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TYPE OF LANDING STAGE, LITTLE HOLLAND.

LANDING OPERATIONS AT THE ESSEX MANOEUVERS 1904

*NEW MEASUREMENTS OF THE DISTANCE OF THE SUN.**

By A. R. HINKS, M.A.

WHEN I received the honour of an invitation to lecture at the School of Military Engineering on some astronomical subject, I had little difficulty in making my choice of a topic. There is just one subject on which I may speak with some little first-hand knowledge; and by great good fortune that subject is concerned with a problem which has both in its nature and its history a connection with the Corps of Royal Engineers.

The problem of the determination of the distance of the Sun is, in some respects at least, the most fundamental in the whole range of astronomy, for the number which represents it is involved in almost any calculation of distances and masses, of sizes and densities, either of planets or their satellites or of the stars. The distance of the Sun bears somewhat the same relation to other problems of celestial surveying as the size and shape of the earth bear to terrestrial. It may not always appear on the surface, but it is generally concealed somewhere in the depths of the calculations. And I am compelled to confess that in one respect the earth-measurers have the advantage over astronomers. The utmost that the astronomer can do is to show that the distance of the Sun is so many times the radius of the earth. But ask him to put it into miles and he is powerless to do so until the geodesists have told him how large the earth is; and it is there that, in the very nature of the case, we are compelled to depend in the end upon the scientific labours of your Corps.

Distance of Sun corresponding to Different Values of the Solar Parallax and Clarke's Figure of 1880.

π.			Miles.	Kilomètres.
8″·760	...	...	93,321,000	150,180,000
8″·770	...	...	214,000	150,010,000
8″·780	...	...	108,000	149,840,000
8″·790	...	...	002,000	670,000
8″·800	...	...	92,896,000	500,000
8″·810	...	...	791,000	330,000
8″·820	...	...	686,000	149,160,000
8″·830	...	...	581,000	148,990,000
8″·840	...	...	476,000	820,000

A difference of 0″·01 in the parallax is equivalent to 106,000 miles or 170,000 kilom.

* Lecture delivered at the Royal Engineers Institute on 9th February, 1905.

Let us look at the matter for a moment as a problem in pure surveying. To measure the distance of the Sun we have as a base a chord somewhat less than the diameter of the Earth, since observations cannot be made on a heavenly body when it is actually on the horizon. Suppose we put our base line at $\frac{8}{10}$ of the diameter. Our problem is to determine the distance of a body so far away that the whole diameter of the Earth subtends at it an angle of only about 17·6 seconds of arc; and with our somewhat diminished base this angle is reduced to a little less than 15″. I believe that the length of your base upon the Great Lines of Chatham is about 1,730 ft. Imagine that from that base you had to determine with an accuracy greater than one in a thousand the distance of an intersected point about 4,500 miles away, as far away as Chicago; and you have a problem which is by comparison simplicity itself. For the ends of our 7,000-mile base are not visible from each other, being on opposite sides of the world; and our angles at the base must be determined by a complicated reference to the zenith, with all the well-known impossibilities of determining absolute places in the sky increased by the special difficulties that arise when the object to be observed is the Sun. You will readily grant that to determine the distance of the Sun by direct observation of that body is impossible, unless you are content with an accuracy of about 1 in 10.

Now it is a curious fact that there is a way of obtaining the distance of the Sun with an accuracy of ten per cent. with no other instrument than a clock keeping accurate time; you do it by observing the times of minima of the variable star Algol. Every 2 days 21 hours Algol drops more than a magnitude, and does this with a regularity which would be unfailing were it not for the fact that at one season of the year we are nearer the star by nearly the whole diameter of the Earth's orbit than we are at the opposite season; and light takes about 16 minutes to traverse that distance. In the middle of November the eclipses of Algol are taking place 8 minutes earlier than the average; in May, could we observe the star so near the Sun, they would be found 8 minutes behind their time; and a practised observer could, on a long series of observations, determine that inequality, with a total range of 16 minutes, well within 2 minutes, that is to say, with an accuracy of about 10 per cent. We have then only to combine this quantity with the known velocity of light, and we have a measure of the Sun's distance. A mere curiosity in itself, it will serve to introduce us to some indirect ways of determining the distance of the Sun which have, both practically and historically, a peculiar interest and importance.

At the present time we are in the thick of a new determination of the distance of the Sun, on a scale of operations greater than has been known before. More than 50 observatories of the Northern hemisphere are engaged more or less deeply on the work, which has occupied a great many of us closely for the last four years, and will give plenty of trouble to some of us for several years to come. Before we enter upon the consideration of the new method and the new opportunities, we might well pause to answer the question, which is by no means superfluous,—How does it come about that, at the end of the 19th century, which had seen attempts almost innumerable to measure the distance of the Sun, the result was still so much in doubt that it was worth while to concentrate quite a large proportion of the total astronomical energy of the world upon a new attempt? I believe that we shall find some explanation of this fact if we examine the history of the various values of the Solar Parallax that were used in the *Nautical Almanac* during the 19th century.

A determination of the distance of the Sun by direct observation of the Sun itself is impracticable; the Sun is too difficult an object to observe with any great accuracy; its distance is too great, and our base is too small, for any method of direct trigonometrical survey to be possible. But we can in effect diminish its distance by substituting for it one of the planets, which can be more accurately observed; for when the distance of any one planet from the Earth is known, the dimensions of other orbits follow by the application of Kepler's 3rd law. And at the same time we can, as we shall see, secure the inestimable advantage that the measures to be made are relative and not absolute.

Let me digress for a moment to insist upon the importance of this distinction. If you wished to find the difference in latitude and longitude between your Institute and the trigonometrical point at Darland, you might determine the latitude and longitude of each, and take the differences; or you might triangulate from one to the other. One is an absolute method, the other a relative; and it is scarcely necessary to emphasize the difference in accuracy between the two. We shall see that, various as are the kinds of measurement which may be made to contribute to a knowledge of the Solar parallax, they are all of them relative measurements. For example, one may observe the displacement of the planet Mars among the stars, as seen from a northern and a southern station, say Greenwich and the Cape; or one may observe the displacement of the place of Venus in transit across the Sun from stations suitably chosen. In each case we are measuring the displacement as viewed from different stations of a near object with respect to one further off, the displacement of Mars among the stars or of Venus against the Sun. We have secured the advantages that the parallactic displacement to be measured is greater than that of the Sun itself; that the objects to be observed, Mars or Venus, are better adapted for observation; and that the measures are relative.

In the middle of the 18th century Lacaille made observations of Mars at the Cape of Good Hope, which were compared with others made at various observatories in Europe; and he deduced a parallax of about 10″. In the same century there occurred the two famous transits of Venus of 1761 and 1769, which were very extensively observed, among others by Captain Cook on his celebrated expedition for that purpose to the South Seas. Many and various were the results obtained by different discussions of the observations, lying between $8\frac{1}{2}''$ and $9\frac{1}{2}''$, but decidedly less than the parallax found from Mars; and we find that at the beginning of the 19th century the *Nautical Almanac* adopted a value in round numbers, 9″, as the best that could be made of them.

Values of the Solar Parallax used in the Nautical Almanac during the 19th Century.

	π
1801—1833	9″
1834—1869	8″·5776
Encke, from Transits of Venus, 1761 and 1769.	
1870—1881	8″·95
Leverrier, from Parallactic Inequality of Moon (1858).	
1882—1900	8″·848
Newcomb, from general mean of many methods (1867).	

In 1824 the German astronomer Encke submitted to a very searching examination the collected results of the transit of 1769, and deduced the result 8″·5776, which, with its imposing train of decimals intact, was incorporated in our *Nautical Almanac* for 1834, survived until 1869, and was responsible for the statement, which many of us can remember in the school books, that the distance of the Sun is 95,000,000 miles.

