again, is a problem of combined engineering and physiology which calls for a most difficult investigation.

In connection with this investigation it is obviously very important to be able to separate the amount of heat communicated to a room as radiant energy from that as communicated by warming the air. We have designed and erected at the University College an apparatus (*Figs.* 3 and 4) for this purpose, which has some points of interest. The heater under test is placed underneath a canopy which collects all the warm convection currents proceeding from it. A delicate electrical method is applied for testing its quantity and also its temperature. The stove is surrounded by radiant heat meters, such, for instance, as Smith's radiometer and thermopiles. The intensity of the radiation in any direction is thus obtained and plotted on polar diagrams (*Fig.* 5), and a balance sheet of the whole heat given off can be obtained with some accuracy by mechanical integration. The same apparatus is applied to the investigation of the heat given off by a water and steam radiator.

It will be understood that the above determinations (which are only a small part of the problems confronting the heating engineer) have had reference only to the measurement of the physical conditions of a room. They do not touch the question of the effect of these varying physical conditions on the body or the sensations of a person subjected to them. That is an aspect of the matter which, as has been said above, cannot be adequately

treated by the engineer. It is essentially a problem of experimental physiology.

It will be evident also that the problems of heating and ventilation are closely associated. We cannot even consider problems of heating without simultaneously considering those of ventilation. We have, for instance, to consider the effect on the human organism of warm air and cold air. In this connection some very interesting experiments have been made by Dr. Leonard Hill in which he has studied the difference in the effect on the organs of the body of hot and cold air by actually inspecting those organs by optical instruments under different air conditions.

A further important point in connection with ventilation is to determine the effect on the human organism of different quantities of dust in the air. The investigation of such a matter naturally imposes on us the necessity of determining with some accuracy how many particles of dust do exist in a particular sample of air. As this number runs into millions per cubic inch, it will be evident that very special methods are required for counting them. The " Aitken " dust counter (*Fig.* 6) effects this, being based on the principle of measuring off a certain minute sample of air, and diluting it largely with a measured quantity of pure and dustless air. A certain fraction of this enlarged volume is measured off. The whole of the particles of dust in this fraction are deposited on a glass plate underneath a microscope and a measured fraction of these particles is actually counted. By multiplying up the total number in a cubic inch the original sample can be calculated. The method by which the particles of dust are deposited is to surround each with a globule of condensed moisture which so adds to the weight of the particle that it sinks and adheres to the plate.

The measurement of the dust particles is clearly only one side of the problem. We have also to measure the effect of different degrees of dustiness on the human organism. That is obviously a matter of great difficulty and concerns the physiologist and is more appropriate to the physiological than to the engineering laboratory.

In no respect has the science of heating and ventilation been more backward than in the knowledge of laws governing the movements of air. If we compare, for instance, what is known of the laws of electrical currents with the corresponding laws of pneumatic flow, we shall see that in the one case the knowledge is for practical purposes complete and definite, enabling calculations to be made with the utmost precision and, what is more important, enabling the results of the calculations to be carried out in practice.

Pneumatic matters on the other hand have been treated with almost a casual indifference by the engineer. One reason for this is, no doubt, the fact that the effects of electrical flow can be exactly and precisely traced by self-contained instruments, often or generally

of direct reading type. The flow of air, on the other hand, is not only extremely difficult to measure, but also very erratic. Further, it is not so vitally important to be able to measure with close accuracy the flow of air as is the case with electricity. No man will be suffocated if he gets 10 per cent. less air than was calculated. It would, indeed, be very difficult to show, experimentally, within 10 per cent., how much air he was actually receiving. But if a dynamo gave 10 per cent. less electrical power than was calculated on there would be trouble. It would be quite easy to show that the maker of the dynamo had failed in his undertaking.

The flow of air is brought about by the operation of very trifling momentary causes constantly varying. So no doubt is the flow of electricity in relatively large quantities at low voltages. The ventilating engineer is concerned with a comparatively large flow of air at very low differences of potential. The problem is comparable with the investigation of the flow of electrical currents in a large mass of metal. If, for instance, we take a cube of copper measuring 3 ft. in every direction, the electrician would find very great difficulty in investigating the electrical currents throughout the mass. Some local circuits would no doubt be set up by any accidental distribution of electro-motive force, such as those set up by the movements of a magnet in the neighbourhood. This exactly corresponds to the problem with which the ventilating engineer is confronted in ventilating a building. Air is introduced, for instance, into a room at a certain point. At other points in the room, sometimes near, sometimes remote from the point at which the air is introduced, currents of air are experienced which the occupants of the room call "draughts" which may, or may not, have something to do with the manner of its introduction. It is held up as a reproach to the ventilating engineer that these draughts exist, and so no doubt it is. He is told that he does not understand his business, because these draughts seem to be erratic, and that he cannot exactly control them. Yet the laws of pneumatics, little as they have been studied, are quite as definite as are those of electricity. The difficulty is that the conditions are so difficult to gauge and to control. The laws of pneumatic resistance have been put forward by the investigators in such a form that they are somewhat difficult to grasp by the comparatively non-mathematical mind of the engineer. The form which the fundamental law of pneumatic resistance in a flux commonly takes is as follows :—

$$p_1 - p_2 = \rho \frac{lc}{a} \quad \frac{v^2}{2g} + \Sigma \zeta \frac{v^2}{2g}$$

Comparing this with the corresponding fundamental law in the electrical field (Ohms law), E=CR, the simplicity of the latter is at once apparent.

We are making an effort at the University College in the Depart-

ment of Heating and Ventilating Engineering to develop experimentally the laws of pneumatics on a somewhat similar basis to those of electricity as first suggested, the author believes, by Dr. Shaw. We are taking the fundamental formulæ in a form exactly comparable to Ohms law, viz. :—

$$H = RQ^2$$

and experimentally testing the validity of this law in all kinds of pneumatic flow.

This involves first the evolution of standard units of pneumatic measurement comparable with those of electrical science. For instance the unit of aero-motive force is naturally a foot of air column or that difference of pneumatic pressure against which it would require one foot-pound of work to force one pound weight of air. The unit of flow (Q) is naturally one cubic foot of air per second. The corresponding unit of resistance is closely equal to the resistance of a round hole 6 in. diameter in a flat thin plate. The connection between these units is that a pressure equal to one foot of air column will cause a flow of one cubic foot per second through a round hole in a flat plate 6 in. diameter.

Now, obviously, if we can compare all pneumatic resistances with this unit, we shall be in a very much better position to understand the flow of air than we are at present, having to work with relatively complicated formulæ such as have been indicated. The fundamental difference between the laws of pneumatic flow and those of electrical flow are that in the pneumatic case the aeromotive force is nearly, but not exactly, proportional to the square of the flow, whereas with electricity the electro-motive force is exactly proportional to the first power of the flow.

This introduces certain differences into the mathematical treatment of the two problems, but these differences are not sufficient to exclude from possibility the application of some similar experimental methods.

We have, for instance, made a large apparatus, the pneumatic analogue of the Wheatstone bridge, for the determination of pneumatic resistances, and sundry methods of battery resistance have been applied to determine the internal resistance of a fan.

The great importance of this method to the practical engineer will be at once obvious. If for instance, we can specify the proper resistance in pneumatic units for a boiler flue and chimney we shall be in a position to deal on a rational basis with the much-vexed problem of chimney shafts, which problem has only been treated in the most incomplete and perfunctory manner up to the present. We can determine by the application of these rules what is the actual resistance of a boiler flue, and are able to tell exactly what is the maximum capacity of a plant in heat units or in pound of steam, even without lighting the fire in the boiler.

The method by which this is done is exactly analogous to the potential method of determining battery resistance, namely by introducing into the battery circuit a number of different resistances which can be exactly measured and observing the currents produced in each case. To apply this method to the determination of the resistance of boiler flues and chimney shaft it is only necessary to adapt a fan to the air inlet to the boiler through a chamber in which a constant low pressure of air can be maintained. An adjustable resistance between the fan and the boiler inlet is then altered and the current measured in several cases from which the pneumatic resistance can be at once established. It is easy to show, for instance, that the total resistance of a plant consisting of say, three Lancashire boilers, 28 ft. by 7 ft. 6 in. should be about ·00172 units of resistance with a chimney height of 100 ft.

It is even possible to determine the value of the resistance without a fan, without even an anemometer, but having a very accurate micrometer pressure gauge. The method by which this is done will be apparent from the diagram. We need measurements of the mean temperature in the chimney from which we can determine the total aeromotive force by calculation. By measuring with accuracy the pressure in the chambers marked A and B (*Fig.* 7) due to the pull of the chimney shaft, it is possible to determine exactly the flow of air through the flues at any given moment by calculation only. A very small amount of calculation will then determine the resistance of the boiler flues and shaft in pneumatic units. The same factor may be determined by graphical methods first suggested by Dr. Shaw (*Fig.* 8).

We have applied the same system in practice to a number of other important determinations. We have found, for instance, the relative resistance of different types of ventilating gratings and flues of different radius and shape. The method, indeed, is capable of very wide extension.

This paper has dealt sketchily and, possibly, very inadequately with a few only of the multitudes of problems with which the real science of heating and ventilating engineering is concerned. Enough has been said to show to engineers that there is a good deal more in this subject than such a collection of mere rough rules of thumb as are to be found in the current literature, and that the subject is well worthy of taking its place among the most difficult of practical science. It is largely because scientific engineers have not, hitherto, taken this subject seriously that it is in a very backward state. It is at the present time in something like the condition that mechanical science was in at the time of Newton or electrical science at the time of Faraday. It would be very much to the advantage of mankind if engineers would take the subject more seriously.

SIEGES AND THE DEFENCE OF FORTIFIED PLACES BY THE BRITISH AND INDIAN ARMIES IN THE XIXth CENTURY.

(*Continued*).

By COLONEL SIR EDWARD T. THACKERAY, V.C., K.C.B. (LATE R.E.).

THE CAPTURE OF LUCKNOW, APRIL, 1858.

In December, 1857, Sir Colin Campbell commenced to concentrate his forces for the final operations of the capture of Lucknow; and it was at this time that the outlines of his plans were drawn up. In a memorandum to Lord Canning, dated December 22nd, 1857, Sir Colin wrote:—

"Colonel Napier has given his deliberate opinion in which I coincide as regards numbers, that 20,000 men will be necessary for the first operation of subduing the city. That having been performed, it will be necessary to leave a garrison in occupation, consisting of at least 10,000 men, viz. 6,000 in the city, and 4,000 in a chain of posts on the Cawnpore roads, until the whole province should have been conquered, and the rebels driven out of their last stronghold."—(*Life of Lord Clyde*, Vol. II., p. 68).

Early in January, 1858, Colonel Napier returned to his post as Chief of the Staff to Sir James Outram at the Alumbagh, where that General had been left with a force to hold the ground pending the return of Sir Colin. Whilst there he soon formed the opinion that the attack should be made on the east side, accompanied by a flank movement on the north across the river Gúmti, which would take the enemy's fire in reverse. He therefore devoted the intervals between his arrival at the Alumbagh, and that of Sir Colin with his force, to a careful inspection of the ground on both sides of the river. The following reasons for these views were published in the *Professional Papers of the Corps of Royal Engineers*, Vol. X., New Series, 1861, p. 68.

"The east side offered: first the smallest front, and was therefore the more easily enveloped by our attack; secondly, ground for planting our artillery, which would be located on the west side; thirdly, it gave also the shortest approach to the Kaiser Bagh, a place to which the rebels attached the greatest importance; more than all, we knew the east side, and were little acquainted with the west."

Everything was decided in accordance with Napier's view, and on the 10th he was appointed to the command of the Engineer Brigade.

The city of Lucknow being upwards of 20 miles in circumference, it was utterly impossible to attempt an investment or a siege under ordinary conditions. The town is bounded on the north by the Gúmti, and on the east by a canal which runs northward from that river. About halfway between the canal and the Residency stands the King's palace—the Kaiser Bagh. This was the citadel of defence, and was covered by three lines. The first was a flanked rampart on the main side of the canal, which formed a wet ditch to it. The second, with a circular trace, enclosed a large building called the Moti Mahal, whilst the third consisted of a line of rampart to the north of the citadel. The first and second lines rested on the river to their left, and terminated on the right in the town itself, where it was impossible for an enemy to advance or turn them. Indeed, the only possible point of attack was from the east, supported by a corresponding advance on the other side of the river to take the lines in reverse. In front of the canal, and about a mile from it, was an extensive block of buildings called La Martinière, about 5 miles from Alumbagh.

Lucknow at this time was in the hands of the rebels, and had been occupied by them since the removal of the garrison with the ladies and children by the relieving force under Sir Colin Campbell. The Alumbagh, distant about 3 miles from Lucknow, however, was still held by a garrison under Sir James Outram, consisting of 4,000 men. At Futtegurh there were about 5,000 men at this period, and about 3,000 on the Ramganga. Materials had been collected to form a bridge to cross this river, but the orders to cross were not issued.

A serious attack had been made on General Outram's position at the Alumbagh on the 16th January. In the morning a body of the enemy, of which the strength is not mentioned in the dispatch, led by a Hindu fanatic, attired to represent the Monkey-god, made a sudden attack on the Jellalabad half-way picquet, at the time commanded by a subaltern, and was received by musketry fire which drove them back with the loss of their leader, who fell mortally wounded into the hands of the picquet, and of more killed and wounded than the enemy could carry off. Two 9-pounder guns, brought up from camp under the escort of a subaltern and 25 men from the right brigade to support the picquet, compelled an abandonment of the cover in front which the enemy had used as a *point d'appui*. The left front and flank were threatened throughout the day, and after dark the enemy's infantry assembled in great strength in front of picquet No. 5, reinforced to 200 men, commanded by a major, who allowed the rebels to approach within 80 yards, and

then opened fire with three guns, and his infantry. As they withdrew with loss, he followed them up with shells from a mortar. Attempts by cavalry against the left rear had been watched and checked throughout the day by four horse artillery guns. The division had a bombardier killed and eight men wounded.

The successful repulse of this attack and the prospect of the arrival of the Commander-in-Chief now moving towards Lucknow relieved the General of much anxiety; but still he felt it necessary to warn headquarters that, owing to the enormous numbers of the enemy and the extent of his position, he was obliged to keep his men in readiness, and as there was a perceptible change in the temperature, the hospitals would begin to fill under so much exposure. Moreover that unless reinforced ere compelled to detach another convoy, he would have hard work in repelling the incessant attacks of the increasing hosts of the enemy, headed by the many territorial chiefs reported to be in the city or immediate vicinity. It must not be supposed that the General allowed his anxiety to be shared by his troops. Seldom has duty of any sort been performed with greater confidence and cheerfulness by all ranks. In the intervals between the attacks, as much as possible was done to relieve the monotony of camp life. Officers off duty were allowed to go for short distances shooting, and to get up races. During Christmas week the usual sports were organized for the men.

About this time the Intelligence Department received news that a grand assault was being planned, and that a particular day, the opening one of a festival, had been fixed for the purpose. The assault, however, did not come off, much to the disappointment of the General, who having been rejoined by the convoy escort and reinforced by some cavalry, had hoped to inflict a severe defeat on the rebels, and to capture some of their guns. The spies reported a day or two afterwards that the enemy's troops and guns had taken up positions during the night; that in the morning their generals had ensconced themselves at a respectable distance in the rear, that the men were accoutred, and all were apparently in readiness. They did not advance, however, and the rebel leaders sent for the chief officers of divisions, to inquire the reason. They replied that they would attack, since it was better to die fighting than to be hanged, but they must have their pay first.

From this period till the 15th February the rebels evinced a nervous restlessness, which betrayed itself in constant assemblies of cavalry and infantry, and by demonstrations of attack, which were instantly stopped by a few rounds from the guns at the supports. About this time the concentration of troops and material for the projected attack on the city had commenced, and on the Cawnpore Road stood a succession of detachments at intervals of an easy day's march, somewhat resembling the system of stages by which a

German field army maintains communication with its base. The continued movement of troops and stores was known to the enemy, and caused the activity on his part which, though occasioning few casualties to the British division, constantly necessitated the turning out and remaining under arms.

On the 13th February the news from the *Court Journal*, as the epitome of daily intelligence was styled in the British camp, was to the effect that an attack on all points of the position was planned for the 15th. It seemed probable that under the mingled taunts, promises, and threats of the so-called "Queen Mother" the rebels might be induced to make one desperate last attempt, and that if, as was expected, she should come out, it was possible that the whole force then collected in Lucknow, regular and irregular, might be inspirited to join the attack.

The General, with a view of being able to inflict a heavy blow, requested when passing on this intelligence to army headquarters, now returned to Cawnpore, that the order for a battalion to be withdrawn from his command in exchange for a raw one of native sappers might be countermanded. The request was complied with, but the next day it was reported from the city that the expected movement of the rebels had been abandoned, and a message was sent to the bridge post for the battalion to resume its march on Cawnpore.

Notwithstanding, however, the failure of the rebel Court to induce their troops to come out in mass, a demonstration took place on the day in question, concealed to some extent by a violent dust-storm, round the left of the British position against the high road, along which a convoy was at the time marching. The horse artillery escorted as usual by cavalry, and dashing well out, supported also by the nearest battalion of the left brigade, sufficed to disperse the enemy's cavalry and infantry, wounding their chief, a Mussulman dignitary, who rode in a litter. The division had only one man wounded.

Next day, the 16th February, the rebels, while they threatened, as on former occasions, the left flank with cavalry and infantry, filled their trenches and the groves in rear of these with the latter arm, but although they began their demonstration in the morning, they did not muster resolution enough for the attack till about 5.30 p.m. when they suddenly issued in clouds of skirmishers against the guns of the centre and left, and in large bodies advanced against the village where the picquet had been reinforced to a strength of 200 men under a lieutenant-colonel. This picquet had three men wounded before it repulsed the enemy. For a couple of hours after dark a heavy musketry fire was kept up against the north and east faces of the Alumbagh without occasioning any loss to the defenders, who aimed grape and shrapnel against the line indicated by the flashes of the muskets.

On the 17th, while a partial advance against the right and left picquets was repulsed by artillery fire, some 2,000 infantry, sent by the enemy towards the right rear, withdrew towards the city on the appearance from camp of a couple of squadrons and two guns. The information received at this time was to the effect that the rebels proposed continuing these attacks daily and from all quarters. Consequently the picquets had to be maintained at abnormal strength, and the troops were harassed by being constantly turned out.

In échelon behind the line of two picquets, both of which were armed with guns, was established a fresh battery guarded by an escort. The Jellalabad half-way picquet was furnished from camp, strength 2 subalterns and 50 infantry. The Alumbagh detachment was increased to 275 rank and file. The proportion of men at the outposts to those in camp was, however, now so great that the reliefs of many of the picquets could only be effected every three days, sometimes only weekly. The General again remonstrated against his troops having under these circumstances to furnish the convoy escorts half-way to the bridge posts in rear.

On the morning of the 21st February, while the strength of the division, particularly in cavalry, was reduced by such an escort, a simultaneous movement took place threatening both flanks, as well as the whole front of the position, the points actually attacked being the north-east angle of the Alumbagh and the fort of Jellalabad with the half-way picquet. The troops holding these posts were reinforced, while a body of about 250 cavalry with two guns was sent to the rear of the fort, and coming suddenly on about 2,000 of the rebel cavalry drove them back on their infantry some 5,000 strong, which latter after advancing to within range of grape, retired with loss. The left flank was threatened by 8,000 to 10,000 infantry with 500 cavalry, against which force were sent with the usual result, four horse artillery guns escorted by about 120 troopers, and supported by the available strength of the left brigade.

The division had 9 men wounded, while the reports from the city gave the loss of the enemy as 60 killed and 200 wounded in front of Alumbagh, with some 80 or 90 casualties near Jellalabad.

A few days before the 25th, the first instalment of troops composing the force which the Commander-in-Chief was concentrating for the capture of Lucknow arrived within the lines of this division, and were temporarily at the disposal of the General. These consisted of a battalion which had for some days past been distributed on the line of communication with Cawnpore, of several squadrons, and of a troop of horse artillery. By this time a large quantity of combustible stores had been collected in the fort of Jellalabad. An attack was expected on the 29th, but did not come off.

On the 2nd March, the advance of the Commander-in-Chief began with a second division of infantry, a brigade of cavalry and four

batteries, from the Cawnpore Road, by a line leading east from Jellalabad, into a position of which the right rested on the river Gúmti behind Dilkoosha, followed on the next two days by the closing up of the siege train and of a third division of infantry causing the withdrawal of the bulk of the rebel forces to the extensive defences which they had constructed along and in advance of the eastern end of the canal, and thus removed the pressure on the front of the 1st Division, which had stood for three months unsupported. It had been for some time previously made movable by provision of carriage for baggage and tents, and it was now gradually reduced by the withdrawal from its organization of the greater portion of the cavalry, of which part was sent to preserve communication between Jellalabad and the Commander-in-Chief's camp, while the remainder made up from fresh arrivals to the strength of a brigade was extended westward to watch the exits from the city in that direction, and by the successive dispatch of battalions and guns to reinforce the main attack from the east. The General was summoned on the 5th to conduct a turning movement on the north bank of the Gúmti. On the 12th there remained in his former camp but one brigade of infantry, and on the 16th only two battalions with the horse artillery.

Meanwhile the advance, from the eastward, of the army by a movement in échelon from the right, as the entrenchments and palaces held by the rebels were successively turned or stormed, had the effect of causing the old pressure on the Alumbagh position to be renewed to a serious extent. On the 15th most of the army was established on a line fronting to the south-west, and, therefore, towards the Alumbagh, from which post the left was distant 3 miles as the crow flies. The space between the Commander-in-Chief's inner flank and the canal was filled by a body of Nepaulese troops, which had arrived on the 12th as allies against the Oudh Pretender, and had come into line with a force of about 9,000 infantry and 24 field guns drawn by men. On the 15th one of their detachments after a short fight took possession of the Yellow House, a building midway between Alumbagh and the canal, but withdrew from it after dark without giving notice to the British outposts, who were in the sequel somewhat embarrassed by uncertainty as to whether that point was held by friend or foe.

During the whole time Sir James Outram held the position at Alumbagh, from the 22nd November, 1857, to the 17th March, 1858, Capt. Olpherts (afterwards General Sir William Olpherts, V.C., G.C.B.) commanded a battery and was present at all the engagements at this time. The previous services of Sir William Olpherts at Benares, and at the Relief of Lucknow by Havelock are well known.

On the 16th, the Commander-in-Chief's right led by the former General of the 1st Division gained another mile to the westward.

"And in short," as was the language of His Excellency's dispatch, "the city was ours." With like brevity it is stated that on the 16th, for the last time, the enemy showed in some strength before Alumbagh; that the Goorkha leader was requested to move to his left up the canal and take the position; that His Highness executed this very well, and that he seized the positions, one after another, with little loss to himself, the enemy's guns falling into his hands. Some details, however, of this, the last brush that took place on the front of the position, may not be uninteresting. They are produced in nearly the identical words of the field officer who commanded in the Alumbagh enclosure.

Between 8 and 9 a.m. he observed from the roof of the palace a large body of cavalry coming out of the city, while infantry manned the batteries and trenches along the front of the position. An orderly was immediately dispatched to the brigadier in camp, who in consequence of this, and information subsequently received, telegraphed in the course of the day to the Chief of the Staff with Army Headquarters :—"The enemy are coming on in immense force, both cavalry and infantry, with field guns on my left front and towards the dense wood close to Alumbagh. Nothing seen of the Goorkhas. I have drawn up my infantry and field guns, and my batteries have opened upon them. I have only 140 cavalry here." The rebels' movement continued to be observed from the Alumbagh roof, their cavalry in most regular order proceeding along the rear of their batteries. A few shots were fired from the heavy guns of the outpost, but the range of the nearest point of their line of march was upwards of 2,000 yards. They were accompanied by three horse and two bullock guns, and their numbers were estimated at not less than 3,000 sabres. The cavalry continued its march until it had passed the left flank of the position some distance, and then, developing upon the plain in order of battle, was seen to charge down in the direction of the village held by picquet No. 5. During this time the batteries and trenches in front of Alumbagh had become crowded with infantry. About 1,000 men with colours came out and took position in spite of the fire of the British rifles, about 400 yards in front of the Mosque picquet, and kept up a warm matchlock fire upon it and the enclosure. Some discharges of grape from all the available guns caused them severe loss as appeared from the bodies found next morning. The enemy's trenches had on the previous occasion been seen by the field officer to be crowded, and he estimated the strength of their infantry in front of him to be not less than 5,000. This attack commenced simultaneously with the cavalry charge, and was not abandoned till about noon. As heretofore the more open left flank was freed by the dash and fire of the horse battery, supported by the available infantry from camp.

Thus the important duty of covering the Cawnpore Road which still formed the line of communication for the British Army Corps until the course of operations in the city had brought the left forward to the westward of Alumbagh, was successfully performed up to the last by the remnants of the 1st Division.

After the evacuation of Lucknow, Lieut. McLeod Innes, who had greatly distinguished himself during the Defence, was posted to General Frank's column during his march through Oudh and gained the V.C. at the Battle of Sultanpore. He afterwards joined the army before Lucknow, and was severely wounded on the day of joining. The amount of labour expended on the works by the rebels was enormous. Streets a mile long had almost every house loopholed, and guns pointed from many of them. The bridge across the Gúmti had also been ruined.

On the night of March 4th two bridges of casks were completed across the Gúmti, a very troublesome and difficult operation. General Outram with his division, consisting of the Queen's Bays, 9th Lancers, and the Highland Brigade and other troops, crossed the river on the 6th and met with little opposition. The remainder of the army being posted at Dilkoosha about 1,000 yards in rear of La Martinière.

Brigadier Franks joined the army about this time with Jung Bahadur and 4,000 Goorkhas. This manœuvre of crossing the river was a splendid success, and completely baffled the enemy. The rebels' earthworks on the south side of the river were enfiladed by the guns of Outram's Division on the other side of the river.

On the 7th the Sepoys made a sharp attack on General Outram, but were repulsed without difficulty, and retired within their lines, leaving him free to push forward.

While referring to La Martinière, special mention should be made of the excellent service rendered by the boys of the Martinière College, whose gallantry in the defence of the post assigned them in the Residency has rarely been surpassed, and forms a bright page in the history of that long siege. In the grounds of the Bailey Guard there may still be seen a masonry pillar with a marble slab inserted, on which are inscribed the words Martinière Post. The three companies formed from the students of the College wore as a badge on their accoutrements a turreted castle with the words "Defence of Lucknow," the same honour as was awarded to the 16th, the Lucknow Regiment of Bengal Infantry, which was formed in 1858 from the loyal remnants of mutinous native regiments who fought throughout the siege by the side of the British, and held firmly to the post called the Bailey Guard.