Meanwhile the attack upon the problem had been maintained in several different ways, and particularly by an indirect method that has many points of interest.

In the Lunar Theory there occurs, among the short-period perturbations to which the motion of the moon is subject, an inequality in a period of a month which depends upon the fact that the disturbing action of the Sun is greater on that half of the Moon's orbit which lies towards the Sun than upon the other half. The result of this is that the Moon is more than 2 minutes behind at first quarter and 2 minutes ahead at last quarter of the place which she would occupy were there no perturbation. It is clear that the magnitude of the effect must depend upon the ratio of the distances of the Sun and Moon from the Earth; and since the effect is large, an oscillation either way of about 125″, this should give a strong determination of the Solar Parallax, provided that the Moon can be observed with the required accuracy and that the theoretical relation between the perturbation and the Solar parallax is firmly established. In 1858 Leverrier found in this way a value of 8″·95; several other determinations supported this large value; and practically all the determinations made since 1830, however much they might disagree among themselves agreed at any rate in one thing, that Encke's value was much too small. We find, therefore, that in the *Nautical Almanac* for 1870, published in 1866, Leverrier's value 8″·95 is adopted, and the official distance of the Sun changed at one swoop from 95,000,000 to 91,000,000 miles.

But now preparations were in full swing for the observations of the Transits of Venus of 1874 and 1882, which for many years had been eagerly awaited in the full expectation and belief that then, with all the manifold improvements in the arts of observation, in the invention of the heliometer and the application of photography to celestial measurement, the question of the Solar Parallax would be definitely settled. We cannot do more than glance at the most beautiful and most complicated geometrical problems involved in the consideration of all the circumstances of a Transit of Venus. But these two diagrams* will show some of the circumstances of the very important phenomena, the times of internal contact at ingress and egress, the times when Venus is just completely on the Sun and just about to begin to go off. Great preparations were made for observing these times of ingress and egress, and the results would undoubtedly have been successful had it not been for the cruel way in which the geometrical sharpness of the phenomenon is ruined by the lighting up of the atmosphere of Venus; there was no instant when tangency was perceptible, and, to be frank, the Transit of Venus as a means of determining the distance of the Sun was a failure. The photographic and heliometer observations had for various reasons met with no better success than the observations of contacts; there was no consistency about the results.

But just as the preparations for the Transits were beginning in 1867, Prof. Simon Newcomb had published an elaborate discussion of the Solar Parallax based upon several different methods. With some of these we are already familiar, and I will call attention to one only, the last, which we have not as yet discussed.

Components of Newcomb's Value.

	π
Newcomb, Obs. of Mars, 1862...	8″·855
Hall, " "	8″·842
Hansen, Stone, and Newcomb, from Parallactic Inequality of Moon	8″·838
Newcomb, Lunar Equation of the Earth ...	8″·809
Powalky, Transit of Venus, 1769	8″·832
Foucault's Velocity of Light, and Struve's Aberration Const.	8″·860
Weighted Mean	8″·848

* Showing the passage of the Earth through the cones enveloping the Sun and Venus. (Not reproduced.—EDR.).

It is an effect of aberration that every star describes yearly in the sky an ellipse of which the semi-major axis is about 20″·5, and this number is called the constant of aberration. It is the ratio of the velocity of the Earth in its orbit to the velocity of light. When the constant is known and the velocity of light is known, the velocity of the Earth in its orbit is known; and since the time of describing that orbit is also known, the size of the orbit and the distance of the Earth from the Sun follow immediately.

In 1876 it appeared then that there was strong evidence against the value 8″·95; and without waiting for the results of the Transit of Venus expeditions, the *Nautical Almanac* adopted for the while the value 8″·848 found by Newcomb from this galaxy of results which looked so accordant; and that value was first used in the Almanac for 1882, the year of the second transit.

But meanwhile Sir David Gill, who had observed the transit of 1874 at Mauritius and had made up his mind very definitely that no good would come out of the transit of 1882, had borrowed Lord Lindsay's heliometer and established himself on the island of Ascension to observe with the heliometer the opposition in 1877 of the planet Mars. Every night the observing station in Mars Bay was carried some six or seven thousand miles by the rotation of the Earth and the planet thereby displaced among the stars by some 40″. The heliometer is by far the most refined instrument for the visual measurement of distance from star to star; the observations extended over months instead of hours; they could be pursued without any of the disquieting feelings that a temporary breakdown would ruin everything; and they were brought to a successful end in a parallax of 8″·78. But one doubt was cast upon the result. Was it possible that the red colour of Mars had influenced the measures systematically? It could not be denied that the effect of the dispersion of the air, which gave the planet a blue fringe above that might be lost in the blue sky, and a red fringe below that would be indistinguishable from the red planet itself, might have produced some effect; and Sir David Gill resolved to try again, utilizing this time three minor planets further away than Mars, with less parallax therefore but with discs so small that they were indistinguishable from stars.

In 1888 and 1889, five observatories, the Cape in the Southern hemisphere, and Yale, Göttingen, Leipzig, and the Radcliffe Observatory at Oxford in the Northern hemisphere, combined to observe the planets Victoria, Iris and Sappho with the heliometer. The labour was immense. The observations proved to be so accurate that they demanded the use in a great part of the work of eight figure logarithms. When, only a few years ago, the whole work was published in two enormous volumes of Annals of the Cape Observatory, it might well have been thought that here was the last word of observation for many years. Yet we are now attacking the problem with more energy than ever!

About ten years ago the end of the century was in sight, and there was a general impression abroad that it was time to set one's house in order and to make a good start on the first of January, 1901. The directors of the four *Nautical Almanacs* (the British, French, German, and American) resolved to meet in Paris in 1896, and with the help of certain distinguished advisers to agree upon a uniform set of constants to be adopted in all the Almanacs from the year 1901. Among these constants was the Solar Parallax. We may summarize the information which was at the disposal of the conference thus:

Solar Parallax from

Gill's Heliometer, Minor Planets	8″·802
Constant of Aberration of Light	8″·799
Parallactic Inequality of Moon...	8″·794
Mass of Earth from motion of Node of Venus alone	8″·763
,, ,, from secular var. of four inner planets	8″·759

Gill's heliometer measures of minor planets gave 8″·802, and no other direct observational result could be compared with this; the Transits of Venus were discredited even though some of the final results had not, and have not even now, been published. The most recent determinations of the constant of the aberration of light gave 8″·799, the parallactic inequality of the Moon, 8″·794. There were thus three powerful methods which converged upon a value close to 8″·80. But to set against them was a method which we have not yet noticed.

The perturbations in the motions of other planets produced by the Earth depend upon the mass of the Earth, and from them that mass can be determined. There is further a well-known relation between the mass of the Earth, the value of the gravitation constant, the length of the year, and the distance of the Sun, from which the latter may therefore be derived when we know the others. Prof. Newcomb had thus determined the parallax in two different ways, and had found two results agreeing closely among themselves, with mean 8″·76, but differing widely from the others. No explanation of this divergence could be found. But the evidence was 3 to 1 in favour of 8″·80, and 8″·80 was adopted in 1896 as the value to be used in all the Almanacs from the beginning of this century.