On the 9th March the Martinière was assaulted and captured with very little loss. The Engineer officers who accompanied the assaulting column were Lieuts. A. M. Lang, J. G. Forbes, E. T. Thackeray,

Swetenham, and H. J. Nuthall. Each officer was in command of a detachment of sappers, and formed up in rear of the Dilkoosha. At the signal the troops raced across the space between the Martinière and the Dilkoosha. After capturing La Martinière the column pushed on to a village on the right close to the enemy's first line of entrenchments. Here, an officer of the 1st Bengal Fusiliers, Lieut. Butler, was seen standing alone on the bastion waving his hand. He had swam across the river, and had climbed the parapet remaining there until the work was occupied by our troops. For his conduct on this occasion, Butler was awarded the Victoria Cross.

On the evening of the 9th, Sir Colin Campbell, who had secured La Martinière in the morning, was able to advance on the canal line which had been enfiladed and taken in reverse by the batteries already established by General Outram. He secured the line without loss. The forward movement was now continued, the houses and palaces being used as approaches. In this way the second line was turned to the left. Batteries were then thrown up to break a large block of palaces called the Begum Kotí on the right which were then stormed and carried.

From thenceforward the Chief Engineer, Brig.-General Napier, pushed his approaches with the greatest judgment through the enclosures by the aid of the sappers and heavy guns, the troops immediately occupying the grounds, and the mortars being moved from one position to another as ground was won on which they could be placed. (Sir Colin Campbell's dispatch). At length the third line was turned, and the Kaiser Bagh entered. Supports were quickly thrown in, and the Mess House, the Tara Kotí, the Motee Mahal, the Engine House, and the Chattar Munzil, were rapidly occupied by the troops, while the Engineers devoted their attention to securing their positions towards the south and west. Owing to being taken in flank by the fire from the guns with General Outram's Division, and to our advance, the enemy had not only evacuated the Martinière, but their first line of entrenchments as well. So the first line up to Banks's house was captured without great loss. While advancing from the Martinière to the village rather a heavy fire was met with from the village, and here the Highlanders lost a few men. The Sepoys could be seen running along the ramparts in hundreds.

On the 11th, the Artillery and Naval Brigade, under Sir William Peel, had battered and breached the Begum Kotí with three 68-pounders. This was then assaulted and carried by our troops, the enemy losing about 500 men. Lieut. McBean, Adjutant of the 93rd Highlanders, here gained the V.C., and greatly distinguished himself, killing 11 of the enemy with his own hand in the main breach.

It was after this assault that Hodson, of Hodson's Horse, lost his life. He was the finest leader of irregular cavalry in India, and

his loss was greatly mourned by everyone in the force. He had arrived at Banks's house just as the party going to attack the Begum Palace had started, and accompanied them. Previous to this he had remarked in a laughing manner to his friend Brigadier Napier (afterwards Lord Napier of Magdala) "I am come to take care of you, you have no business to go to work without me to look after you." The place had been taken before he was wounded. When the soldiers were searching for concealed Sepoys in the court-yard and buildings adjoining, he said to his orderly "I wonder if any are in there." He turned the angle of the passage and looked into a dark room which was full of Sepoys; a shot was fired from inside. He staggered back some paces and then fell. A party of Highlanders hearing who had been hit, rushed into the room and bayoneted every man there. Hodson was shot through the right side of the chest, the ball entering in front and going out behind. He was taken in a dooly to Banks's house, where his wound was dressed. At daylight the following morning he was much better, his hands being warm and his pulse good. The medical officer hoped that if the bleeding, which had ceased, did not return he might recover. At 10 a.m., however, bleeding came on again profusely, and he rapidly became worse. He sent for General Napier, to whom he gave directions about his property, and sent messages to his wife. After this he rapidly sank, though he remained sensible, and was able to speak until he became too weak, and at 25 minutes past 1 he died. He was buried that evening, the Commander-in-Chief and his staff being present. Thus, on the 12th March, 1858, in his 37th year, closed the earthly career of this brave and talented officer. One of those best qualified to judge declared that Hodson with his regiment would have been worth a division, had he been spared to take part in the subsequent operations in Oudh. His particular qualifications for Asiatic warfare would have found an appropriate field for their display. Sir Colin Campbell, in a letter of condolence to his widow, dated March 13th, thus expressed himself:—"I followed your noble husband to the grave myself, in order to mark in the most public manner my regret and esteem for the most brilliant soldier under my command, and one whom I am proud to call my friend."

In the evening a battery was constructed by the sappers at the side of the Begum Kotí. The place presented an extraordinary sight with its palace, gardens, and lamps with enormous mirrors and chandeliers, dead Highlanders and Sepoys lying in all directions. The Engine House was captured by the 20th Regiment. The Sepoys seemed paralyzed by the suddenness of the attack, and had not time to escape. They were piled in heaps among the machinery. A portion of the room had caught fire, and this added to the horrors of the scene. At night a great part of the city appeared to be in

flames. Fires were seen in all directions, while the shells from our batteries continued to pour into the city. The enemy was badly supplied with shells. This was the last day of regular fighting, but the rebels hung about the native city for a few days. The losses on our side during the operations were about 25 officers killed and 50 wounded, and 800 men killed and wounded.

The force under General Outram which had been advanced on the other side of the Gumtí, now recrossed on a bridge of casks, and pushed forwards to capture the Residency. This was the last move and the enemy abandoned the defences. Still there were detached forts held by desperate bands of natives, and it was not till the 21st that all fighting ceased.

During the operations a most unfortunate accident happened. At the Jumma Musjid nine cartloads of powder were found in a courtyard which the General directed to be destroyed. As there was a well on the spot it was considered that the best method of destroying the powder, which was in tin cases, would be to throw them down into the water. A line of men was formed and the cases passed from hand to hand as quickly as possible. By some fatality one of the cases exploded in falling. A flame of fire flashed up, and ignited case after case along the line until the carts were reached when they also exploded. Capt. Clarke, R.E., and Lieut. Brownlow, R.E., who were superintending the operations, received such injuries that they both died during the night. With one exception every man forming the party, to the number of 22, were killed. Strangely enough the only man to escape was the man who was throwing the cases down the well. He was rendered senseless, but eventually recovered.

The duties of the Engineer officers during the Capture of Lucknow, although arduous, were not of such a dangerous nature as at Delhi, and the operations lasted only for fifteen days. The Kaiser Bagh at the time of its capture was a splendid mass of buildings with large gardens and gilt domes and statues.

The amount of loot obtained by some of the regiments was considerable. Diamond necklaces, shawls, and swords of great value were sometimes obtained by private soldiers, and sold for a few rupees. For two or three days after the capture of the town the troops were employed in extinguishing fires and destroying loose gunpowder, an immense quantity of which was found in the positions occupied by the rebels.

(*To be continued*).

THE IRISH ENGINEERS.

MAJOR J. J. CROOKS, of 35, Brighton Road, Rathgar, Dublin, writes as follows :—

"When working at *A History of the Royal Irish Regiment of Artillery*, 1755—1801, I came across a short article in *The Journal of the Royal Society of Antiquaries of Ireland*, for December, 1910, by Lieut. W. P. Pakenham-Walsh, R.E., containing 'Roll of the Corps of Royal Engineers of Ireland, 1251—1801.'

"Since the publication of the History above referred to, I am indebted to the Library of the Art and Industrial Division of the National Museum of Ireland for the accompanying copy of the King's Warrant for Discontinuing upon the Ordnance Establishment of Ireland from the 1st October, 1789, the Corps of Engineers, and for placing upon the said Establishment a Company of Royal Engineers.

"Hoping that the information contained in the Warrant may be of some interest to readers of the *R.E. Journal*."

The Warrant alluded to is as follows :—

Regulations in the Ordnance Establishment in Ireland to Commence from the 1st of October, 1789.

George R.

Right Trusty and Right Wellbeloved Cousin and Counsellor We Greet you well.

Whereas in your Letter to the Commissioners of Our Treasury bearing date the 3rd day of February 1790 you represented that Our Right Trusty and Wellbeloved Counsellor William Windham Grenville one of our Principal Secretary's of State having in his Letter of the 8th October last 1789 to the Marquis of Buckingham late Lieutenant General of Our Kingdom of Ireland set forth that he had taken the earliest opportunity of laying before us our said Lieutenant General's Letter Military of the 1st of October aforesaid representing the situation of the Corps of Engineers in that Kingdom and of the several Officers of which it was composed and proposing in consequence of his different Communications with the Commander in Chief upon the subject the means of putting that essential part of the National defence upon an Establishment best adapted to the

Circumstances of the Country and to our service and that We after taking the same into full consideration were of opinion with our said Lieutenant General, that from that Corps as at present constituted very little assistance could be derived he was commanded to signify our pleasure that in the room of the present Corps of Engineers, a Company of Royal Engineers should be substituted to consist of the following Officers to enjoy the several Ranks hereinafter specified with the same appointments as to pay and allowances as is established by our Regulations for the Corps of Engineers serving in Great Britain. " That is to say,"

Colonel Thomas Pigott Director of Engineers with his Brevet Rank attached as at present to his Commission.

Colonel Charles Vallancey, Lieutenant Colonel

Lieutenant Colonel Charles Tarrant, Major

Major James Ferrier, Captain

Lieutenant John Browne of the 27th Regiment, Captain Lieutenant

Alexander Taylor, First Lieutenant

And one other First Lieutenant

And that with respect to Captain Forth who from the Wounds he had received was incapable of service and was not included in the above succession, It was Our pleasure agreeably to our said Lieutenant Generals Proposal that he should receive his pay as Captain charged upon the Contingencies of the Ordnance and the Commissions for the before-mentioned Gentlemen having been accordingly received there signed by us and dated the 1st day of October last 1789 in order to carry our pleasure before mentioned into Execution accordingly you desired our said Commission would move us for our Royal Letter for discontinuing upon the Ordnance Establishment of our said Kingdom from the 1st day of October last 1789 inclusive the Corps of Engineers with their pay as it present stands thereon, " that is to say,"

	per Diem			*per Annum*		
1 Chief Engineer ..... at	1	2	2¼	405	0	0
1 Director ..... at	0	15	0	273	15	0
2 Engineers in ordinary ..... at	0	10	0	365	0	0
				£1043	15	0

amounting in the whole to the annual sum of one Thousand and Forty Three pounds fifteen shillings.

The Sub Engineer and practitioner Engineer having some time since been discontinued on the said Establishment in consequence of the Death or other avoidance of the Officers who held these Commissions in pursuance of our Letter bearing date the 15th day of May 1766 and for placing upon the said Ordnance Establishment a Company of Royal Engineers to consist of the following Officers

and at the several allowances of pay hereinafter mentioned "that is to say,"

	per Diem			*per Annum*		
1 Director of our Company of Royal Engineers .....at	1	2	2¼	405	0	0
1 Lieutenant Colonel of ditto Company....	0	15	0	273	15	0
1 Major of ditto Company	0	15	0	273	15	0
1 Captain	0	10	0	182	10	0
1 Captain Lieutenant	0	4	8	85	3	4
2 First Lieutenants each	0	4	8	170	6	8
				£1390	10	0

amounting in the whole to the annual Sum of £1390 10 0, the same to commence from the 1st day of October last 1789 inclusive to continue during our pleasure and to be paid and payable in such and the like manner as the Corps of Engineers heretofore placed upon our Ordnance Establishment of that Kingdom was payable and paid; but it being intended that the aforesaid change should not affect Colonel Thomas Pigott who now holds the office of Chief Engineer in that Kingdom by Letters Patent passed under the Great Seal thereof in Pursuance of Our Royal Letter bearing date the 26th of April 1776 you requested that a Clause might be inserted in our said Letter directing that the aforesaid change of the Establishment of Engineers should not take place with respect to the Office of Chief Engineer so long as Colonel Pigott the present Chief Engineer should hold the said Office, but that upon his avoidance thereof the said Office of Chief Engineer should cease and determine and the Office of Director of Engineers as appointed by the aforesaid change of the Establishment with the pay and allowances annexed thereto should commence. Also that a Clause might be inserted in our said Letter for placing upon the Ordnance Contingencies in that our said Kingdom an Allowance of 10/- a Day for Captain Arthur Forth late Engineer in Ordinary in that Kingdom the same to commence from the 1st day of October last 1789 inclusive to continue during our pleasure and to be paid and payable as the other Contingent Expences of the Ordnance are payable and paid, And you further represented that by the 10 Articles of our Instructions to the Treasurer to the Ordnance in that Kingdom it was directed that at Lady Day every year or within 14 days next after he was to deliver or cause to be delivered at the Board of our Office of Ordnance an account, not only of all Monies by him received out of our Treasury within the year ending 31st of December preceding attested by Certificates from our Treasury but also of all other Monies which have come to his Hands within the said Time upon the sale of any sort of decayed Stores or otherwise of our Service as the Charge of his account, and it having been represented to you by the Board of Ordnance in that

our said Kingdom that it would be of great convenience in the making up of their Accounts of Receipts and Expenditures if they were permitted to conclude their year upon the 31st day of March in every year being the period at which the year of the Military Establishment of our said Kingdom is concluded you therefore desired that a further Clause be inserted in our said Letter authorizing you notwithstanding the said Instructions to issue the necessary Orders to the Board of Ordnance to direct their Treasurer to deliver or cause to be delivered at the Board of our Office of Ordnance an account not only of all Monies by him received out of our said Treasury etc. within the year ending the 31st day of December last but also within the three ensuing months up to the 31st day of March next 1790, and that in future the accounts so directed to be made up and delivered in the said 10th Article of Instructions be made up for the period within the year ending on every 31st day of March or such other period as the Government of that Kingdom shall from time to time direct the said Accounts to be delivered as directed by the 10th Article of Instructions within three months of the period to which they shall be made up. Now We being graciously pleased to consent thereto, Our Will and pleasure is and We do hereby direct authorize and require you to give the necessary Orders and directions for discontinuing upon the Ordnance Establishment of that our said Kingdom of Ireland from the 1st day of October last 1789 inclusive the Corps of Engineers with their pay as it present stands thereon, " that is to say,"

	per Day			*per Annum*		
1 Chief Engineer at	1	2	2¼	405	0	0
1 Director at	0	15	0	273	15	0
2 Engineers in ordinary at	0	10	0	365	0	0
				£1043	15	0

amounting in the whole to the annual Sum of One Thousand and Fortythree Pounds fifteen Shillings, and for placing upon the said Ordnance Establishments a Company of Royal Engineers to consist of the following Officers and at the several Allowances of pay hereinafter mentioned " that is to say,"

	per Day			*per Annum*		
One Director of our Company of Royal Engineers .....at	1	2	2¼	405	0	0
One Lieutenant Colonel of do Company at	0	15	0	273	15	0
One Major of do Company .....at	0	15	0	273	15	0
One Captain .....at	0	10	0	182	10	0
One Captain Lieutenant .....at	0	4	8	85	3	4
Two First Lieutenants each .....at	0	4	8	170	6	8
				£1390	10	0

amounting in the whole to the annual Sum of One Thousand three Hundred and ninety Pounds Ten Shillings the same to commence from the 1st day of October last 1789 inclusive to continue during our pleasure and to be paid and payable in such and the like manner as the Corps of Engineers heretofore placed upon our Ordnance Establishment of our said Kingdom was payable and paid and you are to give Directions that the aforesaid Change of the Establishment of Engineers shall not take place with respect to the office of Chief Engineer so long as Colonel Pigott the present Chief Engineer shall hold the said Office, But that upon his avoidance thereof of the said Office of Chief Engineer shall cease and Determine and the Office of Director of Engineers as appointed by the aforesaid Change of the Establishment with the pay and allowances annexed thereto shall commence and you are also to give directions for placing upon the Ordnance Contingencies of that our said Kingdom an allowance of 10/- a Day for Captain Arthur Forth late Engineer in Ordinary in that Kingdom the same to commence from the 1st day of October last 1789 inclusive to continue during our pleasure and to be paid and payable as the othér Contingent Expences of the Ordnance are payable and paid, and We do hereby direct authorize and require you notwithstanding the 10th Article of Our Instructions to the Treasurer of the Ordnance in our said Kingdom to issue the necessary orders to the Board of Ordnance to direct their Treasurer to deliver or cause to be delivered at the Board of our said Office of Ordnance an account not only of all Monies by him received out of Our Treasury etc. within the year ending the 31st day of December last, but also within the three ensuing months up to the 31st day of March next 1790 and that in future the accounts so directed be made up and delivered in the said 10th Article of Instructions be made up for the period within the year ending on every 31st day of March or such other period as the Government of our said Kingdom shall from time to time direct the said accounts to be delivered as directed by the said 10th Article of Instructions within three months of the period to which they shall be made up, and for so doing this shall be as well to you as to our Lieutenant Deputy Justices, or other Chief Governor or Governor of that our Kingdom for the time being and all others who shall or may be herein concerned a sufficient Warrant and so We bid you heartily farewell.

Given at Our Court at St. James's this 26th day of March 1790. In the Thirtieth year of Our Reign. By His Majesty's Command

W. PITT, BAYHAM, APILEY.

Entered at the Signet Office this 7th day of April 1790

J. TIREL MAIN

REVIEW.

STRUCTURAL STEEL. R. A. SKELTON & CO.'S HANDBOOK No. 16.

(R. A. Skelton & Co., Moorgate Station Chambers, London, E.C. Price 10s. net).

THIS handbook has been compiled with a view to being of use to all interested in structural steelwork, and has a very wide scope. As the publishers remark in their introduction, it is not intended to enable the reader who has no engineering training to set about the design of a steel structure, but to furnish guidance to engineers well acquainted with elementary principles, but rusty in the application of them, and time-saving tables and diagrams for the benefit of experts.

The book is divided into two parts, the first part containing lists of sections and materials, together with the various drawings and tables relating to them; and the second part consisting partly of notes and data on the design of structural steelwork, and partly of general data.

The first part commences with a catalogue of rolled steel sections, giving the dimensions and weights of British, metric, and American joists, channels, tees, etc. The next chapters tabulate the properties of the various sections, comprising dimensions, weight, area, moments of inertia, section moduli, radii of gyration, resistance moments, maximum distributed loads, and safe loads in tons for various lengths and loading. The information is most complete, the chapter dealing, for instance, with British standard joists giving special properties, full size part section drawings, and standard girder connections. The succeeding chapters deal with steel plates and sheets; rivets and bolts, giving shear stresses, bearing values, spacing, etc.; wire and miscellaneous fittings, troughing, etc. Plated girders and stanchions are next dealt with; and the first part concludes with most comprehensive chapters on girders and stanchions. In addition to the tables many nomograms are given: *i.e.* diagrams drawn to scale from which a desired value may be read off by the use of a straight edge. Explanations abound; the chapter on girders, for instance, contains eight pages of diagrams and formulæ for shear, bending moment, and deflection in all conditions of support or fixing, and loading.

The second part of the book comprises chapters under the following headings:—Concrete and Reinforced Concrete, giving general principles and formulæ: Roofs, including a diagram giving wind loads on roofs: Foundations: Weights of Various Materials: Extracts from the L.C.C. (G.P.) Act, 1909 (Amendment of London Building Acts): Notes on

Steel Manufacture: Tests, etc.: Mathematical Tables, including four figure logs and anti-logs, natural and log functions of angles, squares, mathematical properties of various sections, etc.: Weights and Measures, including Conversion Tables: and a complete index.

The book is well arranged and convenient for reference. It is thumb indexed throughout, thus enabling the reader to turn at once to the required chapter, while at the commencement of each chapter is usually a summary of the chapter, giving the page on which the desired subject matter is to be found.

Space does not permit of giving more than the foregoing brief summary of this handbook, which contains a mine of useful information, and should prove invaluable to the R.E. officer, who is liable to be suddenly called upon to put into practice the principles learned by him perhaps several years past, and who may feel for the moment somewhat at a loss as to how to set about his task.

J.D.B.

THE ROYAL ENGINEERS JOURNAL.—SEPTEMBER, 1915. Pages 113—176.

THE ROYAL ENGINEERS JOURNAL.

Vol. XXII. No. 3. SEPTEMBER, 1915.

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ROYAL ENGINEERS INSTITUTE.

The following are on Sale at the Royal Engineers Institute, Chatham:—

CAMPAIGN IN GERMANY, 1866.—Compiled by the Department of Military History of the German Staff. Translation. 1 vol. and case of maps. Reprinted for the War Office, 1907. Price, Members, 5s. 3d., post free; non-Members, 6s. 9d., post free.

FRANCO-GERMAN WAR, 1870-71.—Translation of the German Official Account.—By Major J. A. Ferrier, D.S.O., R.E., and Mrs. Ferrier. Members, 5s.; non-Members, 7s. 6d. Post free.

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ROAD CONSTRUCTION AND MAINTENANCE, MANUAL OF.—Compiled by Major E. M. Paul, R.E. Price to Members, 3s.; non-Members, 4s. 6d. Post free.

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Abbreviated Notes on MILITARY ENGINEERING.

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IMPROVEMENTS IN CAMP EQUIPMENT.

By 2ND LIEUT. E. MCKAIG, A.M.I.C.E., R.E. (T.).

THE conditions underlying the construction and equipment of summer training camps to-day are very different to those of a year ago.

In pre-war times, providing the site was a dry one and an adequate water supply available, all was in order to move in and pitch the tents, and the training proceeded. Sanitary and hygienic questions were not so pressing and important owing to the fact that the camp would be at an end in 14 or at the most 28 days. Now, all camps become more or less standing stations and require to remain sanitary and habitable for four to six months or even longer.

After the water supply probably the most important item of equipment to the health of the troops is the latrine. It may be described as a necessary evil, but necessary it remains, the evil can be somewhat reduced.

In most sites the usual hut latrine has many objections, chiefly its exposure to the sun's rays and consequent fly nuisance, and secondly in the vicinity of dwellings its extreme unsightliness; these objections have been got rid of and at the same time other advantages obtained, viz., cheaper construction by making them as shown in *Figs.* 1 and 2, a semi-subterranean structure.

Latrines on these lines have been constructed for camps in ———; some in service for two months have maintained all that was claimed of them, and are highly satisfactory, and in materials more economical than the usual hut. It has been the practice to use on floors of latrines, boards with cross battens as bucket stands; these can be replaced with advantage by sanitary concrete slabs (see *Fig.* 4) with little or no increase of cost. The slabs being made an article of store, weighing about 60 to 70 lbs., could also be used as paving to standpipes (see *Fig.* 5), and night latrine bucket stands, etc. (*Fig.* 6). The V grooves assist in easy washing and disinfecting. They could be made on the site by unskilled labour, but preferably manufactured and delivered to the site by a civilian contractor, and once made becoming permanent.

The main difficulty in field latrines according to medical officers appears to be the fouling of the ground and difficulty in cleansing and disinfecting, and the slab is a simple expedient to minimize this.

The horse lines are another difficulty. In a camp of any duration

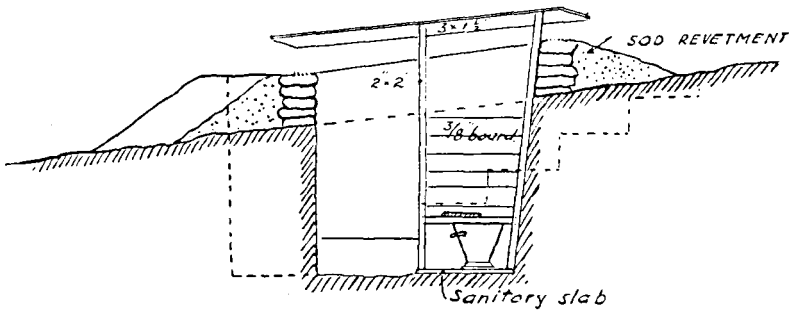


FIG. 1.—*Section A.A.*

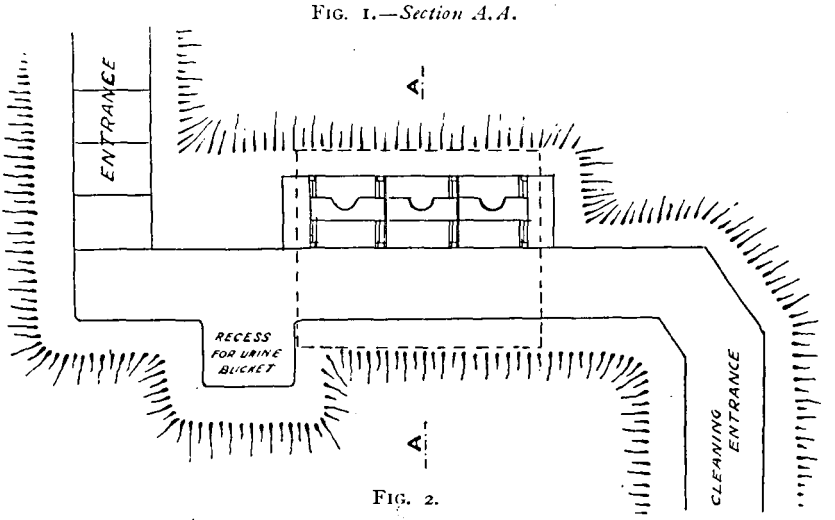


FIG. 2.

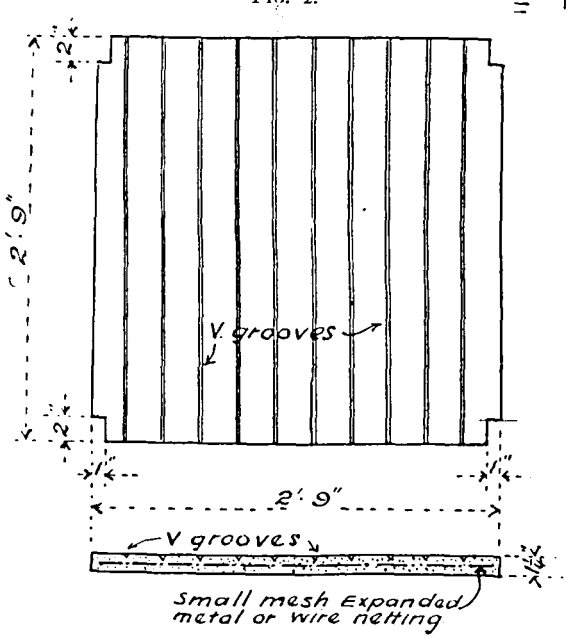


FIG. 4.—*P.C. Concrete Sanitary Slab.*

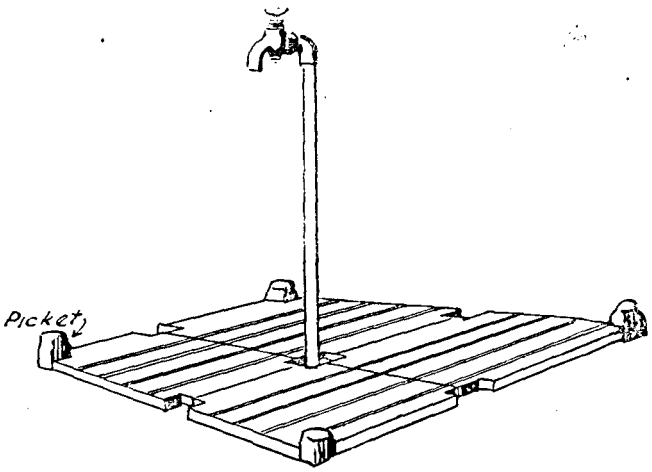


FIG. 5.