It might well have been thought that the question would have been allowed to rest there for a while. At the end of a century of labour four principal results had emerged, and there was a majority of 3 to 1 in favour of 8″·80. But there is a phenomenon, known in politics as the swing of the pendulum or the flowing tide, by whose operation a majority hardly won begins immediately to melt away. A like phenomenon appears to affect the Solar Parallax. We have seen how its adopted value has swung from 8″·57 to 8″·95, and back again to 8″·85 and 8″·80. Scarcely had the resolution of the Paris Conference been taken than the majority in favour of 8″·80 began to melt away. The beginning of the century had been chosen as an auspicious moment in which to make a change, without considering that there were at the end of the preceding century many investigations just then drawing to a close. The value of the Aberration Constant corresponding to 8″·80 is 20″·478. Almost every determination of that constant published since 1896—and there are many—had come out above 20″·50, many of these a long way above. Further investigation of the parallactic inequality of the Moon had not only altered the observed value of the inequality, but had modified the theoretical relation by which the parallax is deduced therefrom. The evidence for 8″·80 was giving way badly; and before the 1901 Almanac came into use, we had this revised table propounded by one of the chief instigators of the adoption of 8″·80. The majority was now 3 to 1 in favour of a value at least as low as 8″·77.

Revised Table.—Solar Parallax from

Gill's Heliometer, Minor Planets	...	...	8″·802
Constant of Aberration of Light	...	...	8″·77
Parallactic Inequality of Moon, probably		...	8″·77
Mass of Earth from secular variations	...	...	8″·759

I suppose that there will always be two opinions upon the question: Is the adopted value of the Solar Parallax to depend upon direct observation; or are the indirect determinations through the constant of aberration, the parallactic inequality, and the mass of the Earth to be allowed a weight in some proportion to their numbers? I take it that those of us who have determined the parallax by direct observations may not unnaturally look upon these indirect methods as interesting confirmations of our result, if they agree with it; while if they differ, there must be something wrong with them. But in the absence of a direct determination of overwhelming weight, there must always be a feeling of uneasiness when one sees three or more results conspiring to deny the truth of one. And however that may be, it is certainly true that about the year 1898 there was a very general suspicion abroad that the value 8″·80 was too large.

At this moment there came a curious stroke of fortune. Dr. Witt, of the Urania Sternwarte, Berlin, was engaged in a photographic search for a minor planet which had long been lost. He failed, but found instead a minor planet for which one would willingly barter the remaining five hundred odd; a minor planet indeed, but moving in a most remarkable orbit, lying for the most part within that of Mars, very eccentric, considerably inclined to the ecliptic, and approaching the Earth on favourable occasions within about 15,000,000 miles. It was immediately recognised that here was a new opportunity for determining the Solar Parallax, and that the determination must be made at once or left alone for thirty years, for a comparatively favourable opposition was due in 1900 and no more good ones till 1930 and 1937. At the meeting of the Permanent Committee which directs the making of the Astrographic Chart and Catalogue of the whole sky, it was resolved to invite a great co-operation of observatories to make a combined onslaught on the problem. The suggestion was readily taken up, with an alacrity indeed which might almost have suggested that the observatories concerned had nothing to do and were glad of a job, an imputation which is immediately rejected when one finds that some of the most energetic participants were precisely those observatories that had their hands most full with the astrographic chart (*Fig.* 1). By a cruel stroke of fate Sir David Gill at the Cape was compelled to remain a spectator of the work, for the planet came so far north that it was practically unobservable in the Southern Hemisphere, while in England we had the unique spectacle of a planet north of the zenith.

Fig. 2, borrowed from Prof. Wilson's articles in *Popular Astronomy*, shows very clearly the circumstances. Corresponding positions of the earth and the planet are joined, and if we follow out in imagination the directions that these lines must have, remembering that the orbit of the planet is inclined 10° to that of the Earth, we see that the planet described a loop at opposition, as all exterior planets do, but that the loop was of very unusual proportions (*Fig.* 3).

To discuss in any detail the circumstances of the apparition, and the way in which they can be utilized for a determination of the parallax, would take too long. But we may get a good idea of a fairly typical case by transplanting ourselves in imagination to the planet Eros on the evening of the 2nd of December, 1900, armed with an imaginary telescope ridiculously out of proportion to the real size of the planet, which is probably not more than 20 miles in diameter (*Fig.* 4). The Earth is past inferior conjunction with the Sun, and appears as a crescent. The North Pole of the Earth is tilted towards us, and by the aid of this projection of the meridians and parallels of latitude we can with great ease trace the path of each observatory as it is carried round by the rotation of the Earth, and can measure from the scales the angular distance at any moment of an observatory from the centre, or the distance between two observatories; which angular distances as seen from the planet are the precise equivalents of the parallactic displacements of the planet as seen from the Earth.

In the programme of observations there was one novel and promising feature—the application of photography. With the exception of the Transit of Venus observations, in which its success was not striking, photography had not been previously applied in a determination of the Solar parallax, for the very good reason that in 1889, at the time of the opposition of Victoria, there was practically only one telescope in existence which was capable of taking photographs for exact measurement, that pioneer photographic equatorial made by the Brothers Henry at Paris. The fact that there were in 1900 eighteen photographic telescopes engaged in observing Eros shows how rapidly the equipment of astronomy has grown in the last few years. We were so fortunate at Cambridge as to have our new photographic equatorial just completed and made to work. (I may remark parenthetically that it took longer to make the machine work than to build it, for when one embarks upon a large experiment, and sets up an instrument, the first of its kind, built upon improved lines, one sets out upon a sea of troubles.)

The great advantage of the photographic method in such an undertaking must be sufficiently well known by you. It is of course this, that one is rendered very much more independent of continued fine weather. A photograph of the planet and the surrounding stars could be made in 2 or 3 minutes of actual exposure. Given an hour's break in the clouds, one could accumulate far more valuable material than could be obtained in a whole night's visual observation, for the photograph once secured could be measured at leisure, by day or on cloudy nights.

Throughout Europe the skies of that winter were far from clear. I had the pleasure at Cambridge of sitting up from dusk till dawn for nearly three months on end, and during that time had not half-a-dozen nights clear right through. Had I been making visual observations I should have done little; as things turned out I was able to get some 500 exposures. The programme was to get 4 exposures per hour throughout the night, making a number of exposures on each plate, and moving the plate a little between each exposure. The stars are then arranged in columns of fours; the images of the planet, owing to its rapid motion, are in echelon.

Now each exposure gives very accurately the place of the planet with reference to the group of stars around it, and for merely parallax purposes the ideal would be to have pairs of such photographs taken at the same instant at stations widely separated. By a very simple use of the measures of some ten or twelve stars suitably disposed about the planet, it would be possible to allow almost automatically for the differences of refraction, orientation, scale value, etc., which make the plates not immediately comparable, and to find at once the parallactic displacement.

We have been speaking of the displacement as very large, and so it is when compared with the displacements dealt with in previous determinations. But look at it this way. We saw that the Earth as seen from Eros subtended an angle of 53′. The scale of the Cambridge plates is such that, if we draw a circle having a diameter of a little over $1\frac{1}{2}$ mm., we represent the apparent diameter on our plate of the Earth as seen from Eros; and within that small circle the whole of the parallactic displacement must necessarily lie. About a millimètre was the average displacement obtained in a favourable combination of observations, and when we consider that we are trying to measure that with a resultant accuracy of 1 in 1,000, it does not seem so very great after all.

We have put the problem heretofore in its very simplest form. In actual fact the exposures at different stations were not simultaneous. Early morning observations made at Cambridge might be combinable with evening observations at Lick more or less simultaneous, or with evening observations 10 or 12 hours before at (say) Oxford; or they might have to stand alone. Any general method of utilizing all the results must secure the possibility of reducing each plate, so to speak, on its own merits, to allow it to contribute its quota, be it large parallactic displacement or none at all, to the general collection of equations of condition. This requires that we shall know the relative places of all those stars which are to be used as comparison stars for the planet, right along the whole track of the planet. And this derivation of a standard star system is by far the most delicate and difficult part of the whole work. One must start with a foundation of stars observed with the meridian circle, and fill in the fainter stars from the photographs themselves, taking care to provide at the same time the places of all those faint comparison stars which have been used by the visual observers. And all these places of stars must be tied together, so to speak, by the overlapping of the photographs, so that the system may run smoothly throughout its length. Absolute errors of zero there no doubt will be, and must be, but it is required that there shall be no sudden jumps in the errors exceeding one or two hundredths of a second of arc.