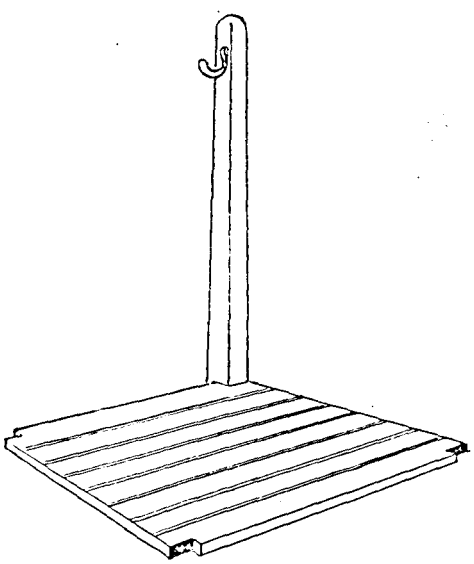


FIG. 6.

in bad weather, it becomes necessary to frequently move these or the health of the animals becomes impaired. *Figs.* 7 and 8 make a good arrangement. Here the cost is increased but not in proportion to the advantages, when the health and comfort of the horses is considered.

Fig. 9.—*Portable Saddlery and Harness Stand.*—For reasons of economy and expedition it is suggested that all the parts of the foregoing should be standardized and made articles of store, and if made at a depôt a great deal of the waste of material that cannot be avoided when camp equipment is arranged at the site would be

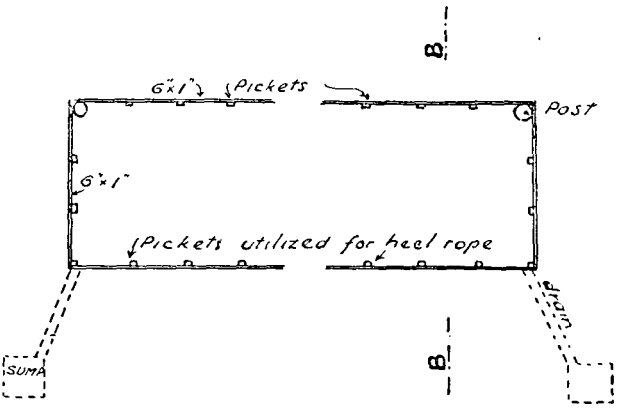


FIG. 7.

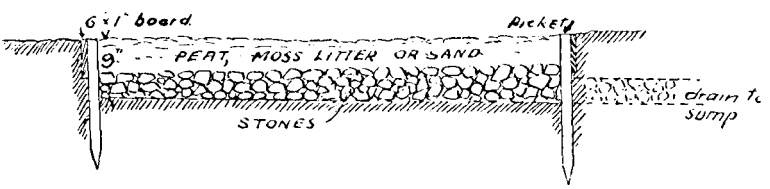


FIG. 8.—*Section B.B.*

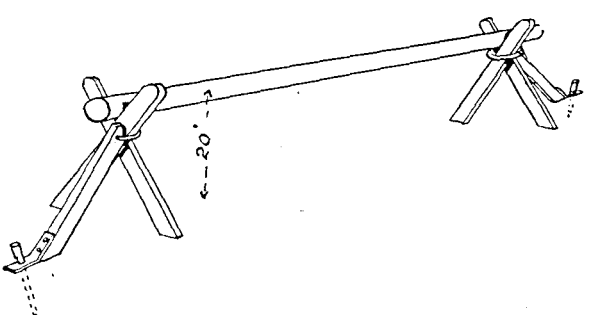
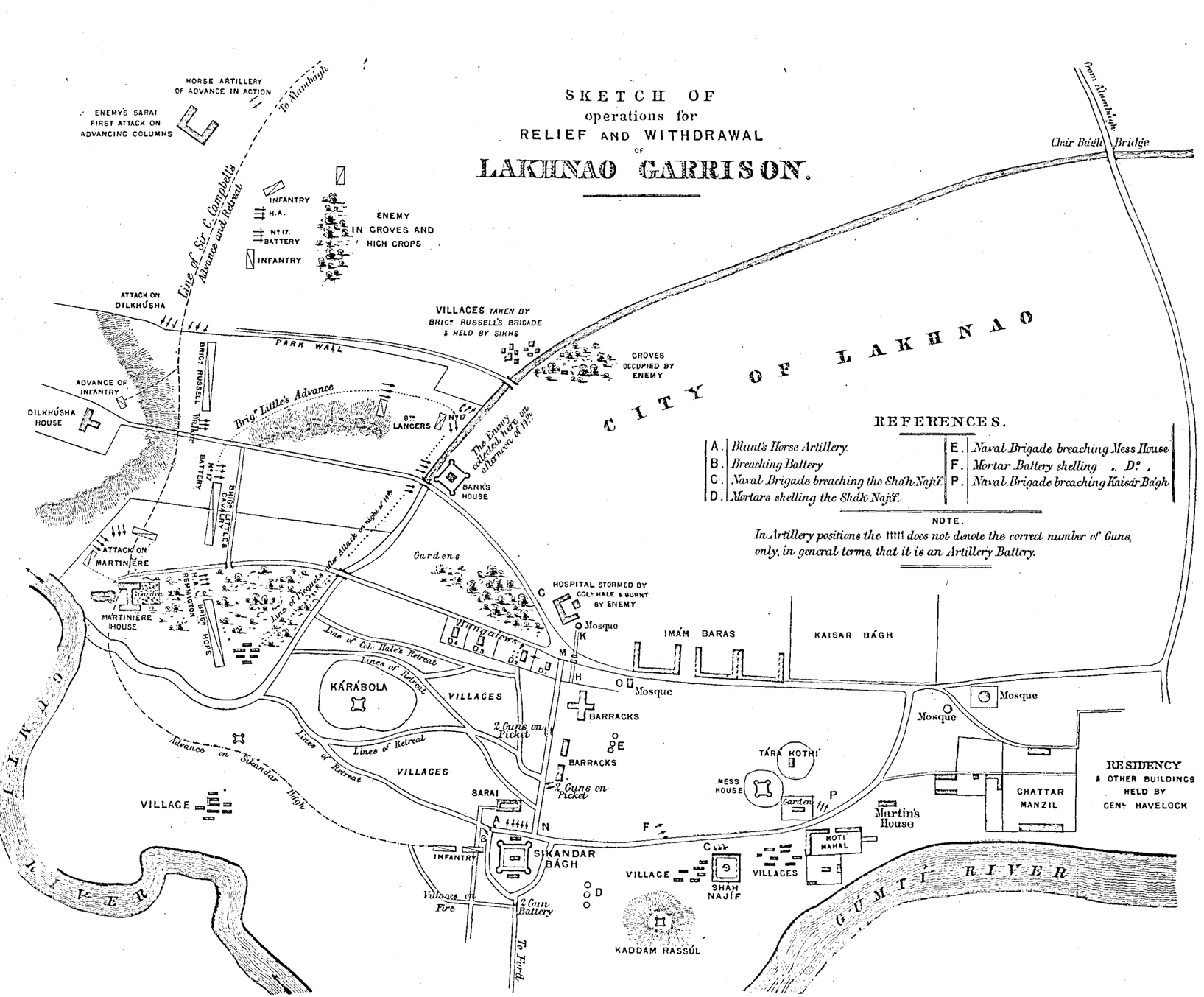


FIG. 9.

prevented and materials usually regarded as expendable would become "return to store." In short the complete equipment of a camp would become permanent and portable, more hygienic and economical.

Without exception all the foregoing could be made during training of Divisional R.E. sappers, and could be made to constitute their trade tests to a considerable extent. The figures accompanying this article are type sketches only, and not intended to be working drawings and subject to amendments and improvement.


SKETCH OF
operations for
RELIEF AND WITHDRAWAL
OF
LAKHNAO GARRISON.
HORSE ARTILLERY OF ADVANCE IN ACTION
ENEMY'S SARAI FIRST ATTACK ON ADVANCING COLUMNS
To Alumbagh
Line of Sir C. Campbell's Advance and Retreat
INFANTRY
H.A.
N° 17. BATTERY
INFANTRY
ENEMY IN GROVES AND HIGH CROPS
From Alumbagh
Chár Bágh Bridge
ATTACK ON DILKHUSHA
VILLAGES TAKEN BY BRIG^R RUSSELL'S BRIGADE & HELD BY SIKHS
CROVES OCCUPIED BY ENEMY
CITY OF LAKHNAO
PARK WALL
BRIG^R RUSSELL
ADVANCE OF INFANTRY
DILKHUSHA HOUSE
Brig^r Little's Advance
8TH LANCERS
N° 17
The Enemy collected here on afternoon of 14th
BANK'S HOUSE
BRIG^R LITTLE
N° 17 BATTERY
ATTACK ON MARTINIÈRE
Gardens
HOSPITAL STORMED BY COL^L HALE & BURNT BY ENEMY
MARTINIÈRE HOUSE
HERMISTON
BRIG^R HOPE
Line of Sequel to the Attack in night of 14th
Line of Col. Hale's Retreat
Lines of Retreat
Mosque
IMÁM BARAS
KAISAR BÁGH
KÁRÁBOLA
VILLAGES
BARRACKS
2 Guns on Picket
Mosque
Mosque
Mosque
Advance on Sikandar Bágh
Lines of Retreat
VILLAGES
BARRACKS
TÁRA KOTHÍ
MESS HOUSE
Garden
2 Guns on Picket
SARAI
VILLAGE
Murtin's House
CHATTAR MANZIL
RESIDENCY & OTHER BUILDINGS HELD BY GEN^L HAVELOCK
INFANTRY
SIKANDAR BÁGH
MOTI MAHAL
VILLAGE
SHAH NAJÍF
VILLAGES
Village on Fire
2 Gun Battery
To Ford
KADDAM RASSÚL
GUMTI RIVER
GOGRA RIVER
REFERENCES.
A. Blunt's Horse Artillery.
B. Breaching Battery
C. Naval Brigade breaching the Shah Najíf.
D. Mortars shelling the Shah Najíf.
E. Naval Brigade breaching Mess House
F. Mortar Battery shelling " D° "
P. Naval Brigade breaching Kaisar Bágh
NOTE.
In Artillery positions the ttttt does not denote the correct number of Guns, only, in general terms, that it is an Artillery Battery.

SIEGES AND THE DEFENCE OF FORTIFIED PLACES BY THE BRITISH AND INDIAN ARMIES IN THE XIXth CENTURY.

(*Continued*).

By COLONEL SIR EDWARD T. THACKERAY, V.C., K.C.B. (LATE R.E.).

THE SECOND RELIEF OF LUCKNOW.

The Commander-in-Chief, General Sir Colin Campbell, reached Cawnpore on the 3rd November, 1857, with the resolution to relieve Lucknow before doing anything else, and he had previously made all his arrangements for an advance on Lucknow. Sir Hope Grant's column which had left Delhi after the capture of that city, had reached Cawnpore on the 26th October, where it was increased to an effective strength of 5,500. Something arrived daily in the way of provisions and carriage, for the certainty of having to carry back with him the women and children had not been lost sight of by the Commander-in-Chief.

Sir Colin Campbell joined Hope Grant on the 9th. The interval, from the 3rd to the 9th, had been spent by the Commander-in-Chief in arranging for the protection of his base at Cawnpore. He left behind at Cawnpore about 500 Europeans under the command of Major-General Charles A. Windham, C.B. Windham was directed by the Commander-in-Chief to place his troops within the entrenchment which, on the occupation of Cawnpore by Havelock in July, had been hastily constructed on the river, and to send into Oudh the detachments of European infantry which might arrive, and on no pretext to detain them.

Having by these instructions secured his base, Sir Colin Campbell started on the 9th, accompanied by his staff, to join Hope Grant's camp in the sandy plain 4 miles beyond Banní. He reached it that afternoon, had a cordial meeting with Hope Grant and his old friends of the Delhi force, and after a short conversation gave his orders for the following day.

In pursuance of these orders Colonel Adrian Hope was sent forward to the Alumbagh, the following day, in charge of a large convoy of provisions. The provisions were to be left there and the carts laden with sick and wounded to be sent back to Cawnpore. That same day a portion of the siege train, escorted by the Naval

Brigade arrived in camp. Early in the morning of the 10th there suddenly presented himself to the astonished gaze of Sir Colin Campbell, a European gentleman disguised as a native, and who in that disguise, had managed to make his way through the beleaguering forces, carrying on his person important dispatches. His name was Kavanagh. To understand thoroughly the nature of the information he brought the reader is asked to remember the account given in the last chapter of this history of the arrival of the relieving force under Outram and Havelock.

On the night of the 25th September the advanced portion of Havelock's force had entered the Residency. They were followed next morning by all but the rear guard. It had already been discovered that the advent of Outram's force constituted not a relief but a reinforcement, that means of transport for the ladies and children, the sick, and the wounded were wanting, that an enormous addition had been made to the hospital list, and that even had transport been available the combined force was not strong enough to escort it to Cawnpore. But one course then remained open to Outram, and that was to hold the Residency, until he should be effectively relieved by Sir Colin Campbell.

Outram's first care was to provide accommodation for the largely increased force. With this view he at once caused the palaces extending along the line of the river the Táráwálá Koti, the Chuttur Munzil, and the Farhat Bukhsh to be occupied, the enemy's works and guns in the vicinity being at the same time destroyed. These posts were taken on the morning of the 26th September.

The six weeks which followed the arrival of Outram's force have not been inaptly described as a blockade. His arrival had terminated the siege. The danger of being overwhelmed by the masses of the enemy had in a great measure passed away. Before the arrival of the reinforcements there had generally been the excitement of defence; it had now become the more stirring excitement of attack.

On the 27th September, for instance, a party of the 1st Fusiliers and some men of the 32nd Regiment, under the command of Major Stephenson, made a sortie for the purpose of taking some guns in the enemy's Cawnpore battery. The British troops were met by a very heavy fire from the enemy, and although they succeeded in spiking three of the enemy's guns, they were unable to bring them back within the defences. On their return, they were exposed to so destructive a fire from the tops of houses and loopholes, that they found it most difficult to carry in their killed and wounded.

On the 29th September, three sorties were made simultaneously. One of these proceeded from the left square of the Brigade Mess, the second from the Sikh Square, the third from the Redan. The third party, composed of 200 men, with a reserve of 150 from

the 32nd and 5th Fusiliers, drove the enemy from their guns, and advanced till they came to a lane commanded by an 18-pounder. In this advance they lost Capt. McCabe, of the 32nd, a most distinguished officer, who was then leading his fourth sortie. Major Simmons, of the 5th Fusiliers, was also killed, and it being ascertained that no further advance could be made without considerable loss, the party was recalled. The second party from the Sikh Square was composed of men from the 32nd, 78th, and 1st Madras Fusiliers, 200 in all, and supported by some men of the 13th Native Infantry, under Lieut. Aitken. They succeeded in demolishing several houses and batteries. The first party from the Brigade Mess, commanded by Capt. Shute, and composed of men from the 32nd, 64th, and 84th, succeeded in destroying a 24-pounder gun, and in spiking two mortars and four native guns of small calibre. Their loss was very severe. Again on the 2nd November Lieut. Hardinge led a party composed of the 32nd, 84th, and 1st Madras Fusiliers, and seven artillerymen, to destroy some guns on the Cawnpore Road. This was done effectively and almost without opposition. To write a detailed account of these operations would require a volume devoted wholly to the Siege of Lucknow. Constantly recurring are the names of Wilson, Aitken, Ouseley, Apthorpe, Forbes, Graham and Cubitt, of the infantry; McLeod Innes, Anderson, and Hutchinson, of the Engineers. Every native officer of the 13th Bengal Native Infantry was killed, wounded, or died during the siege. The subahdar of the regiment, Aman Singh, a gallant old Rájpút, received two wounds at Chinhut, but struggled back into the Residency with the beaten troops from that fatal field, and served throughout the siege, and for many years afterwards as a subahdar-major of the Regiment of Lucknow. All ranks of that gallant regiment the 13th as well as the 48th, and 71st Native Infantry received the Order of Merit.

On the 2nd October, Outram, finding that the garrison was greatly annoyed by a fire from a very strong battery, known as Phillip's Garden Battery, on the Cawnpore Road, ordered a party formed of detachments from several regiments under Colonel Napier to storm it. Napier conducted the attack with his usual combination of science and daring, and took the battery, with the loss of two men killed and eleven wounded. He captured three guns—two 9-pounders and a 6-pounder. There was nothing strange in this, but it was remarkable that he should have rescued a private soldier of the Madras Fusiliers, who had fallen down a well, and had remained there three days, undiscovered by the rebels who were occupying the place.

Outram had been much impressed with the advantages of adopting the direct Cawnpore Road as the mode of communication with the Alumbagh. To carry out this idea, he directed Major Haliburton,

of the 78th Highlanders, to extend the position in that direction, working from house to house. This operation which was full of danger was begun on the 3rd. The next day Haliburton was mortally wounded. Stephenson, of the Madras Fusiliers, who succeeded him shared the same fate on the 5th. Still the work was persevered with. Several houses were pierced through and at last, on the 6th, a large mosque was reached. This place was in great strength of itself and was occupied in considerable force. The intermediate houses were blown up, and the 78th were located in the garden in which rested the battery captured on the 2nd. This became an important post, and not only protected a considerable portion of the old entrenchment, but connected it with the palaces which had been occupied previously.

The work of mining and countermining, so remarkable during the siege, was still further developed under the superintendence of Colonel Napier. Ably seconded by the Engineer officers, Crommelin, Anderson, McLeod Innes, Hutchinson, Russell, Limond, and by others, all the efforts of the enemy in this direction were frustrated. Some of the 32nd, trained during the siege, made themselves remarkable for their dexterity in mining. For general purposes a company of miners was formed of volunteers from the several corps, and placed under the orders of Capt. Crommelin. These "soon gave him the ascendancy over the enemy who were foiled at all points, with the loss of their galleries and mines, and the destruction of their miners in repeated instances." *

The effect on the enemy of the occupation as outposts of three strong positions commanding the road to the iron bridge, was remarkable. During the siege they had occupied positions within a few yards of our entrenchments. From these they were now driven back to a distance so great, that their musketry fire had no chance of doing mischief inside the old position. They accordingly, with considerable skill, altered their tactics. They withdrew their guns to a point whence the fire would clear the outer defences and fall within the entrenchment. The plan was ingenious, and was so far well worked that the point of fire was constantly shifted. It might have been very damaging but for one defect, viz. want of confidence in the success of the plan, which produced, therefore, want of continuity in the working of it and proved fatal.

* Sir James Outram's official report. "I am aware," he also said, "of no parallel to our series of mines in modern war. Twenty-one shafts, aggregating 200 ft. in depth, and 3,291 ft. of gallery have been executed. The enemy advanced 20 mines against the palaces and outposts; of these they exploded three which caused us loss of life, and two which did no injury; seven had been blown in, and out of seven others the enemy have been driven, and their galleries taken possession of by our miners."

On the 9th October the garrison was cheered by the news that Delhi had fallen and was completely in our power, that the King was a prisoner, and that Greathed had set out to lead a brigade to Cawnpore. This news was confirmed the following day by the further intelligence of the victory gained by Greathed at Bulundshahr. From this date relief became a question of time, and if relief could arrive before the 20th November, Outram felt that all would be well. He believed from the information officially given him that even on the reduced scale of rations allowed, the supplies in the Residency would not feed the force longer than the 20th. But this was an entire misconception on the part of the supply department, for the supplies would have lasted for a far longer period.

It was mainly the belief that Outram's supplies were nearly exhausted that induced Sir Colin Campbell to march to Lucknow before disposing of Tantia Topee and the Gwalior troops. Still, though the greatest enemy was impatience, the efforts of the enemy outside the walls never slackened; nor were they wholly without effect. Many officers were killed or wounded between the 25th September and the 10th November, among the former being Lieut. Graydon, of the 44th Native Infantry, Capt. McCabe, of the 32nd, and Capt. Hughes, of the 57th Native Infantry, and among the latter, Browne, Edmonstone, Capt. Lowe, of the 32nd, and Assistant Surgeon Darby, of the same regiment. On the south side of the entrenchment the fire continued to be especially galling, several bullets entering the loopholes. Complete exposure on this side was certain death. On the 4th November, Dashwood of the Bengal Army, a very gallant officer, lost both his legs by a round shot, whilst sketching in the Residency compound. He had been warned by a first shot passing near him, but he would not stir.

On the 6th November, news reached the garrison that Hope Grant had encamped on the Lucknow side of the Banní Bridge, and that he was to wait there for Sir Colin Campbell, whose arrival at Cawnpore was also announced. Sir James Outram had previously forwarded to the Alumbagh a dispatch for Sir Colin, in which were contained plans of the city and its approaches, and his own ideas as to the best mode of effecting the junction of the relieved and the relieving forces. He had advised the Commander-in-Chief to make a détour from the Alumbagh to the right of the Dilkushá, and to advance thence by the Martinière and Sikandrabagh. By means of a preconcerted signal, he ascertained that his dispatch had safely reached the Alumbagh. The success of this mode of communication suggested the improvising of a semaphore telegraph, and the idea was no sooner conceived than it was carried out.

But though written descriptions might be useful to the Commander-in-Chief their value could in no respect equal that which might be conveyed by an intelligent member of the garrison, by one

who had undergone the siege and withstood the blockade, and who could cast the light of personal experience on the insufficient description of a dispatch. But where was the man who would undertake to penetrate the serried lines of the enemy, knowing that death was synonymous with discovery? Disguise was necessary. To ask a man to dare this risk everyone felt was impossible. But it has often been found, amongst Englishmen, that the occasion produces the man. A clerk in one of the civil offices, by name Thomas Henry Kavanagh, caused General Outram to be informed, on the 9th November, that he was prepared to traverse in disguise the hostile lines, and to convey a letter to the Commander-in-Chief in his camp near Banní. Mr. Kavanagh's offer was the more heroic, as of all the garrison he was perhaps the most difficult man to disguise. Taller than the ordinary run of natives he was also very fair. But perfectly cognizant of these drawbacks, Mr. Kavanagh offered himself. General Outram loved a gallant deed; but brave as he was, and loving bravery in others, he yet shrank from exposing a man to the consequences of a deed such as that which Kavanagh proposed. He told him frankly the risks he ran, the almost certain fate that would befall him. But Kavanagh had made up his mind, dangers there were he knew, but having in view the all-importance of his mission he would brave them. Kavanagh chose the garb of a Badmársh, a native "swashbuckler," a soldier for plunder, of the sort which abounded in the ranks of the rebels. He wore a pair of tight silk trousers, fitting close to the skin, a tight-fitting muslin shirt, and over this a short yellow silk jacket. Round his waist he wound a white band, over his shoulders he threw a coloured chintz cloth, a cream-coloured turban being on his head, and he wore native slippers. His face and down to the shoulders, and his hands to the wrist, he stained with lamp-black dipped in oil, his hair being cut short. Thus disguised and wearing the shield and sword peculiar to the swashbuckler, Kavanagh at 9 o'clock on the evening of the 9th November, accompanied by a faithful native spy, by name Kananjí Lál, set out. His journey, though not without its alarms,* proved that Mr. Kavanagh had not counted vainly on his brave and resolute heart. He could not, indeed, reach the Alumbagh, but passing by it, he fell in on the morning of the 10th, with a party of Punjab Cavalry, by whom, after receiving their warm greetings and congratulations, he was escorted to Sir Colin Campbell.

The information thus received by that gallant commander supplied the one link which till then had been wanting to complete his mastery of the position. The following morning his engineer park arrived, and orders were issued for an advance the next day.

* Mr. Kavanagh wrote an account of this journey, *How I Won the Victoria Cross* (Ward & Lock). He died in St. Thomas's Hospital in 1883.

The force under the command of Sir Colin Campbell consisted mainly of regiments which had already fought against the mutineers. They were the 8th, a wing of the 53rd, the 75th, and the 93rd Regiments of the Line, the 2nd and 4th Punjab Infantry (Sikhs), the 9th Lancers, Hodson's Horse, and other detachments; the Artillery consisted of 16 guns all tried at Delhi, a few Bengal sappers, and some Punjabi pioneers, and 250 men of the Naval Brigade, with eight heavy guns, and two rocket tubes mounted on light carts. The total number of fighting men, European and Native, was estimated at 3,400.

It was curious to mark the difference between the old Indian troops and the Highlanders in their reception of Sir Colin. Anxious and fixed was the gaze of the former as he rode down their ranks —men evidently trying to measure the leader who had been sent to them from so far. Enthusiastic beyond expression was his reception by the latter. It was seen at once that to him was accorded their entire confidence, that under him they would go anywhere and do anything. At sunrise on the following morning the troops advanced. The plan upon which Sir Colin Campbell had determined, and he was well instructed by Sir James Outram while possessing the advantage of the presence by his side of Mr. Kavanagh, was to move on the Alumbágh; to store within that enclosure all the tents, and, having drawn to himself the detachments still in rear, to make with a wide sweep a flank march to the right, on the Dilkoosha Park and the Martinière; starting afresh from these points, to force the canal close to its junction with the Gúmti; then covered by that river to advance, up its right bank on the Sikancharbágh. This point once secured, a portion of the force could make a dash southwards. The main body, meanwhile forcing the Shah Nujif, and the Moti Mahál, would open out the way for a junction with Outram. To support this operation, Outram would co-operate by a heavy fire on the intermediate positions held by the enemy from all the guns in the Residency; having forced them he would move out, with all his sick and wounded, women and children, and treasure, between the Gúmti and the Kaiserbágh, and effect a junction with the Commander-in-Chief. It was based upon the plan drawn up by Outram, and transmitted to Sir Colin by the hands of the gallant Kavanagh, on the 9th.