Now when one comes to face a problem like this one must enquire very carefully what is the real accuracy of the photograph. There is no doubt that the ordinary photographic telescope properly worked will repeat itself very well; it will take two plates of the same region which agree with one another excellently. But the question is,—How would two plates of the same region taken with different telescopes agree? We know that individual observers have peculiarities of their own which they can repeat almost *ad infinitum*. Does a photographic telescope do the same, or has it at last conquered that bad habit of idiosyncrasy which has made so much trouble in all refined astronomical work of the older kinds? When we started on the Eros campaign there was practically no information to be obtained upon this point. Almost all the photographic telescopes at work had been engaged upon their own zone of the chart, and almost nothing was known of how the results from different instruments would combine. But in our parallax problem this question is fundamental, and must be answered as soon as possible. I therefore ventured to propose to myself to undertake the reduction of a small section of the photographic results, for a period of 9 days in November, 1900, having before me two objects:—Firstly to discover how far it is possible to combine photographs taken at different observatories, how far, in fact, photographic telescopes are giving really accurate results or merely reproducing their own errors; secondly to obtain a provisional value of the Solar Parallax, with a probable error if possible as small as that found by Sir David Gill with the heliometer, and to find out provisionally whether Eros was going to confirm that result or to join in the secession from the adopted value.

Perhaps I may venture to think that the results of this enterprise have been in some measure successful. I found that as a general rule the results from different telescopes do not combine directly as well as could be hoped, and that there are many precautions which must be taken in using them, if we are to avoid serious systematic error and a ruination of the parallax determination. But I believe that it is possible to avoid these difficulties, and that the photographs properly treated will give a determination of the parallax of far greater accuracy than has hitherto been obtained. I found also that the 300 exposures in that period of nine days, contributed altogether by nine different observatories, gave a value of the Solar Parallax, $8''.797 \pm 0.0047$, which is in such nice agreement with Gill's $8''.802 \pm 0.005$ that one may feel in one's heart (though of course must never express the feeling so prematurely as this) some hope that, in adopting $8''.80$ as the official value of the Solar Parallax, the conference of 1896 was not so wrong as some people have been prepared to believe.

	Distance of Sun in Miles.
From Heliometer Observations of Victoria, Iris, and Sappho. $\pi = 8''.802 \pm 0''.005$	92,875,000
From 295 Photographs of Eros. $\pi = 8''.797 \pm 0''.0047$	92,928,000

I cannot refrain from calling your attention to a by-product of this work which has for me a singular interest, because it seems to exhibit in a favourable light the accuracy which we may obtain with these photographic methods. After Eros had been under observation for some time it was discovered that its light was varying in a short period which was at first thought to be 2h. 38m. Afterwards it was found that the alternate minima of light was unequal, and that the true period should be reckoned as 5h. 16m., two equal maxima and two unequal minima being included within that space of time (*Fig.* 5). The variation appears to be continuous, without sensible pause, which precludes the idea that the planet is double and that the minima are due to eclipses of one body by the other. We must find some other cause. There are two which suggest themselves quite naturally—irregularity of shape and irregularity of surface brightness. For our purpose the important point is this, that either of these causes might produce an apparent oscillation in the place of the planet. To discover if this were so, I grouped the residuals in my equations of condition according to their epoch into eight columns, corresponding to successive eighths of the whole period of 5h. 16m., and took the means for each column. If there were a sensible oscillation in a period of 5h. 16m., these would lie on a sine curve. They obviously do not; there is no sensible oscillation in that period (*Fig.* 6). But notice that if we add together the 1st and 5th, the 2nd and 6th, and so on, that is to say if we search for the half period of 2h. 38m., we get quite strong evidence of periodicity (*Fig.* 7). Now the semi-amplitude of the oscillation is only 0″·03, a quantity so small that one cannot but feel doubts as to its reality. At first I was myself inclined to disbelieve; but when a new distribution of the residuals, starting from a different zero of time, gave a similar periodicity, it began to look as if there were something in it. The more I look at it, the more I believe that it is a reality; and that the photographs have shown themselves accurate enough to detect an inequality of 0″·03, corresponding to a shift of 5 miles at a distance of 25,000,000—by far the smallest inequality in the motion of a planet ever brought to light by observation.

It is this circumstance that encourages one to believe in the accuracy of the photographs. There are altogether 10,000 separate exposures of the planet which will within the next few years be measured and made available for discussion. If 300 give a P.E. of 0″·005, what will 10,000 give, added to 6,000 or 7,000 sets of visual observations? It would be going too far to apply the simple rules of probability and say a good deal less than 0″·001. But I fully believe that, if this great array of observations is ever submitted to complete discussion, the probable error of the result will not be much above 0″·001. And supposing that it should support with its greater weight the value 8″·80 which has been assailed, I believe that we should be justified in saying that the Solar Parallax *is* 8″·80, and in maintaining the proposition that the determination of the Solar Parallax is a problem of geometry and celestial surveying, and that upon the sponsors of the indirect methods lies the onus of showing cause for their disagreement.

This opens up an interesting prospect. Suppose that in course of time there should come to be a clear and definite agreement among the values found for the constant of the aberration of light, and that its value was (let us say) 20″·54, corresponding, as this table shows, to a parallax of 8″·77, not 8″·80, on the assumption at least that the velocity of light is exactly determined, as it seems to be, and that the simple theory of aberration is correct.

Relation between Solar Parallax and Constant of Aberration.

Ab.	π
20″·46	8″·808
·48	·799
·50	·790
·52	·782
·54	·773
·56	·764

And suppose that by that time we are prepared to say quite definitely that the geometrical value is not 8″·77 but 8″·80. The most obvious solution of the difficulty would be to conclude that the simple theory of aberration is not true, and to hand over the problem to the mathematical physicists, who might in the result find that a definite geometrical determination of the Solar Parallax had provided just the criterion which they required to settle certain vexed questions in dynamics.

Again, should further investigation confirm the conclusion that 8″·76 is the only value of the Solar Parallax which will reconcile the existing theory of the motion of the planet with the observed value of the constant of gravitation, it may be that the contradiction between the direct and the indirect methods will at last enable the dynamical astronomers to lay a finger upon that flaw which exists somewhere or other in the theory, and makes it impossible to say at the present time that all the motions of the solar system can be completely explained.

I have ventured to point out that the determination of the Solar Parallax is a problem of wide interest, since it throws upon so many different people the task of keeping up their particular end against an attack whose accuracy is gradually becoming more and more deadly. The dimensions of the Earth, as obtained by geodetic operations, are necessarily beyond the reach of any criticism derived from Solar Parallax results.

Equatorial Radius of Earth.

	Miles.
Méchain and Delambre, 1799	3961·74
Airy, 1830	3962·82
Everest, 1830	3962·67
Bessel, 1841	3962·76
Clarke, 1858	3963·31
„ 1866	3963·28
„ 1878	3963·37
„ 1880	3963·29

Extreme range of these determinations is only 1½ in 4,000.

But it is interesting to speculate whether astronomers will ever be in the position to say:—"We have now determined the Solar Parallax in seconds of arc to a higher degree of accuracy than that of the measurement of the Earth," and to call upon geodesists for better results. I can conceive only one direction in which we may be able to worry the successors in your Corps of Everest and Clarke. Is the form of the equator a circle or an ellipse? I believe that there is some slight evidence for ellipticity, and that it has been put as high as one in three thousand. If that is so, it is just barely possible that we may have to introduce into the computation of the parallax factors for different observatories a term depending upon the shape of the equator. But I confess that this prospect is remote, and that for many years in all probability geodesists, who achieve accuracies of one in a hundred thousand and even talk of one in a million, will be able to take a serene view of the labours of astronomers to arrive at the distance of the Sun to one part in ten thousand.