To carry out this plan, the little army set out at sunrise on the morning of the 12th November. It had marched barely 3 miles when the advance guard headed by a squadron of Hodson's Horse, commanded by Lieut. Gough, striking the road leading to Jalálábád came under the fire of some light guns, covered by a line of fieldworks. Capt. Bourchier at once brought up his field battery, and opened a fire which soon silenced the hostile guns. The rebels attempted to remove these guns, but Gough was amongst them like lightning,

and drove them from the field with the loss of two of their pieces. No further opposition was offered to the progress of the force to the Alumbágh. The camp was pitched under cover of the Alumbágh. Here the force halted for the following day.

The 13th was devoted by Sir Colin Campbell to making arrangements for a decisive advance on the next day. He first despatched a small brigade under the command of Colonel the Hon. Adrian Hope,* of the 93rd Highlanders, an officer of great attainments and brilliant promise, to take possession of the fort of Jelálábád in the right rear of the position at Alumbágh. Hope found that the fort had been evacuated, and returned after rendering it useless by blowing in one of its faces.

Whilst one brigade was engaged in this operation, Sir Colin caused all the camp equipage not required for the hard work in prospect to be stacked within the enclosure. He directed, also, that whilst supplies for 14 days for himself and the troops in Lucknow should accompany him, every soldier should carry in his haversack provisions for three days' consumption. By successive reinforcements and the junction with the Alumbágh garrison, the force had now been augmented to about 5,000 men of all arms.

The Naval Brigade, commanded by Capt. William Peel, consisted of 250 men of the crew of the *Shannon*, seamen and marines, having with them eight heavy guns and howitzers, drawn by bullocks. The Cavalry Brigade commanded by Brigadier Little was composed of two squadrons of the 9th Lancers and one each of the 1st, 2nd, and 5th Punjab Cavalry, and of Hodson's Horse. There were also a company of Royal Engineers, a company of Madras Sappers, a few Bengal Sappers who had served at Delhi, and two companies of newly-raised Punjab Pioneers. The Infantry Brigades were the 3rd, the 4th, and the 5th, commanded by Brigadiers Greathed, Adrian Hope, and Russell respectively.

On the evening of the 13th Sir Colin rode out to reconnoitre, and the following morning at 9 o'clock he gave the order to march. The advance was made from the right, through the fields, crossing the several roads leading from the city at right angles. The turning movement was made at the point expected and the advance bringing forward their right shoulders moved directly on the wall of the Dilkusha Park. As the advance neared the enclosure a heavy matchlock fire was opened upon it from the left. Reinforcements were at once sent to the front, and the British guns opened upon the group whence this fire proceeded, and silenced it. The British skirmishers advancing drove back the rebels and the Dilkusha was thus carried almost without a blow.

The infantry composed of a battalion, made up of companies from

* This distinguished officer was killed at the attack on Fort Rohia in Oudh in April, 1858.

the 5th Fusiliers, the 8th, 64th, and 78th Foot, commanded by Lieut.-Colonel Hamilton of the 78th, and supported by the guns dashed down the slope and carried the Martinière, the enemy not waiting to receive them, but retreating across the canal with all speed, pursued by our cavalry.

Both these important places having been carried the Commander-in-Chief brought up the 4th Brigade and arranged it in position in the gardens of the Martinière. He located there also a troop of horse artillery, and the 5th Brigade was posted on the left in front of the Martinière. These arrangements had not been made one moment too soon. They were hardly completed, when it became evident from the massing of troops on their centre, that the enemy were contemplating an aggressive movement. About 400 yards to the right of the wall of the Dilkusha Park as one faces the canal is the bridge connecting the Martinière plain with the Hazrat-gunj main street. It was on this bridge that the rebels, about 5 o'clock in the afternoon, came down in great numbers and with several guns.

Bourchier's Battery and Peel's 24-pounders occupied a position on some high ground on the left of the bridge, whence they were able to direct a concentric fire on the angle formed by the canal near the bridge, and where the enemy was massed in large numbers. Their fire speedily crushed the enemy out of this position. Then Adrian Hope, forming up his brigade, pushed across the bridge, drove back the enemy with heavy loss, and secured a lodgment on the other side. The attack of the rebels had failed.

That night the men slept with their arms by their side, ready for prompt action. The following day, the 15th, was spent in making preparations for the grand advance. Then Sir Colin made his final arrangements. The whole of his heavy baggage, his supplies for 14 days, he stored in the Dilkushá. Into the palace all the sick and wounded were conveyed. Defences were thrown up round that building, and a force was detailed to guard it.

Having made all the arrangements which skill and foresight could suggest, Sir Colin signalled to Sir James Outram by a code previously arranged, that he would advance on the morrow.

Early on the morning of the 16th the heavy guns were withdrawn from the advanced pickets on the canal, and the detachments of Adrian Hope's Brigade which had been sent to the front rejoined their regiments. The advance guard moved forward from the extreme right. Following the advance guard marched Adrian Hope's Brigade, then Russell's; then the Ammunition and Engineers' Park. Greathed's Brigade followed the remainder of the force as its rear guard. The advance guard, then marched along the bank of the Gúmti through the lane and enclosures without meeting an enemy.

Suddenly for the first time the enemy took the alarm. First from men occupying huts and enclosures in advance of the building, then from the mass of men in the Sikandarbágh* itself, poured an overwhelming fire on the troops forming the advance. Their position was in a military point of view desperate, for they were exposing their flank to the enemy. For a distance of 120 yards to the walled enclosure of Sikandarbágh, they were broadside on to the enemy's fire. The situation was indeed critical. One company of the gallant 53rd in skirmishing order lined the enclosures bordering on the lane, but their numbers were few, and the fire of the enemy was concentrated; the cavalry were jammed together, unable to advance, and the high banks on either side seemed to offer an impassable barrier to artillery. But, up the steep bank the daring Blunt led his gallant troops, and "conquering the impossible," brought them, guns and all, into an open space between the Sikandarbágh and another large loopholed building, exposed to a terrific cross-fire as he advanced. Here unlimbering, he opened with his six guns on the Sikandarbágh. Never was anything done better. Travers followed with his heavy battery, and the sappers and miners having demolished a portion of the high bank, he too was able, by the aid of the infantry, to bring two of his 18-pounders into position and to open fire against the angle of the enclosure. In less than half an hour their fire made a breach in the wall which might be practicable for stormers.

Meanwhile the infantry of Adrian Hope's Brigade had been ordered to lie down, covered by a small bank and some trees. But the moment the breach was considered practicable the bugle sounded the signal for assault. It was made by the 93rd Highlanders and the 4th Punjab Rifles, supported by the 53rd and a battalion of detachments. The Highlanders, under Lieut.-Colonel Ewart, and the Sikhs, under Lieut. Paul, and a native officer of the Sikhs, Subadar Gokal Singh, dashed forward. All ran towards the hole—a small hole in a bricked-up doorway, about 3 ft. square, and about the same distance from the ground. A Sikh of the 4th Rifles reached it first, but he was shot dead as he jumped through. A similar fate befell a Highlander in his track. A young officer of the 93rd, Richard Cooper by name, outstripping the majority of his comrades was more fortunate. Flying, so to speak, through the hole he landed unscathed. Cooper was immediately followed by Colonel Ewart, of the 93rd, and Capt. Lumsden and three privates, then by eight or nine men, Sikhs and Highlanders. Another officer, Capt. Burroughs, of the 93rd, also penetrated within the enclosure but was almost immediately attacked and severely wounded. Lumsden was

* The Sikandarbágh, Anglice, "the garden of Alexander," was a high-walled enclosure, about 150 yards square, with towers at the angles.

killed by a musket shot. Ewart, forcing his way into the court-yard, pushed forward with his following against the men at the other end of it. The few Highlanders and Sikhs then rushed at them and a desperate hand-to-hand encounter ensued. At the critical moment the bulk of the brigade, Highlanders, the Sikhs, and the 53rd, poured in to the rescue.

Impatient of the delay which would be caused by jumping singly through a narrow hole, the bulk of the storming party had turned to the left to force a way by the gate of the enclosure. This gate was locked and barred; and although the men used all their efforts, firing their pieces at the lock, some time elapsed before it gave way. But at last it yielded, and the 93rd and Sikhs dashed through it. Almost simultaneously the 53rd forced a barred window to the right of it and joined in the rush to the rescue of Ewart, of Cooper (still fighting in spite of his wound), and their comrades.

Through the gate and window, and through Cooper's hole which the sappers had succeeded in enlarging, the stormers poured as fast as they could make their way. As they entered the rebels fell back into the towers at the angle of the enclosure, and opened a heavy and continuous musketry fire on our men, occasionally diversifying this mode of fighting by descending to a hand-to-hand encounter. In one of these, Colonel Ewart succeeded in cutting down two native officers who guarded a colour, and in capturing the colour, which he presented with his own hand to Sir Colin Campbell. The fight for the possession of the enclosure was bloody and desperate the rebels fighting with all the energy of despair. Every room, every staircase, every corner of the towers was contested. Quarter was neither given nor asked for, and when at last the assailants were masters of the place more than 2,000 rebel corpses lay heaped around them.

About 300 yards along the road leading from Sikandarbágh to the Residency there was a small village with garden enclosures round it, while about 250 yards further on and 100 yards to the right of the road stood the Sháh Najif, a large mosque, situated in a garden enclosed by a high loopholed wall. This wall was nearly square and very strong. Between it and the Sikandarbágh amidst jungles and enclosure, to the right of the little plain, was a building on a high mound called the Kadam Rasúl.

The afternoon was now waning and Sir Colin Campbell deemed it essential to carry the Sháh Najif. The operation was dangerous and most difficult. On the right the Kadam Rasúl was assaulted and carried by a party of Sikhs. There was great confusion in the narrow lane leading up from the rear. The animals carrying the ordnance and engineer supplies unable to get out on either side got completely jammed, and the confusion near the Sikandarbágh had got to such a pitch that all passage had become impassable; and

had it not been that a staff officer discovered a by-path leading into a broad road which abutted on the Sikandarbágh, neither men nor ammunition could have been brought up.

In front of the Sháh Najif the battle made no way, and the men were falling fast. It was now apparent that a crisis had been reached. Our heavy artillery could not subdue the fire of the Sháh Najif; we could not even hold permanently our present advanced position under it. But retreat to us there was none. What shot and shell could not do, the bayonets of the infantry must accomplish.

Collecting the 93rd about him, the Commander-in-Chief addressed a few words to them. He told them that the Sháh Najif *must be taken;* that the artillery could not bring its fire under, so they must win it with the bayonet. Giving them a few plain directions, he told them he would go on with them himself. The grey-haired veteran of many fights rode at the head of the troops. As they approached the nearest angle of the enclosure, the soldiers began to drop fast; but without a check they reached its foot. There, however, they were brought to a stand. The wall, perfectly entire was nearly 20 ft. high, and well loopholed; there was no breach, and no scaling ladders.

Unable to advance, unwilling to retire, they halted and commenced a musketry battle with the garrison. But all the advantage was with the latter, who shot with security behind loopholes, and the Highlanders went down fast before them. At this time nearly all the mounted officers were either wounded or dismounted. Two of Peel's guns were now brought up to within a few yards of the wall. Covered by the fusillade of the infantry, the sailors shot fast and strong; but though the masonry soon fell off in flakes, it came down so as to leave the mass behind perpendicular, and as inaccessible as ever.

Success now seemed impossible. The dead and wounded were ordered to be collected and carried to the rear. Some rocket frames were brought up, and threw in a volley of these fiery projectiles with such admirable precision, that just skimming over the top of the rampart they plunged hissing into the interior of the building, and searched it out with a destroying force. Under cover of this the guns were drawn off. The shades of evening were falling fast and the assault could not much longer be continued. Then, as a last resource, Adrian Hope, collecting some 50 men, stole silently and cautiously through the jungle and brushwood away to the right, to a portion of the wall on which he believed some injury to have been inflicted, having observed signs of this before the assault. Reaching it unperceived, a narrow fissure was found, and up this, a single man was with some difficulty pushed. He saw no one near the spot, and so helped up Hope, Ogilvy, Allgood, the Assistant Quartermaster-General, and some others. The numbers inside soon

increased, and as they did so they advanced, gradually extending their front. A body of sappers, sent for in haste, arrived at the double, the opening was enlarged, the supports rushed in. Meanwhile Hope's small party, pushing on, to their great astonishment found themselves unopposed. Gaining the gate they threw it open for their comrades. Panic-stricken, apparently, by the destruction caused by the rockets and the sudden appearance of some of the assailants within the walls, they fled from the place, and gave up the struggle just when victory was secure. Never had there been a harder-fought day,* but never was a result gained more satisfactorily. A lodgment had been made for the night and the order was then given to bivouac. The main body of the 93rd garrisoned the Shah Najif; another portion of that regiment occupied the barracks. The troops not occupying these two posts lined the roads and maintained the communications. The field hospital for the wounded was established in some huts opposite the Sikandarbágh which might be regarded as the central point of the position taken up for the night. The men lay down in line with their arms by their sides.

During the hours employed by the troops under Sir Colin Campbell in attacking the Shah Najif, the Residency garrison under Sir James Outram were using all their efforts to effect a diversion. They captured some of the positions to the east of the Residency, and from these maintained a continuous fire of guns and mortars on the rebels.

The British and Sikh troops, lying in unbroken order with their arms by their sides, were awakened early in the morning of the 17th, not by their own bugles, but by the bells of the city and the beating of the enemy's drums. The British soldiers sprang up with alacrity, each man in his place, ready for action. But the enemy did not come on. Sir Colin Campbell was, therefore, able to carry out his own plan and to choose his own time. His plan was first to carry the Mess House, a large masonry building defended by a ditch 12 ft. broad, surmounted by a loopholed wall behind, about midway between the Sháh Najif and the Kaiserbágh. Much would still remain to be accomplished. The strong positions of the Kaiserbágh, and of the Begum's palace covering the vast city behind them would still remain in the occupation of some 30,000 unsubdued foes, and it was in the face of these that Sir Colin would have to withdraw the women and children, the sick and the wounded. Sir Colin commenced his operations with great caution. First, he deemed it advisable to secure his left flank. To prevent the enemy from acting on our left rear he

* "It was an action almost unexampled in war."—Sir Colin Campbell's Dispatch, 18th November, 1857.

detached the 5th Brigade under Brigadier Russell to carry the house called Banks's house and four bungalows close to the barracks, to convert them into military posts. Possessing now the barracks and the Dilkushá the occupation of Banks's house and the bungalows would sever the communication between the Kaiserbágh and the Dilkushá and would cover the left rear of the attacking force.

Having thus made arrangements to secure his communications Sir Colin directed William Peel to open fire with his heavy guns on the Mess House. The fire continued from early morning till 3 o'clock in the afternoon. At that hour the musketry fire of the enemy having been almost completely silenced, it appeared to Sir Colin that the Mess House might be stormed without much risk. It was a building of considerable size, and surrounded by a loop-holed mud wall, covering a ditch about 12 ft. broad, scarped with masonry. The ditch was traversed by drawbridges, but whether these were down or up was unknown to the storming party.

Never was a daring feat of arms better performed. Leading his men at the double across the intervening space, exposed to a hot fire from the neighbouring buildings, Hopkins, of the 53rd, reached the mud wall, dashed over it, crossed the drawbridge, fortunately left down, and entered the Mess House. He had but just gained the place when Roberts (afterwards Field Marshal Earl Roberts and Commander-in-Chief in India) galloped up, handed him a Union Jack, and requested him to hoist it on one of the turrets. Followed by one of his men, Hopkins climbed upon the roof, and giving three cheers, planted the flag on the summit. The flag had not been up ten minutes before a round shot cut the staff and sent it down into the garden. Again did Hopkins plant it, and again it was knocked down. He asked to hoist it again, but just at the moment, an order arrived from the Commander-in-Chief forbidding the further display of it. Simultaneously Wolseley, moving on a different point, had attacked the houses to the right of the Mess House, whilst Irby with a company of the supports, attempted to clear those on the left. Both attacks were successful, and the rebels being driven out fled in panic to the Motí Mahal.

The victorious stormers followed the flying enemy. Wolseley hurried on to the wall of the Motí Mahal, but the opposition was great, and the wall was solid, and the gateway had been blocked up, he had therefore to send back for the sappers. These promptly came up and succeeded in making narrow openings in the wall. Through these Wolseley and his men eagerly rushed, and attacked the network of buildings within. The resistance they encountered was, however stout and desperate, every room being contested. At length, however, he expelled the enemy, and the Motí Mahal, the last building held by the rebels on the line communicating with Outram and Havelock, came completely into British possession.

An open space, nearly half a mile in width, still intervened between the assailants and the advanced positions of Outram and Havelock. This space was exposed to heavy musketry fire from the Kaiserbágh and could not be crossed without imminent risk. But the risk did not prevent the two gallant generals and their staff from crossing the space to meet the Commander-in-Chief.

They started, eight officers and one civilian. They were Outram, Havelock, Napier (afterwards Lord Napier of Magdala), Vincent Eyre, Dodgson, the Deputy Adjutant-General, young Havelock, the aide-de-camp, Sitwell, Russell of the Engineers, and the gallant Kavanagh. They had not gone many paces before they were seen by the enemy, and the musketry fire from the Kaiserbágh redoubled. Napier, young Havelock, Sitwell and Russell were struck down. Outram, Havelock, Eyre, Dodgson and Kavanagh alone reached the Motí Mahal uninjured; then to borrow from the appropriate language of Sir Colin Campbell, "the relief of the garrison had been accomplished." But a most difficult and dangerous task still remained. The garrison, with women and children, sick and wounded, guns and stores had to be withdrawn; and to effect this in the face of the vast force of the enemy was no easy task.

One narrow lane alone led to the rear, and through it the whole force had to be filed. To protect the march of the convoy, the whole of the immense line, extending from the ruined walls of the Residency to the wooded park of the Dilkushá required to be held, and this gave a most hazardous extension to our forces—far too weak for the maintenance of so extended a position. To keep any considerable reserve in hand was impossible. The enemy still occupied the Kaiserbágh in great force. From the Kaiserbágh they threatened the flank and the left rear of the British Army. Sir Colin's first object was then to silence the fire from the Kaiserbágh. He directed the colonels of the 93rd, the 82nd and the 23rd commanding the posts covering the left rear, simply to maintain their positions, whilst he would himself personally superintend the delicate operations of the withdrawal, by the road already traversed, of the sick and the wounded, the women and the children. The order was simple, and was carried out to the letter.

On the morning of the 20th, as a preliminary measure, William Peel opened on the Kaiserbágh a tremendous fire from his heavy guns. This fire continued during that day, the day following, and the 22nd, increasing every hour in intensity. It gradually assumed the character of a bombardment. The enemy suffered enormous losses, and on the evening of the 22nd three breaches in the walls of the Kaiserbágh invited assault. Such however was not the intention of Sir Colin; the bombardment had, in fact, been used to cover the withdrawal of the women and children, sick and wounded. Long before it concluded, these had reached

the Dilkushá in safety. The three breaches effected on the evening of the 22nd were used to carry out the retreat of the glorious garrison of Lucknow. Whilst the rebels passed that night in devising measures to meet the assault which they expected on the morrow, the garrison which had so long kept them at bay, the veterans of Inglis's force, the victors in many fights of Havelock's and Outram's, began to retire at midnight. The guns which they could not carry away they rendered useless. Then behind the screen of Campbell's outposts, Inglis's and Havelock's toilworn bands withdrew. Then these began to retire also; the pickets fell back through the supports, the supports glided away between the intervals of the reserve, the reserve when all had passed silently defiled into the lane, thick darkness shrouded the movement from the gaze of the enemy, and hours after the position had been quitted, they were firing into the abandoned posts.

Hope's Brigade, which had so nobly headed the advance had also covered the retreat. Before daylight on the 23rd the last straggler had quitted the camp at Dilkushá. The reunited force remained at the Dilkushá during that day and the ensuing night. But there was no rest for officer or private. The detachment parties who had come up with the relieving force had to be distributed to their different regiments; carriages had to be allotted; arrangements for the convoy of the women and children under responsible officers had to be made. On this day a reorganization of the whole force was made to remain in operation as far as the Alumbágh.

Havelock died on the 24th. On the morning of the 26th his remains were consigned to a humble grave in the Alumbágh. His gallant son, the leaders who had been associated with him, Campbell, Grant, Outram, Inglis, Napier, and others and a crowd of officers, followed him to his last resting place. He had fought a good fight; he had died, as he had lived, in the performance of duty. The life of Havelock had been a life devoted to his profession. Gifted with military abilities of a very high order, and conscious that he possessed these abilities, he had borne without repining the disadvantages of slow promotion. But every trial of Fortune had found Havelock, cheerful, resolute, and devoted. To the smallest office he gave his best abilities, and had striven also to prepare himself for the eventualities which were to follow. He had lived long enough to hear that his Queen and his countrymen had appreciated his noble qualities, that his name had become a household word among the homes and the hearths of England.

Sir Colin decided on the 26th that Sir James Outram should remain at Alumbágh with a force of about 4,000 men of all arms, 25 guns and howitzers and 10 mortars. Outram would thus occupy a position threatening Lucknow, and would retain it till

the Commander-in-Chief having placed his convoy in safety, and disposed of the Gwalior mutineers, should return to act offensively against the city of Lucknow.

The chapter which will follow with an account of the final Capture of Lucknow will comprise references to the very distinguished services of several officers of the Royal and Indian Engineers both at the Relief and Capture of the City, among whom should be noted the names of Field Marshal Lord Napier of Magdala, General Sir Lothian Nicholson, General Sir Henry Harness, General Sir Wilbraham Lennox, General Sir Frederick Maunsell, General Sir Richard Harrison, Major-General Greathed, Colonels A. Lang, E. Malcolm, J. G. Forbes and others.

(*To be continued*).

MEMOIR.

COLONEL A. J. HEPPER, D.S.O., R.E.

ON the 23rd April there passed away, almost unnoticed in the turmoil of our present life and death struggle, one of our old officers who has done his share in maintaining the reputation of the Corps and passing on the ripe fruit of his knowledge to rising generations of His Majesty's Service.

Albert James Hepper was born at Gibraltar on October 24th, 1839, the third of a family of 11 children. His father and grandfather had been settled on the Rock from the end of the 18th century and were established as regular residents. Such instruction as the Colony could afford in the groundwork of knowledge was sufficient to enable Hepper to pass the Matriculation Examination of London University after a year's tuition at Queen's College, Birmingham. He entered King's College, London, on 1st October, 1857, passing the following July for the Royal Military Academy which had recently been opened to candidates admitted by competitive examination.

Second in his batch he was gazetted Lieutenant, R.E., on 31d January, 1860. After the customary courses at Chatham he joined at Pembroke and was employed on fortifications and barrack works at Milford Haven, Tenby, and other places within the district till 1865 when he proceeded on foreign service to the Cape of Good Hope with the 23rd Company, under command of Capt. R. G. Thorold; Lieut. Arthur Hill being the other subaltern. Landing at East London the company marched 40 miles to King William's Town, which was reached after an arduous march over very bad roads on 8th September.

The headquarters of the C.R.E. were at Graham's Town and the company was broken up into detachments to maintain the numerous outposts held by the British garrison. Natal formed a part of the C.R.E.'s command and it fell to Hepper's lot to replace Capt. G. H. Gordon as C.R.E., Natal, from December, 1865, to February, 1867. This was a responsible position for a subaltern to fill and as there was no telegraph, and a mail only once a month, the C.R.E., Natal, of those days enjoyed a degree of independence which formed an excellent introduction to a career in which initiative and resource have to be combined with readiness to assume responsibility.

Here he met many interesting people more or less well known in South African history and had the friendship of the Colenso family at the time when the famous controversy was at its height. He describes Adam Kock, the conqueror of Griqualand East, as a wizened little Hottentot dressed in secondhand clothes; his staff gorgeous in the discarded uniforms of the Cape Mounted Rifles. Pretorius, President of the Transvaal Republic, came to visit the Governor of Natal about this time. He is described as unostentatious, he and his escort having the appearance of farmers.

A further tour of service in King William's Town was broken by a visit to Cape Town where Lieut. Hepper was married on 19th September, 1867, to Miss Sophie Lees, second daughter of Richard Lees, of Greenhills, Oaken, near Wolverhampton, to whom he had been engaged before leaving England.

In October, 1869, Hepper returned to England, where he resumed duty at Aldershot, performing the duties of Divisional Officer, and being in charge of improvements to the Water Supply at Broadmoor Criminal Lunatic Asylum under the Home Office. He was appointed Adjutant to the C.R.E., Colonel Laffan, on 5th January, 1871, and was promoted Captain on 21st September, 1872, when he was transferred to the Gosport Sub-District of Portsmouth Defences. Service for the next few years included Aldershot, Chatham, Fort George, Edinburgh, where he was employed in completing the Brigade Depôt Barracks at Greenlaw, now known as Glencorse, the show barracks in Scotland.

About this time one of Mr. Cardwell's army reforms was the conversion of the Monmouth and Anglesey Militia Regiments into Engineers, and Capt. Hepper became the first R.E. Adjutant of the latter regiment on 1st April, 1877, a post he did not relinquish till 15th July, 1882. He received a letter from the D.A.G., R.E., expressing the satisfaction of H.R.H. the F.M. C.-in-C. at the good service he had rendered as Adjutant of the regiment.

His next service was at Dover, he being now Major having been promoted on 1st July, 1881. While there he received his first orders for active service in the Soudan, being appointed C.R.E., Wady Halfa, on 21st March, 1885.

Khartum had fallen and with it the heroic Gordon, and the intention was for the troops to advance after the summer heat had passed and march on Khartum. As everybody knows this intention was abandoned, but meanwhile Hepper's orders were to provide huts for the troops at Akasheh, Wady Halfa, Korosko and Assouan by June. It was not easy to provide the huts in the time available, there being no materials up the Nile except palm trees and millet straw. Bricks were made with Nile mud and baked in the sun. Contracts were made with native "sheikhs" for quantities of palm trees and straw. Every sapper and infantryman

who could lay bricks was employed. Work could only be done in the cool of the morning and a couple of hours before sunset, yet all the troops were hutted by June. On 21st April the advance to Khartum was abandoned and the troops subsequently recalled.

Meanwhile the Soudan Railway was being pushed on southwards and was utilized for bringing back the troops on their way to Lower Egypt and other destinations. It was finally pushed on to Akasheh, towards the end of July, and a frontier post garrisoned by the Cameron Highlanders was erected by Capt. Blackburn, R.E., under Hepper's directions, at Kosheh, some 20 miles south of Akasheh.