*RAILWAYS IN WAR.**

By Bt.-Lieut.-Colonel Sir E. Percy C. Girouard, K.C.M.G., D.S.O., R.E.

It will, I fear, be a somewhat difficult task for me to avoid treading old and perhaps familiar paths. So much has been written and published upon the use of railways in war, in these last few years. South Africa and the Far East would alone seem to have exhausted the subject. I trust, however, to be forgiven for any repetitions of former experience in the few new lights or ideas which it has been my endeavour to produce. To give any general review of the use of railways in war would both tax the reader's patience and entail a strain upon his appetite which I do not intend to inflict.

I have sought in this paper to emphasise a few of the guiding principles of the use of railways in war, and also to bring forward some new ideas on railway policy in our Colonial expansion and on the application of railways to siege attack.

The general principles which I propose to dwell upon are:—

(1). The organization most suited to insure the best results in war from the railways of one's own country, be they State or privately owned and worked.
(2). The working of railways in an enemy's country.
(3). The repairs or destruction of railways.

The reports of the work carried out on the railways during the late war in South Africa give the results of much experience and, may I say it, of hard work and loyal co-operation. That the reports sent home could not have been published *in extenso*, in the words of their authors and over their own signatures, is a matter of regret. Those of us who were more particularly engaged on that railway work must, however, be grateful for the excellent manner in which a *Detailed History of the Railways in the South African War* has been published by our Institute through the public spirit and generosity of its members. Whilst not forgetting the original authors, we owe our thanks to Capt. H. L. Pritchard, D.S.O., who collected and edited the reports in South Africa, to Major S. L. Craster, who expended much time and labour in abridging and rearranging them at the War Office, when it was supposed that they would be printed officially at the

* Lecture delivered at the Royal Engineers Institute on 23rd March, 1905.

public expense, and to Major A. T. Moore, who eventually saw them through the press on behalf of the Institute.

In South Africa it was our duty

(1). To control and repair railways in a friendly country, with a friendly staff.
(2). To seize, repair and work railways in the enemy's country.
(3). In a minor degree, to construct new railways for war purposes.

MILITARY CONTROL OF RAILWAYS.

The first duty was that of controlling existing railways. To what degree will it be necessary? In war, how much or how little shall we exercise control? The reply on one very important matter is clear and trenchant—The experience of Continental wars and of South Africa definitely shows that the technical working "should not and must not be interfered with." The experience of these same wars shows just as conclusively that all railways within the sphere of operations, nay, within the country, must be under a distinct military control,—a control intended to assist in their working under war conditions, not to impede. The German and French Governments consider this control to have paramount influence upon the success of operations. Their regulations are exact and detailed. To the efficiency of these regulations must, in a large measure, be assigned the great success of the German arms in 1870-71; and to their inefficiency much of the French failure. In this regard the book by Jacqmin, "*Les Chemins de Fer pendant la Guerre de* 1870" contains much food for reflection.

Now what is to be the control? Simply this;—The army generally must not in war deal directly with the technical staff of railways, be they military or civil. There must be an intermediary staff, not to control locomotives or engineering, telegraphs or refreshments, but to convey to the operating or Traffic Staff the wishes of the General Staff of the Army.

The obvious method to meet this requirement is to parallel, so far as may be necessary, the traffic staff of the railways with a military controlling staff, General Manager, Chief Traffic Manager, Line Superintendents, Traffic Managers, Traffic Inspectors, Station Masters. This is carried out under Continental arrangements. It was applied under the Director of Railways in South Africa. Here were found Assistant Directors in touch with General Managers of civil or military worked systems; Deputy Assistants working with Traffic Managers; Railway Staff Officers with Traffic Inspectors or Station Masters. Their functions were frequently misunderstood by the army generally. Why not deal with the railway officials direct? The answer is to be found in the French experience of 1870-71 detailed by Jacqmin;—Orders and counter-orders were given direct to the civil staff by the

General Staff, the Administrative Staff, Departments, and even the Minister of War; chaos and confusion ensued on all the Eastern lines; when the Prussians occupied Metz they found over 5,000 waggons, loaded and empty, inextricably mixed, and forming a complete block.

What would have been the condition in South Africa without a controlling staff, when our general staff methods were not always too clear, I must largely leave to the imagination of the reader of the French reports of 1870-71. There was in South Africa no general failure on the part of the railways to meet the requirements of the army. Partial failures did occur.

In South Africa complete controlling staffs existed (*a*) in the Cape Colony, dealing with their state-managed lines, and (*b*) in the two conquered states, where they dealt with the technical staff of the military railways, whose organization was in every way similar to that in the Cape. In Natal alone there was only partial military control of the state lines. The reasons for this difference I may not discuss. Fortunately, the partial control did not affect the general efficiency. That it was a mistake and might have been a grave one, when I presume it would have been rectified, must be admitted.

I have heard it said:—"Why all this controlling staff, these tiresome Railway Staff Officers, when we in Natal found the civil staff so easy to work with?" The Natal problem was fortunately a simple one. By February, 1900, the enemy had been driven out, and thereafter the troops stationed on these lines were few, the attacks of the enemy upon the lines rare, some 12 or 15 in two years; the Natal railways then became a line of supply only.

On the Cape side, throughout the war, troops were moving in all directions; columns crossed and recrossed the lines, pursuing the enemy; entraining for military operations was the order of the day in every direction and at points a thousand miles apart. To add to the difficulties the lines were blown up or attacked 300 times in 365 days. A fleet of 20 armoured trains cruised in various directions; originally piratical in their attacks upon the efficiency and capacity of the lines, by close co-ordination with the controlling staff they became an assistance rather than a hindrance to traffic efficiency. There were also specials of a permanent nature for senior officers; and a vast array of hospital trains, the Medical Officers in charge of which reasonably enough asked for precedence, but could not understand delay. Finally, cessation of night running for months. And there was another element which seriously affected the capacity of the lines—the demands of the civil population. On the Cape side, the Commander-in-Chief exercised, and rightly so, complete control. In Natal this was not the case; it cannot be said that advantage was taken of this, but it must have been a sore trial to carry military stores if at any time civil stores were on hand to go forward. The civil supplies paid three and four times the amount of rail carriage.

Throughout the war a staff of at times nearly 300 officers and men worked at the problem of so controlling all the elements against efficiency as to keep the lines up to their greatest capacity. They carried out their duties under very great disadvantages as to training and numbers. They were not always successful, nor invariably praised, but they saw the war through without serious interruptions. Looking back on their strenuous efforts, thinking what a failure of supply would have meant at a time when there were already quite enough difficulties and disasters, one can only regret that their efforts were not more fully appreciated. The success of the supply of the army depended upon them as a whole more than upon the technical staffs they co-operated with, who, though quite capable under ordinary circumstances of meeting the demands of a very large civil population, were by the nature of their training totally unfitted to satisfy military requirements and exigencies.*

I do not think it necessary to use any further arguments as to the necessity of a controlling staff in war. There may be few countries in which we will require it, as ordinary expeditionary railways can

* The lecturer at this point detailed a few of the many cases of interference with railway working in South Africa; these are amusing enough to look back upon, but at the time they afforded great annoyance and delay.