On the withdrawal of the Nile Expeditionary Force, the British troops remaining in Upper Egypt were called the Nile Frontier Force and General, afterwards Lord, Grenfell assumed command on 9th July, 1885, Hepper being appointed C.R.E., Frontier Field Force, from that date. He accompanied the General on a tour of inspection to the south and to meet the rear guard of the Expeditionary Force, under command of General Brackenbury, afterwards Sir Henry Brackenbury, at Abri. On the way back the General and Staff rode to railhead to return to Halfa by train, but Hepper obtained permission to do the journey by boat as he was anxious to experience the sensation of going down some 90 miles of cataracts and rapids. This was now possible as the Nile was rising, and he arrived safely at Sarras in a "whaler" manned by eight Egyptian soldiers and steered by a Nile "*Reis*" in about 12 hours. The writer met Major Hepper on his arrival at Wady Halfa and gathered that the experience had been a thrilling one. A boat that followed next day met with disaster and five of its inmates were drowned.

The summer in the Soudan was not a pleasant time; it was very hot. Supplies were defective and luxuries non-existent; small blame then to those who succumbed to the enervating climate and Hepper was one of these, and had to go into hospital at Assouan, the Army Headquarters. "Fortunately," he says in his memoir, "the Arabs came down the river and attacked our advanced post at Kosheh." The General and Staff therefore left Assouan and arriving at Wady Halfa found the railway had been cut and the post at Ambigole Wells surrounded, and Kosheh beleaguered.

Lieut.-General Sir Fred. Stephenson, Commanding Troops in Egypt, brought down his Staff and reinforcements from Cairo and on 30th December defeated the Dervishes at Ginniss with great slaughter. Hepper was present with the 2nd Brigade throughout the action and subsequent clearing out of scattered parties of the enemy.

After another visit to Abri the Headquarter Staff Frontier Field

Force came back to Halfa and there concerted measures for holding that place, as the frontier post, by Egyptian soldiers, all white troops to be withdrawn to Assouan and Cairo. So the forts and barracks at Kosheh and Akasheh were demolished and all useful material brought back for use by the C.R.E. in the Halfa Defences and 100 miles of railway were abandoned. The task of fortifying the new Wady Halfa Frontier naturally fell to Hepper and was most skilfully executed. The frontier was rendered practically impregnable against any Dervish attack.

Then followed a spell at Cairo and again at Assouan where General de Montmorency, afterwards Lord Frankfort de Montmorency, was commanding.

In November, 1886, the Dervishes came down again within 15 miles of Wady Halfa, and an expedition went out to look for them but no serious fighting ensued. So Hepper's active service concluded on 15th March, 1887, when he was transferred to Cairo for ordinary R.E. duties till relieved in 1888. Meanwhile he had been promoted to Lieut.-Colonel on 1st October, 1887.

Then followed a quiet time as C.R.E., Guernsey, and on 2nd July, 1890, by appointment as Asst.-Commandant, S.M.E., a post requiring many varied qualifications, involving as it did all the management of the *personnel* of the R.E. Depôt and Service Companies, control of Messes and other purely regimental as distinguished from educational duties. These were in the good old days of close-order drill and formal manœuvre. There were three battalions of R.E. and two Field Companies to be manœuvred in brigade on the Great Lines and the A.C. S.M.E. was the Brigadier. Colonel Hepper by position and rank and on account of previous experience was always selected to command a side, or to be Chief of Staff to a commander, and proved himself almost invariably to be on the winning side. It was the fortune of the writer to be his staff officer in many such sham fights in the course of which he was able to assimilate many sound ideas as to the rapid appreciation of a tactical situation from his chief.

The inevitable half-pay on completion of five years' service as Lieut.-Colonel ensued; this luckily proved to be short as appointment to the Ordnance Committee followed on 20th December, 1892, carrying with it the rank of substantive Colonel. Attending a levée held by H.R.H. the Commander-in-Chief at the Horse Guards, Hepper naively remarks that when he thanked H.R.H. for his appointment, the latter looked much relieved as most of those attending his levées were there to ask for something. The appointment lasted till 28th October, 1896, when the military career of the subject of this Memoir was concluded by a grand blow-up at Milford Haven where he was employed by the Ordnance Board on experiments with the pneumatic gun.

Then followed a post as Engineering Inspector under the Local Government Board till March, 1906, when at the age of 67½ Colonel Hepper retired after having served the State for 48 years. His services were recognized by the Companionship of the Distinguished Service Order, Egyptian Medal, the Order of the Medjidieh and the Khedive's Bronze Star.

On 17th December, 1907, he had to bear the grief of the loss of his wife who died as she had lived, full of faith and concerned only for the welfare and happiness of those she left behind.

There is little more to say. The outbreak of the War found Colonel Hepper aged and perhaps a little infirm in his walk but full of mental vigour; taking an active interest in the progress of our arms and ready to help if need be. It fell to the lot of the youngest of his sons to be the first victim. While engaged in tending the wounded at the Battle of Mons he got left behind and is now a prisoner in Germany. The eldest who retired from the Corps in the rank of Major is actively employed as manager of the great Indian Peninsula Railway, and three others are actively engaged in His Majesty's Army.

The end came suddenly on the 23rd April last. He had been seized by a stroke the night previous and passed quietly away with just sufficient consciousness to recognize the only son available off duty, and his younger daughter who had watched over him with loving care ever since the lamented death of her mother had thrown the responsibility for the household on her hands.

He was laid to rest by the side of his devoted wife at Kensal Green on Monday, 26th April, 1915, followed to his grave by a few relatives and friends. His obsequies were like his life simple and unostentatious.

J.A.F.

NOTICE OF MAGAZINE.

REVUE MILITAIRE SUISSE.

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THE TECHNICS OF EXPLOSIVES.

The subject is treated under five heads. The first of these heads deals briefly with the history of explosives: it is explained that explosive mixtures when first discovered were used for incendiary purposes only, a common method of so employing them consisted in fastening the explosive to some missile which was then projected by catapults against the object attacked. A legend attributed the discovery of gunpowder to Schwartz, a Benedictine monk, in 1334 A.D.; this legend is, however, discredited, for gunpowder, it is said, was used for incendiary purposes in connection with the defence of Constantinople in 660 A.D. For a period of nearly 500 years gunpowder was the explosive most generally in use, as a propellant in firearms, as well as a destructive agent in mines. The discovery of guncotton was made in 1845: Noble, whilst carrying out experiments in 1863, first obtained nitroglycerine and later rendered it stable by an admixture of silicious earths, thus giving dynamite to the world. Chemists continued their researches on explosives and discovered compounds more powerful even than those last mentioned. Dewar invented cordite and Turpin mélinite (in 1887).

Under the second head certain general features relating to the subject are discussed and the conditions required to effect an explosion are briefly touched upon. Explosives are, it is pointed out, classified in two main groups, namely those termed "*chassants*," being those used as propellants and those termed "*détonants*" or "*brisants*," being those used to obtain disruptive effects. It will be recognized that these two groups are those which, in this country, are, in popular language, referred to as "low" and "high" explosives. The amount of heat and energy developed on the spontaneous decomposition of explosive substances is next touched upon, a table being furnished of the calories and the energy, per kilogramme of substance, obtained in the cases of some of the better-known explosives. This part of the subject concludes with a brief reference to the rate of propagation of the explosion, both in the case of the "low" as well as that of the "high" explosives.

Under the third head useful information is supplied in relation to the composition and manufacture of some of the more important explosives, *i.e.*, acetylene, nitroglycerine, guncotton, trinitrotoluene, lyddite, fulminate of mercury, black gunpowder, powdered chlorate of potassium, dynamite, and smokeless powder.

Under the fourth head the question is taken up of the utilization of explosives in connection with rifle cartridges, common and shrapnel shell, torpedoes and submarine mines, bombs and hand-grenades, land mines and petards.

Under the fifth head is discussed the future of explosives. The question is there examined as to whether anything can be done to improve the efficiency factor of explosives in such a manner as to be capable of leading the way to the discovery of some extraordinary explosive capable of modifying the conditions of warfare. This examination leads to the conclusion that it would be extremely difficult to produce an explosive more powerful than those already known and in use to-day. As a matter of practical politics, there is little difference between the power of various explosives, so far as their disruptive effects are concerned; an armoured vessel will meet the same fate when successfully torpedoed, whether the charge used be mĕlinite or guncotton, dynamite or trinitrotoluene.

So far as the use of explosives as propellants is concerned, the deterioration of the inner tubes of guns fixes a limit; the explosives now in use are already responsible for a rapid corrosion of the inner tubes and the introduction of more powerful propellants, generating still higher temperatures than those now met with, is out of the question.

It is pointed out that the consumption of explosives, in the present war, is prodigious, but it is held to be nonsense to suggest that the blockade of Germany by the Navies of the Entente Powers is going to result in any serious diminution in the supply of explosives available for the use of the German Army. It is admitted that the cutting off of the supplies of Chili saltpetre has, during the past few months, caused a shortage of nitric acid in Germany, but it is held that Germany can manufacture this commodity quite as readily as Norway and Switzerland; she has not only her own works, but at the present time she absolutely controls the Vilvorde factory in Belgium, which for some years past has been producing nitric acid by the Ostwald process. Similarly, although it may no longer be possible to import cotton, very large quantities of this substance can be obtained from discarded clothing of all kinds. Further, there can be no shortage of alcohol and ether, nor of toluene, benzine, picric acid, etc., which can be readily distilled from coal tar, a commodity which Germany possesses in abundance.

THE MANNER IN WHICH THE "PERPETUAL NEUTRALITY" POSSESSED BY CERTAIN COUNTRIES HAS BEEN VIOLATED.

Fragmentary notes have, at various times, appeared in the *Revue* on the subject of neutral states and the violation of their neutrality; these notes have been collected together and rearranged for publication under the title given above. The article discusses the strategic effort made by Germany last year *viâ* Belgium and the Grand Duchy of Luxemburg. It is stated that the subject cannot be examined in all its bearing in the absence of documentary evidence; this evidence is not available at present; nevertheless, it is held, there cannot be any doubt whatsoever, that the violation by Germany of the territory of the neutral states, Belgium and the Grand Duchy of Luxemburg, has been a very serious

political mistake and, more than that, a moral delinquency of still greater gravity.

It is suggested that the stigma cast by the whole world on the attack on the rights of a neutral nation by one of the belligerents and this belligerent's disregard for its own plighted word disclose war in a new character. The opinion is expressed that, from the foregoing points of view, in spite of all the sadness for which it is responsible, the War of 1914 will mark a step in advance on the road of civilization if, as there is every reason to hope, victory crowns the efforts of the armies of the Entente Powers.

The circumstances under which each of the neutral Powers of Europe, existing prior to the present war, acquired their international status is briefly traced, and attention is drawn to the fact that there are three shades in the character of the neutrality referred to as "perpetual"; this is shown in the following brief summary:—

Swiss Confederation.—The Republic voluntarily and deliberately assumed the status of a neutral state in 1648 (since recognized by the Treaty of Vienna, November, 1815) and maintains an armed force, as much in order to enforce respect for its neutrality as to provide for the eventuality which may impose a duty on the Republic, in its own interests, to change its policy in relation to its conduct in regard to international affairs under circumstances quite independent of the motives which originally prompted the adoption of the attitude of "perpetual neutrality." The Confederation, in fact, possesses all the attributes of a sovereign international state.

Belgium.—The kingdom is a neutralized, in contradistinction to a neutral state, and maintains an armed force exclusively for the purpose of warding off an attack on its neutral territories.

Luxemburg.—The Grand Duchy is a neutralized state and does not maintain an armed force, unless that of microscopic dimensions maintained for state ceremonial purposes may be called one. The Powers, which imposed "perpetual neutrality," having undertaken the obligation of protecting the Grand Duchy against aggression, the maintenance, on the latter's part, of a military force became, of necessity, a work of supererogation.

In view of the foregoing explanation it will be recognized why it is that, in considering the question of the violation of the territories of one or other of the three Powers mentioned above, it should be held that the violation of the neutrality of the Grand Duchy is, of the three possible cases of violation, the gravest and least justifiable.

The earliest example, since the Revolution, of the violation of the territories of a perpetually neutral state is that of which the Swiss Confederation was a victim in 1813; but in that case the Treaty which now regulates the present Helvetic neutrality did not then exist, although the principle involved had been admitted for more than a century.

The violation of the neutrality of Switzerland referred to occurred in the following circumstances:—After the defeat of the French Armies at Leipzig in 1813, Napoleon hastened back to France, in order to organize new armies, hotly pursued by the armies of the Allies (Russia, Austria, Wurtemberg and Bavaria). In December of the year in question, the forces of the Allies were partly echeloned along the Rhine, north of

Basle, and partly held in reserve on the northern shores of Lake Constance. The problem which was exercising the minds of the Allied commanders was that connected with the invasion of enemy territory. Czar Alexander desired to respect the Helvetic neutrality, not so Austria. The latter power exerted diplomatic pressure on the Federal Government with the object of obtaining a voluntary renunciation of neutrality, at the same time, in order to be prepared for the contingency of the Federal Government not yielding in the matter, Schwartzenberg, the Austrian general, made preparations to force an entry into Swiss territory by a *ruse de guerre* (details are given in the article). Switzerland was deceived in regard to the Austrian intentions; the ruse succeeded and the neutrality of the Confederation was violated on the 13th December, 1813, Austrian forces occupied Berne and Soleure and crossed the Rhine on the 21st December; almost simultaneously, the Russians took possession of Basle. On this occasion, the Swiss Army was in no position to offer a resistance to the aggressors and its commander signed the terms of a capitulation on the 20th December, 1813.

Naturally, Germany had no more respect for the agreement, which she entered into with the Grand Duchy in November, 1902, containing the express provision whereby she undertook never to use the Luxemburg railway system for military purposes, than she had for the provisions of the Treaty of 1867, whereby she accepted the obligation to protect the neutral status of the Grand Duchy. On the 2nd August last, German soldiers were simply put on board armoured trains which, without any declaration of war, steamed into the capital of the Grand Duchy, which was occupied on the pretext that this step was rendered necessary for the protection of the Grand Ducal railways against enemy attacks.

Turning to Belgium, it is asserted that the developments which have taken place since 1870 right down to 1914, the changes of the concentration zones of the German armies, the railway construction undertaken during recent years, all betray the German design deliberately to invade Belgium. Everything appears to have been studied in minute detail; success in carrying out the operations depended entirely in a torrent-like descent on to Belgian soil. It can well be supposed that German "Realpolitik" left nothing undone to secure that all the trump cards should be in Germany's hands, so that the successful accomplishment of her purpose should eventually cover the iniquity of the means employed; Germany did not renounce the aid of that which has always been her principal forte, her genius for organization.

Germany has no capacity for improvisation; she relies on studied preparation. Her people are essentially analysts; that which others have invented, the Germans understand admirably how to perfect and turn to their country's advantage. So far as the preparations for this war are concerned, an example is to be seen in the uses they have made of aviation, a French invention adapted for war by German ingenuity. In other matters, too, it is hardly possible that the Great General Staff at Berlin can have neglected, in the 20th century, the admonitions of the great captains of past ages.—(*To be continued*).

Notes and News.

Switzerland.—The question of Swiss neutrality is further discussed. Reference is made to an incident chronicled in the April issue of the *Bibliothèque Universelle.* It would appear therefrom that Prof. Reiss (of Switzerland) who has been investigating matters in Servia had arranged to give an account of his work at the Sorbonne and was expecting a telegram, in which the date of the meeting was to be fixed. Owing to the non-arrival of the telegram enquiries were made and it then transpired that the communication desired had been addressed to the Professor, but it had been held back in the censor's office at Berne. The incident is unfavourably commented upon.

It is pointed out that a German Swiss has been allowed to address a meeting in Vienna, and a demand is made that similar treatment be meted out to the French Swiss. The correspondent urges that it is necessary, at the present juncture, that an opinion on current events should exist in Switzerland, but it must be Swiss opinion, and this can only be formed by permitting free discussion, provided that this discussion is carried on with sincerity and loyalty, and within the limits imposed by international courtesy. It is further held that an incident, such as the suppression of the Reiss telegram, denotes that a conception of neutrality exists which confounds the attitude of the individual, more exactly the citizen, with the responsibilities of the State. Citizens are properly held in check in that they are rigidly forbidden openly to attack the attitude deliberately adopted by the State, lest this should entangle the policy of the latter. Reasons are set out why Switzerland should continue to maintain its attitude of strict neutrality.

A brief reference is made to the suggestion made by certain deputies that the supreme decision on the proposed war tax should be withdrawn from the vote of the people. It is held that a grave error would be committed if this were done. The correspondent expresses the opinion: "We know that our good fortune exceeds our merits: if this is likely to cause us some expense, we will readily foot the bill."

This number of the *Revue* concludes with a bibliography relating to works of military interest.

No. 5.—May, 1915.

The Manner in which the "Perpetual Neutrality" possessed by Certain Countries has been Violated.

The article commenced in the April number on the above subject is concluded in this number. It is suggested that the violation of the neutrality of Belgium, in 1914, should be compared with the violation of that of the Swiss Confederation, in 1813; considered side by side, these two historical examples become more suggestive. So far as the violation of the neutrality of Belgium is concerned attention is directed to the information contained in Emile Waxweiler's work, *La Belgique Neutre et Loyale;* an extract is published in which the statement occurs: "It is no secret that in the reign of Leopold II. the relations of the Belgian Court with the German Court were not particularly cordial. The Colonial policy of the old Belgian King and other diverse circumstances

had been viewed with little favour by official circles in Berlin. Things changed from the commencement of the new reign " (*i.e.* in 1909). In the extract in question references are also made to the marriage of King Albert to the Duchess Elisabeth of Bavaria and the intimate relations established thereby between the Court of Brussels and that of Berlin. In June, 1910, the Belgian Sovereign and his Consort visited Berlin, and in the October of the same year, the Kaiser and Kaiserin proceeded to Brussels on a return visit and were received by the citizens in the Belgian capital with great cordiality. At a dinner given in his honour at the Royal Palace, the Kaiser, in responding to the toast proposed by King Albert, referred to his gratitude for the splendour of the reception accorded him by the Sovereign and the people of Belgium and stated that in it he recognized the pledge of the steadfast union, binding not only the Royal Houses of the two countries but also the people of Germany with those of Belgium. The German Emperor concluded his speech by expressing a vow to draw closer still the relations, full of confidence and of good-neighbourly intentions, already existing between the two peoples.

At that time the German relations with France appeared outwardly to be all that could be desired, so much so that in Belgian political circles many there were who had become confident that Belgium need never fear invasion by the armed forces of her powerful eastern neighbour. About this same period, Germany provided evidence of the closeness with which she kept watch on the external policy of Belgium. During the Boxer rising Belgian interests in China were threatened, consequently, on the initiative of the burgomasters of four of the large Belgian towns, steps were taken to form volunteer corps destined for service in the Celestial Empire. Thereupon Germany protested with considerable energy that the adoption of such measures of protection were forbidden to Belgium owing to her status as a neutral power. Belgium accepted the German view, in spite of the fact that by doing so she imperilled the position of her political and national representatives: she believed, however, at the time that, as some sort of compensation, she had obtained strong and certain evidence of the lengths her powerful neighbour was prepared to go in fulfilment of the obligation undertaken by her to see the neutrality of Belgium strictly observed. Later, it was thought, further evidence of this intention was forthcoming with still greater clearness during the course of the wrangle raised, in 1911, in connection with the Dutch proposals to fortify Flushing. At that time certain newspapers had suggested that in the event of a Franco-German war, in the near future, the neutrality of Belgium would be violated by Germany. The question of Germany's intentions was taken up by the Belgian Foreign Minister with the Imperial Chancellor; the former suggested that a declaration on the subject in the Reichstag, on the occasion of a debate on foreign affairs, would have a reassuring effect on public opinion. To this suggestion von Bethman-Hollweg replied, as will be seen from the Belgian Grey Book, that he well understood the sentiments which had inspired the Belgian Foreign Minister, but he could not accede to the request, declaring, at the same time, that *Germany had no intention of violating the neutrality of Belgium*, but if such a declaration were made publicly Germany would weaken her military position, so far as France was

concerned. Attention is drawn to a speech made on the 29th April, 1915, by von Jagow, the German Secretary of State for Foreign Affairs, at a meeting of the Budget Committee of the Reichstag, and reported in the *Norddeutsche Allgemeine Zeitung*. In this speech occurs the declaration: "The neutrality of Belgium is determined by International Conventions; Germany has decided to respect the provisions of these conventions." It is reported that, on the same occasion, in the course of a reply to a member of the German Social-democrat party, the German War Minister said: "Germany will not lose sight of the fact that the neutrality of Belgium is guaranteed by international treaties."

In spite of the assurances contained in the speeches referred to, it would appear that certain incidents connected with European politics created deep misgivings in the minds of those responsible for the government of Belgium. Similar misgivings prevailed in the Chancelleries and in military circles in certain European capitals; it was felt by the well-informed that the outbreak of a European war was imminent and inevitable. To complete the chain of evidence, Belgium had received, in 1912, from King Charles of Roumania, a ruler tied neither to the Triple Entente nor to the Triple Alliance, friendly advice cautioning her to keep watch on the defences protecting all her frontiers. "The miracle of 1870," said this monarch, "will not be repeated: Belgium is in great danger of seeing her neutrality violated by one of its three neighbours." Other warnings were also received; evidence of a confirmatory nature was forthcoming from German sources that the invasion of Belgian soil was occupying the mind of at least one nation. In his work, *Deutschland und der nächste Krieg*, von Bernhardi had written: "No natural obstacle, no powerful fortress stands in the way there (*i.e.* in Belgium and in Holland) to prevent a hostile invasion, *neutrality is but a rampart of paper*. In the south also, the barrier of the Rhine can be turned by pushing through Switzerland."

King Albert visited Germany in November, 1913; the Kaiser did not hide from him the gravity of the political situation in Europe and declared that it was becoming difficult for Germany to avoid war with France. If war came there was no doubt, in the Kaiser's mind, that the German arms would triumph and carry victory before them.

In his work Waxweiler states that the Belgian Ambassador in Vienna transmitted the text of the Austro-Hungarian ultimatum, about to be addressed to Servia, to the Foreign Office at Brussels on the 24th July, 1914. The Ministers of King Albert took necessary measures forthwith to provide against the contingency of a European conflagration. On the 31st July following, the French Ambassador at Brussels showed the Belgian Minister for Foreign Affairs a telegram, emanating from the Agence Havas, announcing that a proclamation had been issued in Germany creating the *régime* known as *Kriegsgefahr*. At the same time, the French Minister gave the assurance that France would respect the neutrality of Belgium. The various incidents which preceded the irruption of German hordes into Belgian territory are set out in detail in this number of the *Revue*. Germany was no longer ready to give any kind of undertaking that she would respect the neutrality of Belgium, nevertheless, on the 2nd August, 1914, the

German Ambassador in Brussels called at the Belgian Foreign Office and secured the assent of the Belgian Government to his request that facilities should be given for the conveyance, over the Belgian railways, of German reservists, residing in Belgium, who had been recalled to the colours. The only reserve made by the Belgian Foreign Office was that a similar concession would be made in favour of French reservists recalled to the colours. At this announcement the German Ambassador made the remark: "That you must look after yourself, *but you well know that so far as matters concern us you may have every confidence.*"

The Belgians were put off their guard and even the Brussels Press was duped. On the date last mentioned, the German Ambassador at Brussels gave an interview to a representative of *Le Soir* and alleged that Germany had a friendly feeling for Belgium, summing up his views in the phrase: "Perhaps the roof of your neighbour's house will be set on fire, but yours will be safe enough." On the same day, Capt. Bringmann, the German military attaché (at Brussels), called up the office of the editor of *Le XXe. Siècle* on the telephone and requested a categorical denial to be published to the statement, then in circulation, that Germany had declared war on France and on Russia. The conversation which took place is recorded. The Editor asked the military attaché whether German troops had not invaded and occupied the Grand Duchy of Luxemburg. Capt. Bringmann appears to have gone through the form of ascertaining how matters actually stood; on the completion of this fictitious enquiry he returned to the telephone and gave, what can only be described as, an evasive and deceptive reply.

The staff of the two papers *Le Soir* and *Le XXe. Siècle* were completely deceived; consequently, on Sunday, the 2nd August, 1914, these papers, on the faith of the categorical declarations made by German officials holding important positions, published announcements of a reassuring character regarding the international situation.

It was after these interviews had taken place that, on this same Sunday, the 2nd August, the German Ambassador at Brussels called on the Belgian Minister for Foreign Affairs and placed in the latter's hands the demand which astonished the world, calling on King Albert to give an unopposed passage through Belgium to the German armies. The text of this demand is given in the *Revue;* the Belgian Government was allowed, as is well known, 12 hours in which to reply thereto.

If now the mind is carried back to the story of the Austrian invasion of Switzerland in 1813, it will be observed that the interval of a century has not brought about any appreciable change in the procedure which finds favour with the violator of neutral territory: he has, perhaps, become a little more crafty, that's all. The telephone had no existence in 1813; but there was, in that year, the employment of a ruse to throw a neutral people off their guard; the preparation of a stealthy "coup de force" under cover of this ruse; the delivery of an ultimatum giving a sufficiently short period of time for the delivery of a reply, so as to remove all possibility of a proper consideration being given to the question; lastly, as the guiding principle of so much duplicity practised under cover of the pretext of very exceptional circumstances, the doctrine was openly espoused that the needs of strategy were

superior to solemn obligations deliberately entered into by treaties. It will easily be recognized that the programme of 1914 is a close imitation of that of 1813: von Bethman-Hollweg has nothing to be envious of in Metternich; the younger von Moltke has nothing to learn from von Schwartzenberg.

One lesson appears to be taught with perfect clearness by the above comparison: A little nation has no other guarantee of existence or other security in its pursuit after peaceful progress than that provided by the moral force which is based on the intention to recognize *Right*.

If in August last, says the *Revue*, it had been a question of marching German armies on Lyons instead of on Paris, then it would have been the violation of Swiss territory, which Waxweiler would have described in a work dealing with a premeditated invasion. In this case also, he could have discovered, in the recent past, affectionate toasts for republication, suggestions moreover of well-merited confidence in a people and their rulers; probably a firm belief too, in some minds, of the desire on the part of powerful neighbours to respect Swiss neutrality, which belief rumours of the existence of tortious intentions could, in no way, have decreased. Who knows, he may even have been able to discover suave telephone conversations on the part of high-placed officials with editors of newspapers.

It is suggested that Switzerland would, in the case of a German invasion, have suffered more than Belgium. In a situation similar to that in which the forts of Liège were found, there would have only been a few companies of Landsturm echeloned along the frontier; no serious obstacle would have presented itself to prevent the Uhlans being pushed rapidly into Zurich; there these doughty warriors could have cut the railway communications, deprived one-third of the Swiss Army of its supplies, and the Confederation of its most up-to-date factories and its most high-developed industries. It is the desire on the part of the Swiss to escape the experiences of the Belgian people that has, no doubt, inspired the concluding prayer: "Let the peace yet to be consummated bring about the triumph of Right over the abuse of Might."

Explosive and Dum-Dum Bullets.

An article was published in the number of the *Revue*, for February last, which seemed to leave no doubt that the accusation levelled against the Austro-Hungarian troops concerning the use of explosive bullets, against the Serbians, was only too true.

The *Revue* states, in its May number, that it has repeatedly come to notice that explosive bullets have been used in the western theatre of war. Reference is made to the wounds received by a French soldier of the 152nd Infantry Regiment in August last, a photograph of the wound being reproduced; in this case there is evidence that the wound in question was inflicted by an explosive bullet discharged from an American sporting rifle by a German officer. There are grounds for believing that in the other cases where wounds have been caused by explosive bullets to soldiers fighting in the western theatre of operations, such bullets have been discharged by German and not by Austrian troops. Although

the German communiqués have admitted that the German army operating in Belgium has borrowed copiously from the artillery of the "Brilliant Second," on the other hand, no evidence of any kind has been forthcoming tending to prove that the Austro-Hungarian infantry or cavalry have fought anywhere on the front, Basle to the North Sea.

The *Revue* states that the use of dum-dum bullets has also been proved, and points out that a bullet of hard metal such as the regulation French D bullet cannot be converted into an expansive bullet, whatever be the nature of the mutilations it may be subjected to. However, articles, with illustrations, have been published, on frequent occasions, with the object of proving that the D (Lebel) bullet had been converted into the dum-dum pattern. The bullets in use in almost every other European army than the French can be readily converted into the dum-dum pattern and illustrations are given, in the article, of the dum-dum bullets which, according to official reports, have been used by the Germans during the present War. Illustrations are also published which show the nature of the perforations made in walls of damp clay by an ordinary lead bullet provided with a hard metal envelope, and the same bullet converted into the dum-dum pattern. Further, attention is drawn to an article which appeared in *La Nature* of 12th December last, wherein reference is made to a very simple method employed by the German infantry to convert the regulation bullet into the dum-dum pattern. It also appears that the *Berliner Illustrierte Kriegs Zeitung* (No. 15) and other German papers contain illustrated articles showing, what they allege to be, the mechanism fitted to the British rifle, for converting the regulation ammunition into the dum-dum pattern, "in three motions." Another illustration, not reproduced from a German source, shows what would actually happen if it were attempted to carry out the alleged dum-dumming process in the manner indicated.

PROPOSALS RELATING TO THE ARMAMENT OF CAVALRY.

In the first five months, during which the Swiss Cavalry had been mobilized, certain matters in connection with the arms and equipment of this branch of the service requiring urgent attention have, according to the author of the article, come to light, as follows:—

I. The Swiss cavalry require to be mounted on a better stamp of troop horse. The cavalry armament also needs modification; a mounted patrol of Swiss cavalry, armed with the sword only, coming suddenly into contact with an enemy mounted patrol, armed with the lance, would, in the author's opinion, be caught at a disadvantage. A Swiss cavalry soldier when separated from his horse is without a weapon of defence; it is recommended that revolvers should be issued to the cavalry.

II. The method of carrying the carbine is discussed. Reasons are given for the carbine bucket being attached to the saddle on the near side of the horse and the sword and mess tin on the off side.

III. The present War has shown that cavalry may, at times, be called upon to perform infantry duties. On such occasions, a bayonet often comes in very useful, but as the issue of this weapon would, in the

author's opinion, carry with it a loss of mobility and also destroy the cavalry spirit he recommends that the present cavalry sword should be slightly altered and provided with attachments enabling it to be fixed to the carbine for use as a sabre-bayonet (the proposed method of attachment is shown by means of a sketch).

Notes and News.

United States of America.—A special correspondent writes on the subject of military organization and points out that the citizens of the great Republic are divided into three camps on this question: The pacifists, they are most obstinate and will not dismiss from their minds the chimera with which they have been obsessed in the past; the progressists, they are much in evidence and desire a serious increase in the military forces of the Republic; between these extremes stand the "hesitants," the *statu quo* is good enough for them, subject however to the proviso that the youth of the country be made to undergo a "thorough" military training during the period spent at school. It would appear that the pacifists, instead of being completely nonplussed by the brutal blow struck at their pet theories during the past few months, are infinitely more obstinate and more blind on the American Continent than those of their ilk in Europe; it is suggested that this may be accounted for by the fact that the former are further removed than the latter from the material evidence of the bankruptcy of anti-militarism. The pacifists have endeavoured to bring pressure to bear on President Wilson and have prayed him to intercede with the belligerent powers in order to obtain a general disarmament. It is suggested that they form a dangerous class, since certain of their arguments, specious in themselves, are of a nature to impress the public and Congress, when brought forward by men much in public evidence, such as Carnegie, Bryan and Daniels (Minister for the Navy). It is shown that want of military preparations has not prevented the United States of America from being involved, in the past, in military operations; the only result of the policy of "petits armements" has been to inflict unnecessary loss and suffering on the troops and to jeopardize the success of their operations. Nevertheless, the Utopianism of Carnegie and of Bryan has captivated many members of the American Congress.

The progressists are led by General Wood, ex-Chief of General Staff, and now G.O.C. Eastern District, some Congressmen, including Hobson (a hero of the Spanish-American War), and Garrison, the Minister for War; this class naturally desires considerable improvements to be effected in their country's military system. Unfortunately, the progressists are not unanimous as to the methods to be employed to attain the ends desired, some advocate the formation of new regular units, others desire to see the National Guard increased to double its present strength, whilst a third group restricts itself to a recommendation that a system of strong reserves should be instituted. It is suggested that this class is too lazy to devote its time to the thorough examination of the problem under consideration but limits its attention to "faits accomplis."

such as the " American Legion " recently formed. The Legion is a non-official institution; however, its formation has given umbrage to the pacifists and especially the " League for the Limitation of Armaments." The pacifists attacked General Wood for giving official countenance to a private institution, in that he had permitted his A.D.C. to act as an adviser to the Legion. It appears that the Minister for War has passed a mild censure on the General, but the letter conveying the censure discloses the fact that the Government is disposed to give the Legion official recognition and to incorporate it into the army system as soon as the Legion is constituted on a sound basis. The hesitants, when recommending preliminary military training of the youth of the country during their school days only, appear to lose sight of fact that the object of such training is to habituate lads to military discipline and to facilitate the practical training at the recruit stage: practical training during the years of manhood is held to be essential for the development of the recruit into an efficient soldier. The special correspondent is of opinion that the opening of the Panama Canal has complicated the problem of national defence under present circumstances; an examination of the situation leads him to the conclusion that the protection of the Canal zone proper—15 km. (about 9 miles) wide and 75 km. (about 46 miles) long—necessitates the detaching of 3 infantry regiments, 4 squadrons of cavalry, 1 brigade of field artillery and 18 companies of garrison artillery for this specific purpose, and incidentally involves an increase in the mobile troops detailed for the defence of Hawaii, the garrison of which should then, exclusive of the garrison artillery, be raised to 6 infantry regiments, 1 cavalry regiment, and 1 regiment field artillery; thus raising the infantry and field artillery units which would be immobilized in connection with the defences of the Panama Canal to 9 infantry regiments and 12 batteries of field artillery.

After many years of peace the Red Indians of Utah have recently given trouble; they have been assassinating members of one of the other tribes. The maladroit handling of the situation by the magisterial authorities exasperated the situation, and by degrees the whole region was in a state of effervescence. Instead of dealing with the situation in the usual way, that is by the despatch of a punitive military expedition, General Scott, Chief of the General Staff, made his way to the camp of the revolters accompanied only by an A.D.C. and an orderly. The General is known to the Indians by the name, " The white-man who-stoops-not-to-tell-lies "; it sufficed for him to assure the disturbers of the Pax Americana that equity and good conscience alone would guide the judges, who would try them, in arriving at a decision as to their guilt or innocence. Knowing, as they did, that the offence with which they were charged involved a death penalty on conviction, nevertheless the assurance of the General of a fair trial caused the revolters to surrender themselves into the hands of the judicial authorities.

It is stated, on the authority of General Wood, that the colour adopted for the new campaigning kit of the German Army was borrowed from the American Army. American officers, attending the German manœuvres recently, decided one day to wear their service kit. Their appearance in such a practical outfit is said to have created a veritable

sensation in German military circles ; the German officers were converted to the innovation at once, but the Kaiser pronounced against it, arguing that the dull uniformity would militate against *esprit de corps.* A press campaign followed in favour of the change and the Kaiser capitulated.

France.—A correspondent discusses the problem of the tactical offensive and defensive. He states that, according to his information, Colonel Hubert, of the Swiss Army, recently addressed a copy of a brochure to the President of the Swiss Confederation, which the former is publishing in Paris under the title, " The Present War," but this copy did not reach the Chief Magistrate of the Helvetic Republic. Colonel Hubert's work deals with the strategy and tactics of the first eight months of the War and is written with the spirit of impartiality desirable in a neutral. It is pointed out that the opinions of military writers on the relative merits of the offensive and the defensive have frequently undergone a change on the conclusion of an important campaign. The resistance offered to the British arms by the Boers led to the defensive being considered superior to the offensive ; whilst the success of the Japanese armies against the Russian masses caused opinion to swing to the opposite view.

Reference is made to General Foch's work, *Principes de Guerre,* and an extract therefrom is published wherein the General states, " Improvements in firearms bring an increase of strength to the offensive, to the attack intelligently conducted ; history affords examples of this, and a logical examination explains the reason for it." And he proceeds, by a mathematical statement, to demonstrate the accuracy of his views on the subject. Colonel Hubert apparently attacks the above-mentioned mathematical treatment of the subject and refutes the accuracy of the General's deductions, but in order to do so ignores the postulate on which the calculations, in the case mentioned, are based, namely, the superiority of the numbers employed in the attack as compared with those on the defence. In his own work, Colonel Hubert claims that : " The absolute theory of the tactical offensive, in all cases and at any price, has cost the French as well as the German Army the flower of the youth in their first line troops, both in officers and in men." That is to say, this theory has proved disastrous in the present war. The Colonel is a firm believer in the defensive and states : " It is not impossible, when time is available, to cover one's front with field defences on a front of 100 leagues (*i.e.* 250 miles) as promptly as did Wellington formerly on a front extending over 10 leagues only. It is this circumstance which throws light on the singular characteristics developed in the present war since last autumn."

The defensive has at the present hour become so powerful that pronounced salients are to be found in relation to the fronts occupied by one belligerent and the other ; salients which are practically enveloped by the enemy's artillery and machine-guns, and these engines of warfare, in spite of their power for destruction, do not manage to wipe out the troops in the salients or cause them to surrender : such are the positions familiarly known as the " Wart " of Dixmude ; the " Knob " of Arras ; the " Hernia " of St. Mihiel. To the great wonderment, not only of

the non-expert but of the expert also, Rheims, an open city, Soissons, a small town without importance, remain impregnable in spite of the incessant rain of shot and shell poured on them by the German artillery.

Colonel Hubert's opinions bring to mind the discussion contained in General Percin's work, *Le Combat*, in which the General examines the same question under the title "*Offensive ou Défensive*," with such great impartiality as to leave the reader in doubt as to the side to which he inclines. The Colonel's view seems to be that the Germans have made a mistake in following up their strategic offensive with a tactical offensive, instead of resorting to the tactical defensive after their preliminary successes. Accepting this as a basis for a further examination of the subject, he concludes that, in order to obtain success, it is necessary that centralization of command should cease; concentration of authority, although good for a war of manœuvre, is not, he thinks, desirable in a war of immobility.

General Percin holds that the adoption by the Frency Army, just prior to 1870, of the doctrine, "with the new arms of the day, the advantage has gone over to the defensive" proved fatal to it. The General points out that "The defensive is a form of combat which, even where the intention clearly exists to assume the offensive, must often be resorted to without choice. This will not be the "*défensive généralisée*," admissible only to a side which is notoriously inferior in material and moral forces; in such cases it will be the "*défensive localisée*" which will be assumed along certain portions of the front, permitting troops to be economized for a vigorous attack at other portions of the line of battle.

It will not be a defensive assumed by choice or one long premeditated, but rather "a defensive imposed by force of circumstances on some fraction of an army which is not in a position to deliver an attack. . . . The defensive is not an inferior form of combat, reserved for troops of mediocre quality and for chiefs of weak character. The defensive demands, on the contrary, energetic chiefs and trained troops."

To sum up, General Percin rejects *in principle* the "*défensive généralisée*," in order to advocate alone the "*défensive localisée*." In the present war, it is the "*défensive généralisée*" which has established itself on the western front.

Portugal.—A special correspondent points out that international questions are the order of the day, and the world is so disturbed that even the most peacefully minded nation does not know whether, at any moment, it may not be called upon to enter into the great conflict of arms now in progress. The Spanish Press appears to have added fuel to the flames by reviving a discussion on the classic theme of the absorption of Portugal into Spain by force of arms, just at a time when the latter country had summoned a contingent of 30,000 men to the colours and recalled to Europe a considerable portion of its army which had been operating in Morocco. It is stated that history has shown how grave a mistake was made by Spain in 1580, when she annexed Portugal and exercised a violent and arbitrary domination over the country; during her reign of 60 years, she did not succeed in making Portugal a Spanish province. The correspondent continues: "We do

not constitute an artificial nationality; there is not, in Europe, another people amongst whom the idea of 'la patrie' is more highly developed. Our race, geography, history, religion, jurisprudence, all these form a characteristic *unité morale* amongst nations; these qualities, moreover, have grown up by a process of spontaneous evolution. It is this *unité* which we possess and that distinguishes us so markedly from other peoples; that is the reason that our race cannot be blended with other races nor even assimilated by them. . . . We have confidence and do not fear, for the moment, the phantom of the '*Spanish peril*'."

The almost unanimous insistence of the Spanish Press on the exchange of diplomatic notes between the two countries made it necessary for the Portuguese Minister for Foreign Affairs to make formal and categorical declarations on the subject; these declarations dissipated the doubts existing in the minds of the Portuguese people and public confidence was again restored. Meanwhile, the friends of Portugal in Spain and a certain section of the Press in the latter country immediately entered the lists in defence of Portugal. The Spanish Minister for Foreign Affairs himself intervened and declared, *inter alia*: "The events of which Portugal is the theatre and the questions which affect that country cannot leave Spain indifferent. . . . Spain has herself considerable interests in the maintenance of peace in Portugal and in the prosperity of that country; the Spanish Government, above all things, must adopt measures to destroy the ridiculous fairy-tales attributing to her hostile intentions or ambitious designs against her neighbour." The opinion is expressed that the propaganda referred to as the "Union ibérique," is the ambitious and chimerical dream of certain light-hearted politicians and does not constitute a national aspiration in Spain. The existence of the Portuguese Republic neither inconveniences nor menaces her neighbour, similarly Spain neither incommodes nor threatens Portugal.

No. 6.—June, 1915.

INDEPENDENCE AND NEUTRALITY.

Le Devoir Suisse.

This article is headed by an extract from Pictet de Rochemont's *De la Neutralité de la Suisse dans l'Intérêt de l'Europe*, published in 1821, in which he has some words of advice to offer on the subject of Swiss neutrality; in this extract, *inter alia*, the statement occurs: "It is necessary in order that *this neutrality may be real, effective and firm* . . . that there should never be any secret influence in the Republic's councils of a nature to give rise to a suspicion of partiality or to disquietude regarding its consequences, at the supreme moment when this neutrality is put to the test. The true policy for Switzerland to adopt consists in serving, turn about, as a shield for its neighbours, in cultivating their good will so long as this does not involve loss to its dignity." The writer of this article, taking the extract as a text, deals with the division of opinion in Switzerland on the question of the War. He frankly admits that he holds views in opposition to those held by the French-Swiss and their representatives, nevertheless, having been offered the hospitality of the

columns of the *Revue*, he takes advantage of the offer, since he considers it a privilege to defend unpopular ideas. He expresses the opinion that, in the French regions of Switzerland, some are going too far in their partizan attitude on the subject of Right and of Justice, however necessary and justified it may have been at the beginning of the War to have taken up a stand against the German peril. If care is not taken to curb this partizanship, he fancies that, under the pretext of being neither Prussian nor, for the matter of that Bernese, some there are who run the risk of gently sliding down a slope until they find themselves, without warning, not even Swiss; the conduct of these partizans, it is feared, will lead them into spoiling a good cause. The writer points out, in his article, that in the years from 1798 to 1814, the schism in Switzerland was much wider than that existing at present; but time passed, history sat in judgment and justice was done to the grand patriots on both sides. These patriots may have been divided in ideas, by sympathy, age, even by their acts: what mattered that if, after all, they remained one at heart.

Reference is made to the founding of the "*Nouvelle Société Helvétique*" in January, 1912, and to the circular issued at the same time. Extracts are given from the circular; it dealt with the internal dangers of Switzerland and drew attention to the serious international situation, pointing out that the outbreak of a European conflagration was imminent, there being 99 chances to 100 that Switzerland might be involved. It was asked whether the country was ready to face the crisis; what was to be its attitude, surrounded as it would be by belligerent nations? What was to be done, whose advice was to be listened to? It was pointed out in the circular that, in practice, the Swiss might find it difficult to act in conformity with the duty imposed by the juridical position of Switzerland as a neutral state. It was recognized that neither a perfect organization, nor a strong army, nor excellent institutions were in themselves sufficient, but that behind the army that fights, behind the authorities who direct, there is wanted the *esprit publique* capable of inspiring and sustaining them both. The development of a patriotic sentiment was required which would lead the people in the hour of danger to say: "*We desire to remain Swiss, we and our descendants.*" The "*Nouvelle Société Helvétique*" had but one object, namely, "to strive, by the union of the Swiss, particularly in matters tending to divide them, for the maintenance of the dignity and the security of the country." In performing this task the *Société* afforded, at least, an example of the "*devoir Suisse*"; in the case of the individual what is wanted to attain the same end is "*une attitude personnelle.*"

The "*devoir Suisse*" should consist, in practice, of a series of small precise daily duties; these may, in appearance, be wanting in heroism, but they demand virtues which are rare, such as stoicism, prudence, tenacity, etc. The present War came as a surprise to the great majority of the Swiss. The scenes of July, 1914, are described; the mobilization of the army; the flight of the tourists; the panic of the civil population; the terror of an invasion. The order and quietness with which the Swiss Army was mobilized reassured the public. Everyone later became patriot and militarist and only insisted on the right to fight against a

possible invader, whoever he might be. This was the second stage: the period of *nationalisme exaltée.* The danger of an invasion had apparently passed away; Switzerland was then forgotten, but the interest in the belligerents remained. All fear having been dissipated, some began to take sides and allowed themselves to be dominated by their sympathies, their affinities of language or of race. Suddenly the command was heard: Be neutral. On this there followed the third stage, a weakening of national sentiment and divisions of public opinion. It is stated that at one time these divisions of opinion had grown to such dimensions in Switzerland that many staunch patriots became seriously alarmed. Excesses gave birth to a reaction and many commenced to work in the cause of national union. Thanks to these efforts a sincere and durable *rapprochement* between the Germanic and Latin parties of Switzerland took place. National duties, such as those inaugurated by the "*Nouvelle Société Helvétique,*" reawakened the Swiss spirit, whilst international enterprises such as Red Cross work toned down hatred, strengthened the European spirit, the sense of justice and of humanity. Thus it was that the fourth stage was reached: that of the "*réaction salutaire.*"

An attempt is made to discover the *causes profondes* of what has passed. It is pointed out that war exalts man's caprices; it develops heroism, but it obscures the intelligence, unchains passions and the primitive instincts of man. It was natural then that the violation of Belgian neutrality should have caused a wave of indignation and reprobation to pass through Switzerland; indifference in face of the facts brought to light would have been blameworthy.

It is stated that the first lesson the War has taught the Swiss is the fact that they are still dominated by foreign influences, and that they are still lacking in an *opinion publique,* an opinion guided by the sole principle: the general and paramount interest of the Fatherland. It is recognized that public opinion will, as a rule, only form round some central idea; in the case of the Swiss it should be—the idea of Switzerland itself, its independence, its neutrality. Owing to defects in the national system of education this idea is to many Swiss, vague and obscure. It is asserted that never has more tomfoolery been talked on the subject of neutrality than has been the case in Switzerland since the beginning of the War. The majority of the people are ignorant of what it consists, and, above all, of their duties in relation thereto. So much so indeed is this the case that, after the neutrality of Belgium and the Grand Duchy of Luxemburg had been violated, there were many Swiss who persuaded themselves that these facts in themselves afforded an efficient and formal guarantee that the independence of Switzerland, at all events, was thereby secured. The first reason given why Switzerland should remain neutral is that a duty is imposed upon her to remain true to her word and to show respect for the obligations entered into by her with the European Powers. The writer of the article argues that a Swiss individually violates the neutrality of his country each time he shows, either by act, word, or deed, direct hostility towards one of the belligerent powers in any openly public manner, or when his conduct in any way provokes a hostile incident. He does not agree

that in a democracy, such as that under which the Swiss live, neutrality can be looked upon solely as a political attitude of the State. It is not possible, he thinks, to separate the individual from the State; even were this possible, it would, in his opinion, be dangerous to attempt such a separation. The second reason given why Switzerland should remain neutral is that the national interest demands the adoption of this course. There is still a third reason why Switzerland should remain neutral, it is dictated by the *esprit confédéral;* each member of the Confederation has a duty to fulfil towards the other members of the Republic, the duty of forbearance. The writer of the article expresses the opinion that it is the duty of those living under the Federal banner to treat the German-Swiss as the eldest son of the family. It is to this section of the community that Switzerland owes her separate existence, this section it is which has founded the nation.

AN OLD ARTICLE.

An anonymous article appeared in the *Revue* for May, 1902, in which an attempt was made to study the probable features of the next great war. At that time, people's thoughts were preoccupied with certain conceptions which differed so widely with the views expressed in the article referred to, that the majority of readers failed to grasp the author's meaning. The *Temps* has unearthed the article in question and republished it with comments, in its issue of 7th April last. The identity of the author has also now been disclosed; he is none other than Colonel Mayer, of the French Artillery, now in command of one of the Sectors of Paris. His ideas were in flagrant opposition to the dogmas of official orthodoxy, to the teaching of the "*École Supérieure de Guerre*," to the views held at the "*Centres des hautes études militaires*," to the accepted doctrines of the General Staff, both in France as well as out of it. The Colonel first published his ideas in the "*Bibliothèque Universelle*" of February, 1891, under the title "*Évolution de la Tactique*"; there he examined the developments likely to arise from the increase in rapidity of fire of the weapons in the soldiers' hands and from the introduction of smokeless powder. He wrote for the information of the general public and pronounced himself clearly opposed to the views of the theoreticians who argued exclusively in favour of the offensive. "Let us not give our support," he wrote, "to those who claim that the offensive has lost nothing of its value." He declared that the defensive was not, as some had said, "an attitude of which the whole strength resided in purely negative advantages. It had a virtue of its own." The Colonel foresaw that battles would no longer be fought, as a rule, on the open ground hitherto sought after, but that armies would henceforth progress "craftily in broken country, adapting in field warfare the practices of street fighting." He expressed the opinion that preparations for the new methods of war should be taken in hand "by a general reorganization of the army, by a different distribution of the combatant arms, by a complete remodelling of the weapons of war, by a radical transformation in the methods of command employed up to the present day"; he contributed many articles to the daily papers and to periodicals on the foregoing matters.

The article referred to above was closed with the following warning: "Let us learn to be content with these vague indications. The Sibyl herself, if questioned regarding these disturbing secrets of the future, could reply in none but unintelligible words; her fragmentary dicta would alone convey ominous threats. A presentiment exists that something terrible is brewing and sure knowledge there is, alas! that the key to this enigma will alone be found in the blood of numerous victims." This article remained unnoticed. Colonel Mayer returned to the charge in the number of the *Bibliothèque Universelle* for April, 1902, with an article entitled "*Le Combat dans la Guerre Moderne.*" Subsequently, he decided to appeal to the members of his own profession and prepared an article for the *Revue*, taking advantage of a situation which had, at that date, risen in France owing to the publication of certain propositions by General de Négrier in the *Revue des Deux Mondes*, which had created a considerable stir in military circles. He wrote an article entitled "*Quelques idées françaises sur la guerre de l'Avenir,*" in which he associated his own revolutionary ideas with the views published by General Négrier in his contribution to the *Revue des Deux Mondes*. The Colonel called attention in his article to the fact that the French Army continued "to proclaim the superiority of the offensive" and "to rely on the moral effect of the bayonet charge"; he continued, "By the side of this doctrine which contains the official articles of faith, there is yet another doctrine now about to see the light of day. In the processes of the new war, it is prophesied, new formations will be utilized, ancient dogmas will be cast aside." A description is given by the Colonel of the plan of attack formulated by General Négrier, the characteristics of which consisted in the suppression of reserves, the disposition of troops in successive lines 1 league (about 2½ miles) in rear of one another, so that no risk might be run of blows aimed at the first line reaching the lines in rear; the General's idea being that a succession of waves of attack would roll on irresistibly against some one selected rock of defence, there either to break up themselves, or to pulverize and consume the rock. But in reproducing the General's plan, Colonel Mayer left no doubt in the minds of his readers that, in his opinion, it was highly improbable an attack could renew itself, in the manner indicated, against an opponent on the defensive in well-prepared positions. He stated definitely that, once the front of the attack had come into collision with the defences, trench warfare would, by the force of circumstances, have to be substituted for the war of manœuvres. Further developing his views, the Colonel gave a very realistic picture of the battle of the future; he spoke of the possibility of the use of torpedo-like shells, of the dropping of bombs by aircraft and the employment of new methods in war, hitherto unheard of, which, on account of their unknown origin, would produce bewilderment and surprise. The resemblance of the field warfare of the future to the siege warfare of the past was, in the author's opinion, likely to be very close indeed. His views can be summed up in the following terms:—The war of the future will consist of a "*combat défensif*" which will drag its painful course with alternations of very localized successes and very partial reverses, without producing any decisive

results where the fighting is of a purely defensive character. So far as other troops, which may be available, are concerned they can best be employed in some other region, as far away as possible from this theatre of defensive warfare, where they should attempt, by their boldness, to shake the *morale* of the higher command. In the article of May, 1902, the opinion is expressed that the opposing armies would remain facing one another in their respective positions for an indefinite time; the operations of war would not cause the raising of the blockade unless, indeed, the diminution of supplies caused one side or the other to yield. It would be circumstances of an external nature, such as the exhaustion of financial resources, or the general political situation, which would terminate the War and even then this would happen without either belligerent having gained any marked advantage or having met with any decisive defeats. Nevertheless, it will still remain necessary to show foresight, calmness, boldness, and the true offensive spirit even on the defensive. More than ever before must the troops, the staff, the higher command and the civil population put forth all their energy. Still more than ever before will it be necessary for the generalissimo and those under his command to possess expert professional knowledge and experience.