Shortly after the Natal line had been opened through to Pretoria, and at a time when the quick despatch of every truck load of supplies was of vital necessity, the Director of Railways was informed that the line had ceased working. On inquiry by telegraph, the block was found to have occurred at Standerton, where the engines had become stalled owing to lack of coal. There was ample coal available in a large stack; but on the civil staff attempting to remove it, they were informed that this could not be done as it formed "*the base of a military post connected with the defences.*"

The Delagoa Bay through line was at another period almost completely hung up under extraordinary circumstances. A large mob of cattle was driven in by our Columns and handed over to a Commanding Officer on the line of communications, with orders to send them on to Pretoria, some 80 miles away. The railway could not transport them, and the officer in question had no mounted troops at his disposal; an *impasse* thus appeared inevitable, when the happy inspiration occurred of escorting the cattle by armoured train. (Such trains were at that time outside the control of the Director of Railways). The result was inevitable; *the cattle moved at two miles an hour, so did the armoured train, and the railway in its entire length became blocked.*

South of Bloemfontein the mail train was found to lose time constantly at a certain station. On inquiry it was found that the delay was caused by the Commanding Officer attaching a four-wheel horse box to the train (a procedure entirely against the railway regulations) and proceeding with his horse to a point some ten miles south, where the train was stopped, the animal jumped out, and *horse and master took their evening exercise.*

usually, by the smallness of their problem, look after themselves. In India, the appointment of Bt.-Lieut.-Colonel H. C. Nanton, R.E., who has had much experience of controlling work, as Assist. Quartermaster General, Railways (Mobilization), would indicate the adoption in that country of the most modern ideas in the use of railways.

There remains to be considered our own home question. At present we have an Army Railway Council and a Railway Volunteer Staff Corps. Both are mainly composed of the general managers of the great railways, who have been granted Lieut.-Colonel's or Colonel's rank. The great advantage of these organizations as general advisory bodies is undoubted.

But no general or detail regulations for the use of the English railways in case of invasion have been issued. The contingency of raid or invasion may be a very remote one, but it cannot be neglected. It is usually argued that our railways have such a vast capacity for carriage that they will have no difficulties whatever in meeting all requirements. I do not for one moment doubt this under ordinary conditions, but war and invasion will produce entirely different circumstances. The French railways, by no means inefficient, were, before a single Prussian had crossed the frontier, thrown into very great confusion by the multiplicity of orders they received; and by the time Sedan had capitulated they had become hopelessly blocked.

Imagine an enemy landed on our East coast, and making a rush to destroy the midland factories, on which our navy might largely depend, breaking all communications as they advanced. Orders and counter-orders would arise in every direction to increase the confusion to chaos, unless the railways had a definite military staff, possessing some knowledge of the railway systems, to which they could appeal. It is one matter to transport a bank holiday crowd of even 80,000 people, who take tickets and are subject to railway bye-laws; to handle, equip, and supply the vast number of brigades which might be mobilized in case of invasion would be quite another thing.

In France, dealing with a regular army and a supposedly efficient staff, the results were only too patent. In England the position would be infinitely worse. We would have to depend upon partly trained citizen soldiers and staffs; and in such a case, of how much value would the Army Railway Council be? The General Managers could not in war attend to its business as well as to their own. Certainly they would take the orders of its military members, the president of which, I presume, would become a Director of Railways; but in the absence of a controlling staff, who had studied in peace the various systems under this Director of Railways, and in war assisted the technical staffs and protected them, I must humbly contend that the General Managers would be quite impotent in their endeavours to carry out the orders of such a Director of Railways.

Assuming such a contingency of invasion or raid, it is my firm opinion that, if it could be carried out even partially, the railways of England would be thrown into hopeless confusion in a very short space of time.

WORKING OF RAILWAYS IN ENEMY'S COUNTRY.

So much for the controlling of railways. Now a few words on the working of railways in an enemy's country, that is railways seized from the enemy.

They may be connected with lines under British control, as was the case in South Africa, or they may be distinct systems. The question as to how they are to be worked will depend upon how their staff behaves, *i.e.*, whether they can be trusted. If they can be trusted, as was largely the case in the Orange River Colony, take them over; if hostile, replace them at once, as we did with the officials of the Netherlands Railway.

If the systems taken over are small, and contiguous to important British lines, add them to the latter, and introduce a controlling staff. If they are large systems with central organization and contiguous, organize a new technical staff from General Manager downwards; the contiguous British lines will always assist, and a reasonable reserve kept up on the British or Colonial railways, or the army itself, will provide the remainder. By adopting this system, the working will be more directly under military control, and political difficulties will be avoided.

Lines seized as distinct systems present other difficulties; the staff, though not openly hostile, may be unsympathetic. Where practicable, replace them and give to the whole a new technical staff for the period of the war. Here more than ever is required an efficient controlling staff; possibly even knowledge of a foreign language may be essential to secure the best results in working. Certainly a portion of it should have studied the capacity and details of the particular lines in peace.

REPAIR AND DESTRUCTION OF RAILWAYS.

Successful reconstruction is a question of good staff organization in peace and ample staff and materials in war. The nucleus staff in peace may be very small, but it must know:—

1st. Where its additional staff will come from in war.
2nd. What is the nature of the railways it is to reconstruct.
3rd. Where the materials are to be obtained.

Reconstruction generally should be on simple lines. Complicated stores kept up in peace are therefore unnecessary.

Three great impediments may be encountered, singly or in combination :—

(1). The wholesale destruction of permanent way.
(2). The wholesale destruction of bridges.
(3). The destruction or removal of rolling stock.

The first and third call for good reserves of rails and sleepers and of rolling stock respectively, or better still the knowledge of where they are to be found.

The second will resolve itself into the nature of the obstacles to be overcome. In South Africa fortunately the rivers, with few exceptions, carried but little water; their beds being often 60 feet below the level of the destroyed structure, it became a matter of deviations, with small bridges on piers constructed of rails and sleepers. When the rivers are deep and the volume of water considerable, great delay must ensue. If the beds are suited to pile driving, this form of bridge building, combined with deviations on sharp gradients, would appear the most expeditious. With hard bottoms will come the greatest delay, and then recourse must be had to concrete in bags. It is hoped that the Corps may be afforded opportunities in peace of practising, to some extent, upon these types of structure.

Finally, the destruction of railways. One method, and in most cases the most important, is that of blowing up every rail joint over long stretches of line. This is more or less effective in causing delay, according as to whether important structures (such as bridges and tunnels) can be easily turned.

In South Africa there were no tunnels of any importance, and the nature of the rivers did not make the bridge deviations as serious as might have been the case. If, on arrival at Bloemfontein, we had found the permanent way destroyed right down to Norvals Pont, it seems probable that a retirement of our entire army might have been necessary. Or if the enemy, in retiring north, had blown up every second rail joint from Dundee and from Bloemfontein, a rapid advance on our part would have become an impossibility. Between the 3rd May and 9th June, 1900, nearly 180 miles of reconstruction were completed north of Bloemfontein, involving the repair or deviation of 50 bridges but not more than three miles relaying of line. Had this entire 180 miles been destroyed, a very serious delay would have ensued. Fortunately 300 miles of new rails were available; but under such conditions as a continuous destruction, the opening for traffic earlier than November of this 180 miles to the Vaal river would have been a cause for sincere congratulation. This is the simplest and best form of effective destruction, where the line is not likely to be required by the destroyer or where an advancing force can effect it in rear of their opponents, an occurrence of a somewhat unlikely nature.

In South Africa, the enemy was profuse in the use of dynamite—unnecessarily so. The bridges have to be rebuilt and paid for. Where deviations are possible the destruction of two spans and their piers is quite sufficient. Tunnels in rock should be left severely alone, though the blowing in of their portals, if driven through earth, will lead to some delay. Water supplies should be destroyed in the most thorough manner.

RAILWAYS AS AN ALTERNATIVE TO WAR.

There remains to draw attention to what is, perhaps, a somewhat new line of thought in the connection between railways and war. I have been dilating upon the use of railways during military operations; may I now ask consideration of their use as preventatives or minimisers of certain classes of such encounters.