NOTES AND NEWS.

Switzerland.—It is pointed out that, by degrees, the confusion which has existed in Swiss minds on many subjects is at last being cleared up: the confusion between neutrality and sovereignty; the confusion between international policy and the policy of conquest; the confusion between military and civil power; the confusion between a state of peace and that of war. It is stated that the consequence of so much confusion has been to render more and more difficult the task of the Federal Council; the breach between the citizens of German and those of French sympathies has added to the difficulties of the situation. It is urged that the situation cannot become grave if the Central Government will only take advantage of the resources of the federative system: what is wanted is closer contact between the citizens and the Cantonal authorities and less interference by the bureaucracy. Regret is expressed that the equilibrium previously existing in the Federal Council between the two most important Swiss Communities was disturbed just prior to the outbreak of the present War. Turning to another question, it is considered to have been a serious mistake to have placed the censorship, in peace time, under the military authorities, as this has caused the army chiefs to be reached by public criticism; it is felt that it is not too late, even now, to place the censorship in civilian hands.

INFORMATION.

Switzerland.—The new grey-green uniform adopted for the Swiss Army is described.

This number concludes with a bibliography of literature of interest in military circles.

THE SUPPLEMENT.

"The European War" (*continued from the* R.E. JOURNAL, *June*, 1915).—The third part of the *Supplement* on "The European War" is published with the April number of the *Revue*. The opening paragraphs relating to "The Battle of the Aisne" appeared in the second part of the *Supplement;* the account of this battle is continued in the third part and is dealt with under four subheads. The first of these subheads is entitled "The Commencement of the Battle in the Light of German Telegrams." The situation, from the German standpoint, during the opening phases of this battle is disclosed in three telegrams dated 14th, 15th and 16th September, 1914; these telegrams announce that the engagement, which commenced on the German right wing on the 13th *idem*, had extended eastward until it had involved the German troops in the neighbourhood of Verdun. Attention is drawn in the *Supplement* to the fact that all references to the Battle of the Marne had been slurred over in the earlier German communiqués and that a *lacuna* existed in the series of German war telegrams (*i.e.* covering the period 3rd—14th September). In a German telegram of the 16th September, it is claimed that French attacks had been repulsed and that German counter-attacks had been crowned with success. On the following day, a German official telegram gave hopes of victory; it said, "Between the Oise and the Meuse, the battle still continues but there are indications which lead to the conclusion that the resistance of the enemy is weakening. On our extreme right the enemy has attempted to break through our lines. This attempt, although carried out with considerable enterprise and great bravery, has finally broken itself spontaneously, and without any pronounced effort being made on the part of our troops. The German centre gains ground slowly but surely. French sorties from Verdun, on the right bank of the Meuse, have been easily repulsed." In publishing the foregoing official telegram (sent to the Press on the 18th September) Wolff's Bureau added the following non-official *postscriptum*:—"The Great General Staff has good grounds for expecting that decisive results will follow to-day from the battle."

Before midday on the 18th September, and in continuation of the information of the previous evening, the German Great General Staff announced the "*decisive*" defeat of the 13th and 14th French Corps and parts of another division south of Noyon (the French Headquarters immediately contradicted this report). In spite of the success claimed, the German hopes of the previous evening were not realized. On the 21st September, the seizure by German troops of the fortified heights of Craonne and the reoccupation of Bétheny, near Rheims, were announced. The text of the German telegrams sent out between the 19th and 28th September appear in the *Supplement*. The general impression created by the accounts contained in these German telegrams is that a battle of moderate dimensions, confined mainly to the German right wing, had taken place, but that, in spite of the claim of "*decisive*" results having been obtained, things were really stationary. Further, apart from the successes claimed for the German attacks at Noyon and Bétheny, the battle is described as having been due to the initiative of

the Anglo-French troops. The second subhead is entitled "The Commencement of the Battle in the Light of French Telegrams." The French accounts give more details than do the German. The fact is the German Press found itself in a false position; it had somehow to reconcile a defensive-offensive situation with one preceding it, which had been out and out offensive, and no sufficient excuse existed for the omission to refer to the transition phase. The French Press was more at its ease; after the Anglo-French success on the Marne, it had drawn attention to the fact that, during the German retirement, the enemy had offered resistance to the Allied columns in pursuit. It had also announced that a new battle was in progress and had given a clear account of the same. Further, the French General Staff was also free from the embarrassment probably experienced by the German General Staff, owing to the equivocal nature of the latter's account published with regard to the fight on the Marne. The German check on the Marne had probably been held to be a temporary accident, unfortunate certainly, but easily reparable. The text of the communiqué of the 15th September, explaining the situation at Noyon, Soissons, and to the north of Verdun is given, as also the text of the French telegrams, dated 17th, 18th, 20th and 21st September, which describe the succeeding tactical phases of the battle; these telegrams show the general character of the fluctuating events of the engagement which continued up to the end of this month. A comparison of the accounts given in the two sets of telegrams, the German and the French, appears to disclose the progress of two different battles, so dissimilar are these two accounts. The German version tells first of an offensive which throws the enemy on his defence, then the latter, in spite of the difficulties of the attack, resumes his offensive efforts; however, the Allied forces are broken up on coming into collision with the German armies which had eventually assumed an attitude, more or less, of a defensive character; the French account speaks first of an offensive also, but admits that the defensive was assumed, between the 18th and 24th September, in face of the enemy's activity whose attacks were renewed, time and again, without cessation. A communiqué of the 24th September is published in which the features of the fighting on the Marne and the Aisne are briefly compared. The third subhead is entitled "The Two Official Versions." It is pointed out that, of the two accounts, the French was the one least likely to throw dust in the eyes of the public. The French account leaves the door open to the announcement of a success, but makes it clear that patience is required and that the realization of the hopes awakened by the victory of the Marne must be postponed. Full credit is given to the enemy for his vitality, and no doubt whatever is left that the enemy is far from being destroyed yet. It is further pointed out that in the fighting on the Aisne there were not so few fluctuations along the battle front as the German version would lead one to suppose. Attention is called to the doctrines relating to the defensive laid down in the German regulations and to the fact that the French version of the fighting represents the progress of events as having more closely followed the teachings contained in these German regulations than does the German version. Again, it cannot be believed that, in the middle of September,

1914, after only six weeks of hostilities, the German higher command had renounced its intention to destroy the forces of their opponents, the very objective of its strategy; the more so, in view of the general situation which required that France should be disposed of early, so as to free the German hosts for the campaign in the east. These two motives, added to the principles laid down in the official military doctrine, lead to the conclusion that counter-attacks in force were resorted to as the surest means of reaching the desired goal. The earlier German communiqués themselves lend truth to this view; they give rise to the hope, if not the conviction, of Headquarters that victory was in sight, on the fifth day after the assumption of the defensive. Everything, even the German version, leads one to the conclusion that the French version most accurately represents the true situation in relation to the events on the Aisne. The fourth subhead is entitled " The Amplified German Version." In it attention is drawn to an official note published in the *Norddeutsche Allgemeine Zeitung*, the object of which was to calm the public mind, in view of the disquietude created by information from foreign sources. The note hinted that the public had become spoilt owing to the surprising progress made by German arms in the first days of the war. The Great General Staff, it claimed, had not, like the non-combatants, committed the serious fault of underestimating the value of the French Army. Under this subhead, an examination is made of the notices relating to the War published by the German Press, and the conclusion is arrived at that these notices provide fresh evidence of the truly scientific nature of the organization created in Germany for the manufacture of equivocal accounts of the doings of the German Army. Several of the German communiqués are published in this part of the *Supplement*. In communiqués dated 16th September, information is given connecting up the events on the Aisne with those on the Marne. It is claimed therein that two German Army Corps had crushed five French Divisions; the Anglo-French forces had been pushed back across the Marne on to Paris, etc. Other telegrams dated 18th and 21st September are also reprinted. The story now told causes the progress of events on the Aisne to fit in with the German doctrine of war, and the *lacuna* in the series of despatches, that between the 3rd and 14th September, is filled in. The public are told to have patience; not to believe the lies being published abroad; to have confidence in their leaders who, it is claimed, are telling the truth. This amplified version produced the desired effect, the public was completely reassured; more than that, they felt that so far as France was concerned her game was up; and at the beginning of October, the belief was very prevalent that the French Army was completely out of action. The later German version clears up the contradictions in the French and German official telegrams despatched since the 22nd September. In the case of the telegrams of the former, whilst lulls in the fighting were referred to, it was stated that a battle was in full progress, with " German attacks of unheard-of fury "; the telegrams of the latter, on the other hand, spoke of the engagement as being finished and of a victory already won. It was alone required to complete the success so far obtained.

Under the title of " The Episode of Saint Mihiel," an account is given

of the capture, on the 25th September, of the " Camp des Romains " by the Germans. In view of the magnitude of the operations on the western front, this development can but be considered to be an incident of minor importance. The German General Staff, having determined to force a passage through the French line in the neighbourhhod of St. Mihiel and thus to reach the Meuse, brought up a considerable artillery force under cover of which they made themselves masters, on the 21st September, of the foothills at Vigneulles-lès-Hattonchâtel and at Creue. On the 25th September, the Germans effected a breach in the northern rampart of de Rivière's line, captured the " fort du Camp des Romains " and established themselves at Chauvoncourt, on the left bank of the Meuse. The French delivered a vigorous counter-attack from Toul, this arrested the German offensive towards the west at this point and later caused the Germans to retire; within a few weeks the latter were back again on the right bank of the Meuse. The official accounts of this affair are set out in the *Supplement*. Both the French version and the German one, relating to the Saint Mihiel episode, are symptomatic of the methods of the press services of the two countries. On the French side, the main lines of the incident are precisely indicated, as also the results obtained, but so far as the partial reverses are concerned immediate news of which might create a disquietude out of proportion to the true significance of the event, references to them are postponed to a more opportune occasion. Further, silence on the subject of the capture of " Camp des Romains " is maintained for another reason; the French public had attached, in recent times, an exaggerated importance to fortifications, *per se*; therefore, it might have proved prejudicial to publish complete details of the German success. On the German side, system demands that no references shall be made to anything in the nature of a reverse and that, even in dealing with successes, care must be taken to suspend references to a success by switching off on to some side track where the end desired has not been fully attained.

An examination into " The Operations on the Somme " is commenced in this part of the *Supplement*. It is pointed out that it was early recognized by the French General Staff that the direct attack on the Aisne front could hardly be brought to a successful issue unless it was accompanied by a flank attack similar to that which was largely responsible for the victory on the Marne. However, the Anglo-French left now no longer rested on an entrenched camp and, since a movement directed with the object of enveloping the enemy's wing was an operation strongly advocated in the principles of war accepted officially in Germany, it was to be expected that the enemy would be on his guard against an attempt of this nature and would seek to meet it by a return to the offensive. These two concordant motives prompted the French General Staff to extend its offensive along the west of the Oise, in order to be prepared against any counter-stroke the enemy might be contemplating. The French telegrams early betray the preoccupations of the French General Staff. The German telegrams, as usual, are less prompt to disclose what is passing in the minds of the Great General Staff and are much less explicit in the statements issued for public information.

The manœuvre on the Somme marks the end of the Battle of the Aisne. French troops slipped away from their right towards their left, behind a curtain formed by the corps extended along the Aisne front, and prolonged the line of battle towards the north as far as Flanders, and an Anglo-French "*crochet offensive*" faced a German "*crochet défensif.*"

The French version of these operations is next examined.

The first precise mention of an engagement, in force, on the right bank of the Oise is contained in a telegram dated 19th September; in telegrams of subsequent dates, the events taking place in this region are duly chronicled. On the 23rd September, a French telegram announced "Between the Somme and the Oise, our troops have progressed in the direction of Roye. A detachment has occupied Péronne and has maintained itself against fierce attacks of the enemy." On the 26th September, it is admitted that the French troops had to give way before superior forces of the enemy. A second telegram of the same date announces that a very violent battle is still raging between the Somme and the Oise; the Germans have been pushed back, followed by the French who have made progress, extending their front to the north of the Somme. On the 27th and 28th September, a lull in the fighting is reported to have taken place, to be followed on the 29th September by German attacks to the north as well as to the south of the Somme, by night as well as by day. The Germans have been repulsed but the engagement continues to develop northwards. During this period the German telegrams were almost silent on the subject of these operations. A German telegram of the 26th September, *inter alia*, spoke of an "eccentric" attack and the repulse of a French division near Bapaume; the French Press made no reference to this. The affair at Bapaume formed a part of the general operations on the Somme, but the Germans could not refer to this fact, without making the admission that the fighting was becoming further removed from Paris; they had once more to make a choice between announcing what, on the one hand, was of advantage, namely, a partial success, and what, on the other hand, was an inconvenient piece of news to be hidden away, namely, a failure. Therefore, the affair of Bapaume was treated as an isolated episode.

During the early days of October, a change in the character of the struggle is notified, the effort on the Somme front had become more strenuous; that on the Aisne front had slackened. The French communiqués create the impression that an adversary has to be dealt with whose efforts are becoming more strenuous. The orientation of the line of battle is also changing. Telegrams which disclose the progress of events, day by day, between 5th and 12th October, along the Somme front are reprinted in the *Supplement*. They show that from the date last mentioned, the battle has crystallized on the Somme front, as it did 10 days earlier on the Aisne front; it has transformed itself into trench warfare. This part of the *Supplement* contains the opening paragraphs of the German version of the operations, the subject being continued in the fourth part of the *Supplement*.

The German version is colourless as compared to the French. Less use is made of the auxiliary means employed on previous occasions.

What information is available is all contained in the communiqués of the Great General Staff, and that is little enough. Since it had been announced that the *élan* of the Anglo-French armies had been broken at the Battle of the Aisne, it would never have done to have credited the enemy with renewed activity, involving a new deployment in very considerable strength. This probably explains why the curtain was drawn to obscure the great counter-offensive of the 25th—27th September. It is now known that the greater part of the VI. German Army had been transferred from Lorraine to the right wing, the decisive part of the front, to execute this attack. But the Press was rendered mute on account of its past and could not refer to the operations on the Somme as being in the nature of an attack in force. The communiqué of the 26th September claims that a spirited attack of the Anglo-French forces on the German right wing had been successfully repulsed. Then, except for the affair at Bapaume, the situation did not appear to change sensibly till the 30th September. On the date last mentioned, it was announced that the enemy's troops had appeared to the north and south of Albert. As in the case of the affair at Bapaume, it is stated, that the Allies were in superior force to the Germans; however, they were compelled to retire with heavy loss. Except as regards details, the main facts brought out in the German account correspond with those contained in the French version. On the date last mentioned, it is announced that the heights of Roye and Fresnoy have been captured. A private telegram explains that this occurred during an attempt on the part of the French to envelop the German wing. A communiqué of the 2nd October confirmed that the general character of the operations was as indicated in the above-mentioned private telegram; the French had renewed their attempts at envelopment and Germans had countered this move; on this day it was also announced that some of the Antwerp forts had been taken and Termonde occupied. On the 4th October, it is made known that the battle on the right wing was progressing successfully. On the 6th October, a Berlin telegram announced the extension of the front towards the north with the object of enveloping the French left. Similar information was contained in the communiqués issued on the 7th, 8th and 11th October. The text of telegrams issued from the 3rd to the 12th October are republished *in extenso* in the *Supplement;* these telegrams contain announcements relating to important German and Austrian successes in the western and the eastern theatres of war, and therefore the brief references to the fighting on the Somme, being so to speak in parenthesis, are almost obscured by the more important and impressive news.

The discussion of these operations is concluded in the *Supplement* in a section entitled "The Recapitulation of the Battle." It is considered that it would be useful, before steps are taken to compare the telegrams from the two sources and also certain other information which has come to light subsequently, briefly to enquire into the theoretical considerations involved. The problem to be considered is no longer that of a "*combat de recontre,*" as was the case in August, 1914, when the German and Anglo-French armies came into collision on the Marne, but the attack and defence of a region strengthened by field fortifications.

The present-day doctrine, as laid down in all the regulations dealing with tactics, is that the occupation of such a position should not be contemplated, except as a last resource. The general theory is briefly sketched out in the *Supplement;* the Battle of the Aisne exemplifies the application of this theory in actual practice. The French higher command, seeing the enemy in retreat before the Anglo-French armies, decided, at first, to launch a direct attack. This attack would disclose whether the enemy was so broken as to be incapable of making further resistance, or whether it was still in a position to make a stand in some chosen position. Hence, the French attacks and the groping along the front during the period, 13th—16th September. Evidence was soon forthcoming that the Anglo-French armies had selected two regions for their principal attacks, that of the Argonne towards the banks of the Meuse, and that to the north of Compiègne, where their left wing was advancing; by degrees, it had become clear that the German army had recovered itself and, since it was deemed to be capable of holding on to the position taken up by it, a flank attack was considered necessary to force the Germans back. Consequently, French reserves were moved to the west; these gained ground, step by step, towards the north, that is laterally; at the same time, the Germans continued to hold these French troops in check and also extended their own line towards the north, on a front parallel to that of their opponents. Then for a day or two, 22nd—24th September, the movement seemed to have come to a halt. The French army on the Marne had put all the men then immediately available into the fighting line; to extend further would have led to a dangerous attenuation of the troops on the front occupied. The Germans now seemed to be on the point of making another vigorous thrust; a counter-offensive was commenced by them along the whole front and continued during 25th—27th September; it was particularly aggressive on the west wing, from Lassigny to Roye and the neighbourhood of Péronne. In the meanwhile, on the French side, troops (partially fresh) were moved into the firing line; they had been formed in rear, to the west of Paris, and consisted of four Territorial divisions and a cavalry corps. Coming from the south of Amiens, this force marched towards the Upper Somme; before it could reach the river, it had to meet the shock of the German counter-attack. In its progress northwards, this French force had become too attenuated and its leading columns gave way before the German onrush. The French commander, however, had no intention of yielding; the French Territorials held their own, fresh reinforcements were hurried up from the Aisne and pushed still further to the north, there to obtain a decisive result. These French reinforcements proceeded, *viâ* Amiens, to the north of the Somme; the cavalry covering the left wing of this force reached the Scarpe Valley. The movements of the Germans during this period is next considered. Hardly had they taken up their position on the Aisne, when their counter-offensive gave some indication of their intentions. At first, their counter-attacks were intended directly to parry the French attacks. Towards the 20th September, operations were undertaken by the Germans in the neighbourhood of Verdun; it appeared as if an attack against the fortress itself was being prepared, any-

way the French advanced troops in the Woëvre were driven in. At the same time, a German counter-attack was launched against Noyon, on the French left. Lastly, a violent thrust was made in the centre, against Rheims, having for its objective the piercing of the Allied line. These three counter-attacks failed. The Great General Staff, being convinced, however, that it was on the German right front that the serious peril for their army lay, recognized that it was there that every effort should be concentrated, at once, for a counter-stroke. In haste, German army corps were quickly transferred from left to right, from Lorraine to the Somme; at the same time, all detachments in the north of France and Belgium were recalled; it was necessary, at all costs, to upset the barrier which was rising, and becoming longer with each succeeding day, in front of the portion of the German right wing thrown back in a north and south direction. Then, there commenced the great fights, the struggle for the liberation of the Aisne front. German divisions in close columns advanced against the foe; a new counter-attack carried out against Noyon failed; a counter-attack in the region of Roye appeared to succeed one day (the French General Staff admit a set-back), but on the day following it failed also. There it was that the decisive point lay; there the two French armies from the Aisne and the Somme had already succeeded in making a junction. The German armies must bring about their complete separation again, that way lay victory. New German divisions were now brought up, a fresh counter-attack on a grand scale was undertaken along the whole front, first towards Albert, then between the Ancre and the Somme, without cessation near Roye and the region of Chaulnes, to the north of Arras, to the south of Lassigny; this also failed. A final hope remained. There were still German reserves in Belgium. To get rid of the menace of Antwerp, the attack on its southern forts was renewed; the troops not required for this purpose were pushed south. The fronts occupied now extended to the north of Lille, but the principal German effort was still continued in the neighbourhood of Arras and on the Oise. About this time, day by day, the German telegrams begin to be pitched in a lower and lower key: "Situation satisfactory, we commence to gain ground."

According to the point of view from which the situation is looked at, the immobilization of the troops on the front on the Somme may be considered as a check either to one or to the other of the opponents. The enveloping movement against the German right by the French brought about a weakening of the troops available for the defence of the Aisne, but it did not result in the abandonment of this position. The enveloping army was not in sufficient strength to force back the enveloped wing. On the other hand, the effort of the Great General Staff to free the German right wing from the French pressure and to resume the offensive also failed in its purpose. But this is not the question which requires consideration from the point of view of the "*manœuvre morale*," rather is it, which of the two General Staffs can be said to have presented an account of the operations which corresponds most nearly to the actual facts of the situation. In the *Supplement* it is pointed out that an argument of a strategic nature can be invoked in

favour of the French version; this version draws attention repeatedly to the vigour of the enemy's attacks, whilst the German General Staff is guilty of dissimulation wherever success vanishes from its grip. The latter General Staff was better placed than that of the Western Allies to bring about a transfer of troops from the Aisne front to the Somme. It is unbelievable that it would not have sought to obtain the greatest possible advantage from this situation in order to resume the offensive.

THE BATTLES IN FLANDERS.

The progress of events renders it necessary to commence a new chapter in the history of the war; it is given the general title, "The Battles in Flanders." In dealing with the events chronicled in this chapter a new method of examination is adopted to expose the methods of the "*manœuvre morale.*"

In the case of the fighting on the Marne, the versions of the situation given by the two belligerents have been examined and the characteristics of these two accounts thus ascertained. In the case of the fighting on the Aisne and on the Somme an appeal was made to the accepted doctrines of warfare, specially that of the German Army, in order to establish the standard by which to judge the situation. In the case of the fighting in Flanders, it is proposed to investigate events from the point of view of the elements taken into consideration in preparing an appreciation of the situation and in relation to which, as events have progressed, the daily official communiqués issued by the two parties have probably been framed. By the side of these two accounts is placed a picture of the general impressions formed by an examination of the communiqués covering the whole period; an attempt is then made to draw conclusions from a comparison of the three accounts referred to, which conclusions it is hoped may, at least, have the merit of being based on sound arguments.

In a section entitled "The Preliminaries relating to the Battle of the Yser," attention is drawn to the fact it was first learnt from private sources that a new German army was being formed for operations in Belgium, where it was expected to join up with the German forces released after the capture of Antwerp. The German telegrams had made no allusion to the numbers of the Belgian troops captured in Antwerp. A suspicion arose that the Belgian army had escaped, and later, it transpired that it had got away in time and had reached the sea. The first official news relating to new operations being in contemplation was obtained from a French source; a telegram of the 5th October announced that a large German cavalry force, followed by the other arms, had appeared between Lille and Armentières. The French cavalry was engaged for several days with this force on the banks of the Lys, in the neighbourhood of Armentières and further west, and it appeared that the heads of the German columns had been pushed towards the north-east. Infantry engagements ensued at Lille and this town fell into German hands on the 12th or 13th October. On the latter date, it was announced that the French had assumed the offensive on the front Béthune-Hazebrouck against the Germans reported to be occupying the line Bailleul-Estaires-La Bassée. Further north, engage-

ments were reported right up to Cassel. At the same time, it was learnt that the Allies had reached Ypres. The only information given by Berlin, at this date, was that Lille had been occupied. A German telegram of the 14th October first refers to the Belgian army, it says: "The enemy's troops, including a part of the Antwerp garrison, are rapidly retreating on Ghent towards the west, in the direction of the coast. Our troops are in pursuit." Next day, the Great General Staff let out the truth concerning Antwerp: "At Antwerp, we have taken from 4,000 to 5,000 prisoners." On the 16th October, a private telegram to the *Journal de Genève* announced that the Belgian army had joined up, on the left of the Anglo-French line, between Armentières and the North Sea.

The situation then, as disclosed on the 16th October, stood as follows: The Anglo-French troops had prolonged the left front of the Allies from La Bassée-Estaires-Bailleul and faced the Germans who had occupied Lille; the extreme left of these Allied troops had advanced to Ypres; still further on the left, the Belgian army had effected a junction with the Allies and had extended the front until it rested on the sea; the German army in pursuit of the Belgians had reached Bruges and Ostend. Private telegrams also indicated that the Germans had been considerably reinforced by formations of the Ersatz-reserve, landwehr and volunteers. It became necessary to exercise caution in preparing an appreciation of the strategic situation. The Allies proclaimed a strategic victory as being already certain; the German newspapers made a similar claim on behalf of the Great General Staff. The succession of events seemed to indicate that the operations were about to enter on a fourth phase. The first had been the "*manœuvre de la Meuse,*" where the Germans had had the initiative and had pushed back their enemy to a distance of some 180 km. (about 112 miles) within the latter's own territory. The second phase had been the "*manœuvre de la Marne*"; the Anglo-French armies had wrested the initiative from their adversary and forced him back over a distance of some 80 km. (about 50 miles). The third phase was that of the "*manœuvre de l'Aisne et de la Somme*"; the Germans wrestled to regain the initiative in the region in which they had been thrust back, the Anglo-French put up a fight to retain it. And now the fourth phase was reached, the "*manœuvre des Flandres*"; the Germans, having despaired of regaining the initiative in the region referred to under the preceding phase, still continued their efforts to gain this end but decided to change the venue for the trial of their prowess; they shifted it 100 km. (about 62 miles) further north, at the same time sheering off towards the west.