There is little doubt that railways would in many cases obviate some descriptions of warfare only too well known to the British army—wars necessary for, or concomitants of, our Imperial expansion. There are some of our fellow subjects who doubt the wisdom of this expansion, past and present; but the *pros* and *cons* of Colonial policy do not come within the scope of this paper. The Empire has been and is committed to extension in many directions. Too often it would appear that such extensions have been carried out over several years of gallant but fruitless operations, entailing vast expenditure, when the pacification and establishment of order would have been more economically and permanently secured by the construction of a railway.

For instance, it is probable that the Soudan would never have been lost to us if the Nile Valley railway, originated in the seventies, had then been carried to Khartoum, instead of being left derelict as it was in a rock cutting some 60 miles south of Wady Halfa. Had this line been completed at its inception, the millions of expenditure of 1885 and subsequent years would probably have been unnecessary. To Lord Kitchener is due the entire credit of realising that the retention of the country and the success of a campaign would depend upon rail communication. The campaign of 1896–98 was the building of a railway with attendant military operations, rather than military operations with an attendant railway. The condition of the Soudan since 1898 is the proof of the wisdom of Lord Kitchener's policy. For such countries let the operations be those necessary to push a railway through and protect it; the cupidity of mankind will do the rest; trade will settle the country.

An example of the opposite treatment has been before our eyes for the last three years in Somaliland. To-day, after many gallant but, it must be acknowledged, somewhat fruitless attempts, are we much nearer our goal? The millions spent have been swallowed in the sands of the Haud, marked by the bleaching bones of camels and the unknown graves of Imperial soldiers. The £4,000,000 thus spent might have been devoted to railways and attendant operations, and to-day would be represented by a railway from Berbera to Khartoum, with a branch to Abyssinia, and the ultimate easy pacification and development of the country. In our West and East African possessions also, and in German South-West Africa, will be found the same want of appreciation of the real solution of the difficulty.

A railway is not to be looked upon as a universal panacea for all evils. But if we look back though the history of North, West, South-East, or North-East Africa, and place to the debit side of the account the huge sums spent in the Kaffir, Abyssinian, Egypt (1885), Ashanti and West African (since 1896), Central African, Rhodesian and Somaliland wars, we find a vast expenditure that would have fully provided sufficient funds to pacify the countries and develop their resources by pacific means. The Soudan campaign alone was carried out upon such lines, and left in its wake an asset in the form of 760 miles of railway which has enabled us to retain, develop and civilize the entire basin of the Nile.

The construction of lines for such purposes as the above should usually be undertaken in times of peace, in which case the design may be fairly left to those best fitted to judge of local requirements. Where they form part of an expedition depending upon the railway, as was the case in the Soudan, the constructors must have entirely different ideals. The main considerations must then be :—

(1). Rapidity of construction.
(2). Capacity to meet unusual strain.

In such work it will be found that the main difficulties are :—

(1). Staff.
(2). Maintenance of rolling stock.

To meet these you require a line worked by as small a staff as possible, and therefore by as few trains as possible. By having few trains you reduce the maintenance of rolling stock; your engine drivers, upon whom everything may depend, will be fewer in number and, it may be hoped, of a higher average of capacity. There is no use talking of long lengths of narrow gauge, with large numbers of trains and frequent stopping places; the staff will defeat you. In war, where a day's delay may mean a general expenditure of thousands, run no chances that the railway, if depended upon for communications, may be the cause. You require heavy engines and high capacity waggons,—little else will matter; if anything can, these will ensure the success of the line and the meeting of all army requirements, with a large factor of safety, and that factor one must have.

Where the gauge is not predetermined by existing lines, boldly adopt a reasonable one; remember that you can always obtain 4′ 8½″ gauge stock at any time, and by arrangement with India and the Colonies it would seem possible to inaugurate a reserve of mètre or 3′ 6″ stock. The mètre I cannot favour, the stock at present being much behind the times; but the 3′ 6″ of South Africa and Japan shows engines quite equal in power to many on the Indian 5′ 6″ and rolling stock of very high capacity. Why should we be afraid of these larger gauges? Curvature is no obstacle in most countries. In the Royal Arsenal you will see 4′ 8½″ gauge stock careering round curves of 250 ft. radius; in Natal, on 60-lb. rails, ten-coupled engines working round curves of 330 ft. radius combined with grades of $\frac{1}{30}$. This will meet your wants anywhere that you are ever likely to require war railways constructed in war.

Summing up this phase of railways, not so much for war, but intended to obviate or minimise it:—

It would seem desirable in developing new or savage countries, which also require pacification or the maintenance of order, to inaugurate a policy of railway construction. Where this development necessitates immediate operations, build your lines of high capacity as to train power. If the operations can be made subservient to the progress of the railway, adopt such a gauge as will ensure the slow pacification and occupation of the country, and provide for the future development of its resources.

The foregoing is not of universal application to war; it forms but a distinct characteristic of the requirements of an Empire developing like our own. Other nations in a lesser degree may find it applicable in Africa or elsewhere, but not in such a large number of instances as are certain to arise in our future progress.

RAILWAYS FOR SIEGE ATTACK.

The last application of railways to war, which I should like to bring to notice, is of a different nature altogether. It is not a question of finding means of transport for supplies or men, but the possible use of railways for siege attack. Siege operations have been rather at a discount for some years past. There are not many of us, but I feel sure there are some, who can remember a time when these were very much before the minds of officers of our Corps; they were then considered a very necessary part of our training as Royal Engineers. First and second artillery positions, the sap roller and the crowning of the covered way, seem to have sunk almost into oblivion, no doubt because sieges were not imminent. Port Arthur has, however, brought about a change, and once more we find that siege attack is about to become a pregnant question.

Consider any of the numerous great fortified Continental centres, which may occur to your minds, perhaps even be familiar to the eye.

Would it be possible to undertake the attack of such places without railways to provide you with *matériel* and *personnel?* As a matter of fact railways run through practically one and all of them. Having your railway, why use as your battering force guns mounted on wheeled carriages? or why with infinite labour, as our allies have done at Port Arthur, construct narrow gauge railways to bring up the gun, the carriage, and the accessories of huge howitzers, which are then planted in one particular spot soon to be known to the enemy. It would appear to me much more reasonable to make these guns travel, and, as far as possible, fire from railway carriages of the ordinary gauge which is supplying you from your base.

Many objections will at once arise. Firstly, can the gun be thus fired? and what gun? In 1891 I had the pleasure of giving a lecture at the Royal United Service Institution upon the use of "Railways for Coast Defence." I had not much knowledge then, nor had anyone, of what could be done with guns on railway carriages. In the Royal Arsenal one could see guns, up to the 16.25 inch, firing daily in the direction of the line. On the question being submitted to Colonel Kensington, R.A., he gave as his opinion, after much consideration, that a 6-inch B.L. gun could be fired at right angles to a 4′ 8½″ gauge line, provided that girders were run out as in the case of cranes. It must be very satisfactory to Colonel Kensington to know that his theory has since been amply proved by practical experiment; at the time it was enunciated the average garrison gunner would not have granted it much support.

The South African War at one time threatened to produce a siege, that of Pretoria, where fairly modern forts with modern armaments were known to exist. At the same time the enemy at Modder River were giving us some trouble with their heavy artillery. The navy came to our rescue with heavy B.L. guns mounted on wheels. With a view to trying the use of the railway itself, it was pointed out that the railway department had both the shops and the goodwill to mount heavy guns if required. This offer was approved, and in a few weeks the two heaviest siege guns ever seen in the field were made ready. The carriages, designed by the combined wit of the machinery officers and the Chief Loco. Superintendent of the Cape Government Railway, were most creditable achievements, old engine and tender frames being utilised as a foundation. The guns mounted were a 6-inch B.L. and no less a monster than a 9.2-inch B.L. The 6-inch went into action at Modder River. It was deemed unsafe to fire it at an angle of more than 16° to either side of the centre line of the railway; but by placing it on a so-called firing curve a wider field of fire was secured. The gun behaved exceedingly well in every way; and later on it was fired at right angles to the railway, without any damage either to itself or to the line, which was of a 3′ 6″ gauge. The 9.2-inch gun was never in actual action, but it had ample practice and behaved well; if it had been necessary to use it against the 100-pr. guns of the Pretoria forts, for which purpose it could have been brought within range without constructing any new lines, there is little doubt that it would have given a good account of itself.