Put shortly, the "*manœuvre de la Meuse*" was an offensive on the part of the Germans, a defensive on the part of the Allies; the "*manœuvre de la Marne*" was an offensive on the part of the Allies, a defensive on the part of the Germans; the "*manœuvres de l'Aisne et des Flandres*" consisted, jointly, in an offensive on the part of the Allies, a counter-offensive on the part of the Germans. The Great German Staff took in hand, on a big scale, the strategy attempted on a smaller scale from the days of the commencement of the "*manœuvre de l'Aisne.*"

In a subsequent section entitled " The Battle of the Yser," the operations which took place between the 16th October and the 5th November are dealt with under three separate subheads. The first of these subheads is entitled the " First Engagements." On the 16th October, the Allies occupied the whole region of the Ypres up to the coast; the Germans had, by this time, invaded Western Belgium, and had penetrated as far as line joining Ostend-Thourout-Roulers-Menin. The communiqués issued from Bordeaux and from Berlin both on the 18th and 19th October are republished *in extenso* in the *Supplement* and disclose the fact that the battle, properly so-called, commenced on the 17th October; at the same time, they provide evidence of a disagreement in the accounts issued from the two camps. On the morning of the 19th October, the German public was not yet aware of the course events had followed during the past 48 hours. So far as they knew Antwerp had been captured and the German hosts were in pursuit of the Belgian army; all else was ignored, it was not worth mention. The French communiqués create a different impression; they show that important events were in progress in the region which had formed the French left and the German right. The problem, which the armies on the Lys had to solve, was whether the French, who had pushed back their opponent some 200 km. (about 124 miles) to the north of the entrenched camp of Paris, would be obliged to retrace their steps or whether the Germans would continue their retirement. For many days the Great General Staff had maintained a strict silence; it would not have done to give any indication that far-reaching changes in the plan of campaign were under consideration. In order, if possible, to deceive the enemy as to their real intentions violent and repeated attacks were made by the Germans on the front Lassigny-Roye-Albert, so that the Allies might be induced to fix attention on this region and retain their forces in strength there. However, the latter discovered the surprise packet in preparation for them in good time. Since the 6th October, the communiqués of the Allies had reported the presence, in the north, of large masses of German cavalry and also indications of a German offensive move being in preparation. At this same period, the Germans, who had been content to observe Antwerp during the whole of September, suddenly decided to rid themselves of the menace which the retention of this fortress in the enemy's hands created. Active steps were taken on the 28th September to reduce Antwerp. The Allies, having come to the conclusion that, in spite of the desultory attacks continued by the Germans, the Battle of the Aisne had been won, took steps on the 6th October to prepare a counter-manœuvre to meet the latest developments of German strategy; as on previous occasions they made preparations for acting on the offensive. Whilst the Belgian army from Antwerp was marching on to the Yser, the Allies had massed the bulk of their forces in the region Hazebrouck-Béthune, in order to effect an offensive move astride of the Lys. In case of a success here this would have proved more advantageous than a direct counter-stroke against the German offensive movement along the coast; an Anglo-French success would have placed the German forces between a victorious enemy and the sea. On the other hand, if the German right wing had won the

day, any check that the Allies might have suffered would not have imperilled their line of retreat and, therefore, would not have been of a serious nature; the Allied front would merely have been drawn back. The examination of the foregoing facts shows what value is to be attached to the German telegrams; nothing seemed, at this time, to possess any importance whatsoever in the German mind.

The second subhead deals with "The Decisive Phase." The communiqués issued from Bordeaux and from Berlin, on each day, from the 20th—27th October are republished *in extenso* in the *Supplement.* During the period covered by these communiqués, the general situation does not show, what may be called, a change; however, all this time, the Germans were making desperate efforts to break the Allied front on the line Lille-Ypres-Dixmude-Nieuport. The Berlin telegrams of this period create the impression that the decision was going steadily and continuously in favour of the German troops, in spite of the support which the British fleet attempted to afford to the left flank of the Allied line. From the Berlin message of the 26th October, it would appear that practically the whole of the canal had passed into the possession of the German troops, the Allies being left with only its extremities in their hands. Success smiled on the Germans also along the remainder of the front, in the region of Lille from the commencement, and at a later period in the region of Ypres. The French telegrams tell of events of a much more fluctuating character and are more in keeping with, what is known to form, the main features of a battle raging on so wide a front as that actually occupied. Berlin, on the 24th and 25th October, claimed that the passage of the canal had been forced on the left, *i.e.*, at a point held by the Belgians; the earlier French telegrams make no mention of this, but at 7 a.m. on the morning of the 26th October, the French admit that the Germans had crossed the Yser, between Nieuport and Dixmude, and in a later telegram, of the same date, issued at 3.35 p.m., it is announced that the Germans who had crossed the Yser had made no further progress. It will be remembered that attention was drawn to the adoption of a similar course by the French in dealing with the episode of St. Mihiel. Whilst the Belgians held the canal from Dixmude to the sea, fluctuating movements were taking place on other sectors of the front. During the early days of the battle, loss of ground near Bassée, south-west of Lille, was announced, and also that ground had been gained near Armentières; then followed progress in the regions of Langenmark, Armentières and Lille. A comparison of the communiqués during the decisive phase of the battle indicate that, if any advantage at all was gained by the Germans, this took place on the extremity of their line in the west; the effect of such a strategic success would be alone to push the Allied left flank back along its natural line of retreat. This portion of the Allied line may be supposed to have been pivoted on Arras; the displacement of this pivot would have only resulted in tactical victories. The topography of this region contributed largely towards rendering tactical progress laborious. The Yser Canal is only the first of the obstacles to an advance in this region. The German right wing would also have to traverse the Moeres district which had already become famous in the history of past wars. In a relatively short time all the

region north-east of Dunkirk, from Moeres to Bergues and to Furnes, could be inundated. In spite of the confident tone exhibited in the German telegrams up to the 26th October (that of the subsequent date is silent on the subject of the canal), the German attack had only obtained indifferent results; their telegrams admit as much. The telegram of the 24th October referring to the passage of the canal spoke of an *important* force having crossed this obstacle; the telegram of the following day had increased its dimensions to a *new force in considerable strength*. Under the circumstances, the success of the whole operations may, at least, be supposed to have been doubtful. A third subhead entitled "The End of the Battle on the Yser," is commenced in this part and concluded in the fifth part of the *Supplement*. The situation is introduced by a republication, in the *Supplement*, of the communiqués issued from Bordeaux and Berlin, day by day, from 28th October to 5th November (those up to the 31st October appear in the fourth part). The German offensive on the Yser seems to have reached its maximum violence from the 24th to 27th October; on the 28th October, there was a weakening in their effort. The French telegram of the 29th October refers to the German attack having moderated, whilst the German telegram of the same date announces the arrival of Belgian reinforcements. However, the Germans had not admitted their check, they still claimed to be gaining ground, even on the 30th October, although the French had already made known that inundations extended along the banks of the Yser. The Germans, it appeared, had even attempted to resume the offensive right up to the inundated zone; but this was the end. On the 1st November, they admitted the difficulties caused by the inundations and, two days later, that it was impossible to overcome these difficulties.

The Germans retired from this region without experiencing any loss whatever, at least so they said. This retreat, however, it was claimed, had brought immediate compensation elsewhere. The announcement of the capture of a series of localities between Dixmude and Lys would, no doubt, provide consolation to the German public for the abandonment of the canal after its successful passage. A German attack on the front Ypres-Lille aroused great expectations. A success on their left wing (on this front) would cause the flank of the Allies on the Somme to be uncovered; on the right success would bring the Germans in rear of the Yser defences. The terrain seemed also to be less difficult; by advancing on the Ypres-Lille front, the zone which can be easily flooded was avoided. The German public therefore need not trouble itself concerning the check on the Yser since, after all, it only resulted in a local retirement and did not involve a defeat at the enemy's hands; the operations were only of secondary importance. As a matter of fact, the communiqués relating to this phase are not in agreement; even the Belgian telegrams which had, in their contents hitherto, followed closely the information given in the French and English telegrams, now contained matter of a contradictory nature. However, these telegrams enable the front held to be traced approximately. It is enough to seek the regions in which the belligerents claim successes.

On the 30th October the Germans had taken Bixschoote, and they

claimed, on the same date, to have occupied Zandvoorde and Hollebecke, to the south of Ypres, and on the 2nd November to have captured Messines. The Allies had announced that they had progressed north-east of Ypres, in the neighbourhood of Passchendaele which stood at the salient of the angle formed by running a line through Bixschoote-Passchendaele-Messines. Little importance need be attached to the differences in details. For example, the Allies had given out that they had retaken Messines partially and Hollebecke entirely, thereupon the Germans, who had at first claimed to have seized the latter village, of their own accord explained that their claim was confined to the occupation of the Château only. These incidents have no material bearing on the broad aspect of the operations, which bear evidence of a convergent attack by the Germans on Ypres, and the very large forces employed for this purpose afford proof that an enterprise, from which decisive results were expected, had been undertaken by the Germans. In theory, such a situation should have turned out unfavourable to the Allies, but a scrutiny of the telegrams discloses no remarkable difference in the tactical situation of the two sides. The later despatches, indeed, seem to betray either a suspension or a relaxation in the German effort. To the French claims of the 4th and 5th November, relating to sensible progress having been made by them between Dixmude and the Lys, the German telegrams make a reply, in a decreasingly minor note, which almost amounts to an acquiescence. The most that can be said is that, after many days of strenuous fighting, the German Army had not obtained any permanent success on the Lys. There was even a momentary suspension of the German operations, which coincided with the definite check met with on the coast. The consequence of this was that the Allies, finding it no longer necessary to preoccupy their minds with the Yser sector, were in a position to transfer their available forces into the Ypres region; they did so with all the advantages to be obtained from the increase of *morale*, arising from a success, whilst the enemy had to suffer all the disadvantages experienced after a reverse, especially where very considerable forces are engaged and the loss suffered is heavy. The persistence of the French attack on the front Dixmude-Passchendaele largely neutralized the value of the German attack on the front Passchendaele-Messines. Theoretically, the latter, being a flank attack, constituted a grave peril to the Allies. The check to the German arms on the Yser Canal, it is held, prognosticated a general weakening of the German offensive in Flanders.

The next section of the fifth part of the *Supplement* deals with "The Battle of Ypres"; it opens with a reprint of the communiqués issued from Bordeaux and from Berlin, each day, from 6th—8th November. The French telegram of the 6th November indicates that the battle, between Dixmude and the Lys, which was dying away had suddenly broken out afresh. A similar outbreak of activity on the part of the Germans occurred, at the same time, on the Aisne and on the Somme. This German manœuvre was intended to cover the retreat of active troops in the north. It also confirmed the information, coming from private sources, which had reported the arrival on the Yser of newly-

formed, or second reserve, army corps from Germany. These troops had been tried severely on the Yser and, for the attack on Ypres, it became necessary to double the active corps; consequently troops of the former reserve were drawn from other parts of the front. On the side of the Allies reinforcements had come up, a continual transfer had been taking place from the Aisne and the Somme to the Flanders front. The German telegrams announced appreciable progress, on the 6th November, but this was done probably with the object of discrediting the suggestion that the enemy might be about to resume the offensive again. Soon, a delay in the movements was announced and attributed to the mists which then prevailed. The communiqués issued from the two headquarters, on the 9th and 10th November, are reproduced and their contents examined. They show that, during the 8th and 9th November, the action had recommenced once more, and again it is on the front between Dixmude and the Lys that an attempt is made to obtain a decisive result. On the 9th November, the Germans returned to the charge and the opposing lines on the offensive came into collision. The telegrams referred to state the claims of the two parties; these telegrams contradict one another flatly. Each side claimed to have defeated the other. Finally, the communiqués issued from Bordeaux and from Berlin, day by day, from 11th—15th November bring the account of the Battle of Ypres to an end, although both sides continue to announce desultory fighting on dates subsequent to that last mentioned. After the partial suspension of activity on the 8th November the Germans had recommenced operations with a violent intensive effort; their hopes ran high that this effort would be crowned with success, that is to say, if the tone of their communiqués was not intended to deceive. A change is also noticeable in the tone of the dispatches of the Great General Staff announcing the capture of Dixmude. A French communiqué, issued on the 11th November, admitted that the Germans were in possession of this place. The Great General Staff, on the same date, not only announced the capture of Dixmude, but also that "*our troops* have crossed the canal." It is pointed out that the use of the words "*our troops*" was capable of creating an impression that an offensive movement on a big scale had been carried out, and yet the words might equally refer to the passage of a patrol merely, or even of a company. The expression used is elastic and prudence dictated that there should be a suspension of judgment on the situation described. On the following day it is seen that the success, of the 10th November, has not come up to expectations. Berlin still announces that the attack along the canal south of Dixmude has made progress, but the information is tainted with the same uncertainty as that created by the first announcement. During the whole of the 12th November, the possession of this canal crossing had not permitted the main attack of the Germans to obtain the decisive results which were to change the face of things in Flanders. The incident terminated similarly to that at St. Mihiel. The German offensive in Flanders wasted away, as did those which preceded it on the Aisne, at Noyon, on the Somme, to the north of Arras, as well as to the south of Lassigny. The Bordeaux telegrams, on the other hand, tell of the successive reoccupation of ground lost and a weakening of the enemy's attacks, whilst they mention the

persistence of the "*mouvements d'approche*" of the general fighting line of the French; the German communiqués refer only to the difficulties of the undertaking, quibble about the value of the partial success of their opponents and make much of incidents occurring in places far removed from the decisive theatre on the western front. Assuredly the Kaiser had lost the battle.

The operations in Flanders are summed up in a section entitled "The General Character of the Battles in Flanders." It is pointed out that the earlier engagements were of the type known as the "*bataille de rencontre.*" Neither one side nor the other was willing to abandon the initiative, both still desired to wage war in accordance with the doctrines inculcated by the advocates of the offensive. However, circumstances were about to impose a different attitude on them. The immediate means for carrying on the offensive failed the Allies; the convex form of their front rendered the transfer of troops from east to west a tedious and long operation; the reinforcements for the British troops could alone be provided on a small scale. In the case of the Allies the spirit of the offensive remained intact, but its application had to be postponed. In the case of the Germans, the necessity which existed for fighting simultaneously on two widely separated fronts did not permit of any postponement. A new German army was organized in haste, soldiers trained for only six weeks, volunteers and others, young and old, were quickly gathered together. This army was pushed immediately into the firing line on the extreme right wing on the western front, whilst the transfer of troops from east to west in the north of France and in Belgium was taking place in connection with the consolidation of the German front from Lille to the sea. At this moment, the general plan of the great battle of the west became clearly defined, the front of the Aisne and even that of the Somme were nothing more than "*fronts d'opérations suspensives.*" That from Lille to the sea along the Lys was the front of an immense echelon jutting out from Germany, having a "*refused*" wing which precipitated itself with violence on the enemy and made offensive counter-strokes on a large scale after it had checked the enveloping attack of the enemy. Taken as a whole, this immense manœuvre of counter strokes, over a front of more than 100 km. (about 62 miles), lasted four weeks and consisted of three distinct phases:—

(*a*). The operations round Lille, which connect, in time, the attempts to liberate the Somme front with the counter-attack of the wing, properly so called.

(*b*). The operations of the Yser, carried out by the German army from Antwerp and the new reserves.

(*c*). The operations in front of Ypres, representing the supreme efforts of the remains of the army referred to in (*b*) absorbed into the reinforcements brought from other fronts.

If these three phases are considered as a whole, whereof the third admits of two representations, it is seen that the battle resulted in a sharp and bloody struggle which lasted for 30 days. From the first day to the thirtieth it had gradually developed from the sea towards Lille, passing by the Yser Canal, to the north, to the east, to the south-

east of Ypres and by the west of Lille. And when the battle was finished, it was still on this self-same line that the last of the German communiqués speak of the same good progress made, of the same success won, slow maybe but sure, the same satisfactory advance. Nothing had changed, there was only one German army the less.

The fifth part of the *Supplement* concludes with the consideration of the "manœuvre morale des Flandres"; the tactical operations are first dealt with. If the succession of French and German communiqués are examined closely and compared, on the whole, no marked contradiction in their purport will be observed. As on previous occasions, it will be found, the German Press had been more careful than the French, not only to carry dissimulation to excess, but also to suppress reference to all reverses. The French picture represents a defensive battle, the German picture an offensive one. The difference only appears clearly from the conclusions to be drawn. The French defensive brings about a check of the enemy's attack; the operations end, because the attack has failed. On the other hand, it is claimed that the German offensive is victorious, the German troops continue to progress, although as a fact, they have lost the battle. The foregoing summaries show that the news services have remained faithful to the regulations drawn up for their guidance, that is so fundamentally; however, an evident evolution is taking place in the form of the German service. By degrees, it succeeds in imitating that of its adversary. Greater exactitude is also shown in the terminology adopted; the tone is circumspect. In a general way, the attempt to play on the imagination of the public is abandoned in the official service of the civil authorities, as also in the auxiliary information service of the Great General Staff. Such was the situation during the period of the operations of the Aisne and of the Somme. The Battle of Flanders marks a new evolution in the system. The auxiliary official information service disappears in its turn, and only the communiqués of the higher command and the so-called private Press telegrams remain. The private Press telegrams are only private to the extent that they are issued anonymously. A certain number of the so-called private telegrams are reprinted in the *Supplement* and a comparison of their contents with those of the official communiqués shows how closely the two sets extend and support one another in the interests of the "*manœuvre morale.*" The consideration of the aspect of the question dealing with the strategical operations is commenced in this number.

W. A. J. O'MEARA.

REVIEW.

HISTORY OF THE CORPS OF ROYAL ENGINEERS, VOL. III.

By COLONEL SIR CHARLES M. WATSON, K.C.M.G., C.B., M.A., late R.E.

THE following is compiled from the *Morning Post* of July 19th:—

Colonel Sir Charles Watson's third volume, covering the years 1886—1912, exhibits the same characteristic of ubiquity as the previous two volumes (Major-General Whitworth Porter's *History of the Corps*, Vols. I. and II.).

The organization of the Corps is a subject of professional rather than of general interest. Sir Charles Watson shows separately the War Office Staff and the District Organization. The story of the regimental units of the Corps is continued from the previous volumes: many new and increased duties have, with the advance of science, devolved upon them, such as Submarine Mining (transferred to the Royal Navy in 1905), the working of electrical searchlights, military balloons and telegraphs. Large additions to the Corps were authorized for the South African War, in which 250 officers and 5,220 men of other ranks took part. The details are all available, but cannot be given here. The Aeronautic Corps was again reorganized in 1911. The construction and maintenance of barracks for the accommodation of the British Army at home and abroad has previously been one of the important duties of the Royal Engineers, which has now, for the first time, its history completely narrated. In 1793 the barracks were removed from the charge of the Board of Ordnance, and a new Barrack Department was created. Under an extraordinary system extravagant expenditure of the Barrackmaster-General was for a time practically unchecked until the post was abolished. Barracks were again under the Board of Ordnance for thirty years before 1855. There is now a Civil Department called the Barrack Construction Department. The services rendered by the Engineers in the Sudan campaigns of 1885—1899, and in the South African War, are chronicled at sufficient length. The Survey work performed by the Corps has been very widely extended in all branches and in many countries, whether in cadastral work, the delimitation of boundaries, exploration, or the revision of maps.

The short biographies of thirty distinguished officers of the Royal Engineers carry on the series which was commenced in General Porter's volumes. If other evidence were wanting, they afford proof of the variety of careers open to members of this Scientific Corps. They should show to young officers what their predecessors have achieved, and the rewards attainable by success in able and devoted service. The whole volume is, indeed, replete with information and instruction.

CITY & ENVIRONS OF LUCKNOW

SHEWING THE PLAN OF MILITARY OPERATIONS & THE ROUTES FOLLOWED BY THE BRITISH ARMY, IN RELIEVING THE RESIDENCY IN NOVEMBER 1857. AND IN TAKING THE CITY IN MARCH 1858.

NOTE.

This map has been compiled from Capt. Vonrenen's Survey in Seasons 1862-63 & 65-66, Scale 0"= 1 Mile, & Plan of Lucknow, surveyed & drawn by Lieut. A. M. Lang, & U. Champain D. Ward, Bengal Engrs. & Mr. J. Roy, Exr. Engr. in accordance with Capt. Mcorsom's Origl. plan to accompany the Chief Engr's report of the Siege Operations, also from plan reduced & compiled from Brig. Napier's large Plan of Lucknow & the Sketches of the Q. M. Genls. Dept. &c. in the Office of the Surveyor Genl. of India, Calcutta, January 1859. The plan of the Residency has been taken from The mutinies in Oudh by Hubbles, & the Machi Bhawan from a plan supplied by the Deputy Adjt. Genl. R. A. (in India).

REFERENCES TO RESIDENCY INTRENCHMENT.

1. Church Garrison.
2. Evan's Battery.
3. Sheep House.
4. Slaughter House.
5. Unfinished Battery.
6. Racket Court.
7. Lawn.
8. Begam Kothi.
9. Dr. Fayrer's Garrison.
10. Financial Garrison.
11. Sago's Garrison.
12. Judicial Garrison.
13. Anderson's Garrison.
14. Cawnpore Battery.
15. Duprat's House.
16. Barracks.
17. Martiniere School.
18. Brigade Mess.
19. Sikhs' Square.
20. Goinda Lines.
21. Gubbins' Battery.
22. Gubbins' Garrison.
23. Omaney's Garrison.
24. Bailey Guard Gate.
25. Water Gate.

REFERENCES TO THE CITY.

1. Residence of the ex-King's Brother.
2. Residences of members of the Oudh Royal Family.
3. Lal Bara Dari.
4. Chatar Mansil Garden.
5. Lockhart's Post.
6. Capt. Peel's Guns.
7. Enemy's Buland Bagh Battery.
8. Enemy's Garden Guns.
9. Mosque.
10. Hazratganj.

SYMBOLS AND REFERENCES.

City Boundary .....
Village Boundary .....
Pucka Buildings .....
Kutcha Buildings .....
Limits of Cultivation .....
Metalled Road .....

REFERENCES.

Major-Generals Havelock and Outram's advance on 25th September, 1857, thus .....
Sir Colin Campbell's advance in November, 1857 .....
Retreat of the Old Garrison.....
Sir Colin Campbell's advance in March, 1858 .....
Major-General Outram's route, March, 1858 .....
British Batteries .....
Enemy's Batteries .....

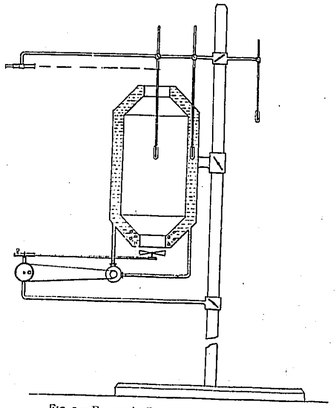

FIG. 1.—BARKER'S RADIANT THERMOMETER.

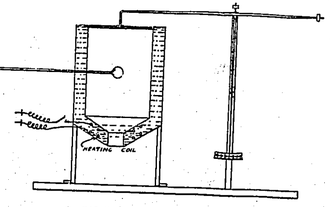

FIG. 2.

FIG. 3.

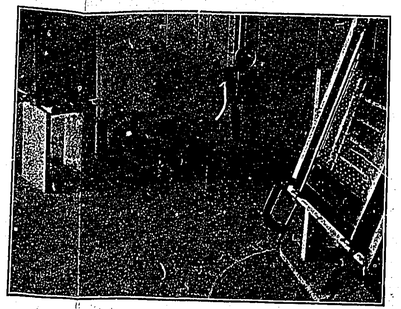

FIG. 4.

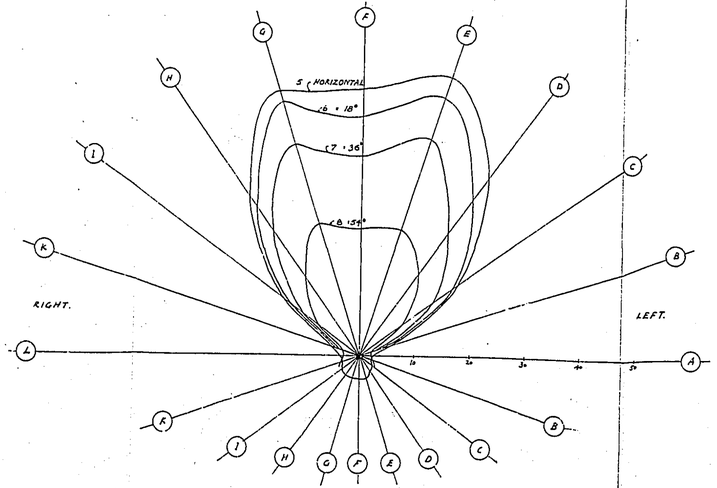

FIG. 5.—LATERAL DISTRIBUTION OF RADIATION OVER PLANES AT GIVEN ANGLES TO THE HORIZONTAL.

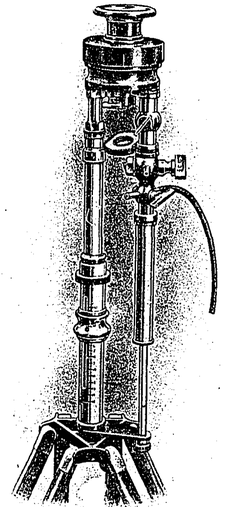

FIG. 6.—AITKEN DUST COUNTER.

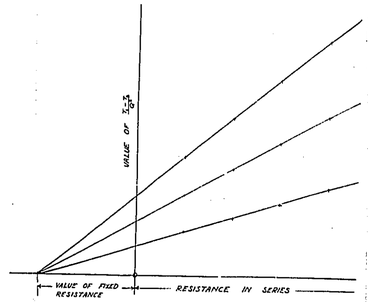

FIG. 8.

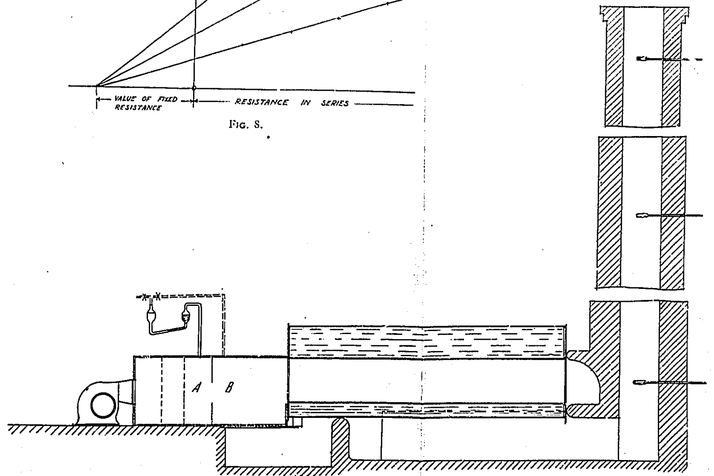

FIG. 7.—METHOD OF DETERMINING PNEUMATIC RESISTANCE.