To return to our Continental fortress (I have one in my mind; a series of modern works surrounds a vitally important centre, which is approached by many lines of railway; the forts are often inconspicuous, largely armed with 6-inch guns, some behind steel or in cupolas). Proceed to attack any side of it. First your communication railways must be intact, a necessity in any case for ordinary siege attack. Proceed then to construct your first artillery position, involving primarily 20 miles of railway of the same gauge; heavy grades and sharp curves there may be, but on no side of the fortress is the task impossible; at most, three weeks should suffice for the construction of the base line of your first and last artillery position. Now come your guns, which can be anything up to the limit of what the bridges can stand, even the 12-inch B.L. if necessary; they can travel on main lines at the speed of ordinary trains. Your base line of railway will, of course, have been traced to secure good artillery positions. For the use of the heavy guns you may have to put down turntables, if you wish them to deal with more than one fort at a time; if not, ordinary curves will do. From the fire of the armament which exists to-day in all European land defences, such siege guns would be perfectly safe, in fact they would be out of range.

It is a fascinating study to take contoured maps, which are freely obtainable, and trace series of such proposed artillery positions. They are often of an almost ideal nature. And if you can further this study by actual visit to the ground, you will, I submit, be confirmed in the view that this form of siege artillery attack must be the system of the future.

ORGANISATION OF ENGINEERS FOR AN INFANTRY DIVISION.

By Major A. L. Schreiber, d.s.o., R.E.

It is noticed that, in the few articles which have been published recently, all writers have agreed that at present the Field Company is insufficiently mobile, and each has suggested some means of progression for the sapper other than his own feet. With these opinions as to mobility I am somewhat at variance.

Most Engineers, who have served in the "Field," will probably agree generally with the proposals of Lieut.-Colonel Roper (in the April number of the *R.E. Journal*) for the organisation of the Engineers in an Infantry Division.

It is merely thought, however, that the items of his summary of the present organisation should be put in a different order of importance. First should come : "The C.R.E. does not form part of the Divisional Staff." Strictly speaking, this cannot be called a shortcoming "at present," as there is now no C.R.E. at all with a Division ; yet we may express a hope that the previous arrangement will be reverted to.

I do not propose to deal now with the remaining items of the summary (with which I am generally in accord) other than the statement—"The company is not sufficiently mobile." This item, to my mind, should be placed last in importance. It could be understood if it referred to the fact that in many Divisions in South Africa a large and miscellaneous sort of Field Park was tacked on to the Field Company, rendering its transport cumbrous and unweildy. Since it refers to the *personnel,* its importance appears considerably overrated.

Mobility is a rather difficult question to discuss, as it must lead to a comparison between the tasks to be performed by the Engineers and by Infantry.

Taking the question generally, there is of course no doubt that the man who can be brought fresh to his job—whatever that may be, whether storming a position or digging a shelter trench—is infinitely more valuable than one who is already tired. Then comes the test of *morale,* courage, endurance, grit—whatever you like to call it.

No one can fail to be impressed with the superiority of a mounted force over a dismounted. Under many conditions this might even be put as ten to one. I believe that a Column of 1,000 good mounted men could, in South Africa, have harried, worried and rendered useless for all strategical purposes a whole Infantry Division with its squadron, field guns and cow guns thrown in. All that, however, is somewhat apart from the question under discussion. We are dealing with Engineers who have to serve with a force that marches on its feet.

Of course nothing would be nicer than to provide men with vehicles; but are they necessary? I have felt the greatest sympathy with the sapper, whom I once heard express his strong preference for a "third-class ride over a first-class walk," while bumping over the rough veldt on a springless buck wagon. But when we deal with warfare it is not a question of sympathy so much as one of necessity.

We may be inclined to look at our own mobility from too narrow a standpoint. Could not an infantry officer put forward the strongest reasons for means of conveyance on behalf of *his* men?

There is no doubt also that up to date our infantry have been unduly spared when the need for temporary defences has arisen. In future they must dig more than they have ever done before, and this is what the British soldier hates, be he infantryman or sapper. The main initial cause of the Majuba fiasco—the lack of temporary defences, due to the idea of sparing tired men—was probably at the root of several disasters that actually occurred in the late war in South Africa, and might well have produced hundreds of others.

It was hard enough on mounted men when, towards the end of the war, picquets were very rightly compelled to dig defences even for one night's halt. How much harder work therefore would be the lot of infantry, if they really took every precaution when in touch with a determined enemy.

On the line of march there is not much skilled work required of the Engineers; it is when a force is halted that their chief utility and technical skill are exhibited.

It may, however, be stated as an axiom that the sapper should march as light as possible, as all his strength *may* be required at any moment for manual labour. He should only take his arms and ammunition; his greatcoat, and rations even, should be carried for him. For this purpose each Section of a Field Company should have a light two-wheeled cart—Maltese, Scotch, or any other light pattern—to go with the "first line" and be always with the men. It is regretted that in the new *War Establishments* none of these very useful vehicles have been added, although the transport of a Field Company has been otherwise increased.

Another important point, so often neglected by the Staff, is that the Field Company should always be well to the front on the line of march. This point is mentioned in some notes, recently circulated, on the organisation of the Japanese army.

When talking of mobility, it must be remembered that a dismounted party may be slow, but it is fairly sure and handy. Vehicles, whether drawn by horses or mules, or mechanically driven, are subject to many hindrances. The animals may die, the petrol may run short, or there may be merely a block on the road. Any transport officer can realize from experience the full meaning of the latter! How many times has the man on foot reached camp hours before the weary, cursing, broken-down transport—even of the "first line"—crawled in in the dark!

I put horses out of the question. We shall not get sufficient skilled workmen who can be trained to become moderate horsemen, and much less so moderate horsemen who are capable of becoming skilled workmen. It is true that there ought to be no reason why a skilled man of any trade should not be taught in a few months to sit on a quiet horse or pony going at a moderate pace. I cannot, however, help feeling that if our Field Companies were mounted they would deteriorate in technical skill.

The system may be carried out successfully with a small technical unit such as a Field Troop, but it would be impracticable with a larger body. In some ways and for some reason never yet discovered the horse has a peculiarly deteriorating effect on many men; it has a tendency to attract them away from their normal peaceful vocations! I have seen even non-combatants, when mounted and with feathers in their hats, appear the most truculent swashbucklers of the whole force.

Moreover, we must not omit to consider the additional animal rations, and consequently transport also, that any system of carrying men, whether riding or on wagons, would involve. Horse rations weigh about six times those of men's; they soon mount up, and any addition requires strong arguments to be justified.

The very important factor of the supply of animals themselves need only be mentioned.

Finally it is contended that, as far as I can discover, a Field Company has not yet been known to fail in mobility, and the only requirement is that all its men should march "light."

*LANDING OPERATIONS AT THE ESSEX MANŒUVRES, 1904.**

THE total numbers landed were :—11,600 men, 2,700 horses, 61 guns and 315 wagons. These represented two Infantry Divisions, comprising :—

16 battalions of Infantry,
6 batteries of Field Artillery,
2 field companies of Engineers,
1 pontoon troop of Engineers,
1 telegraph section of Engineers,
2 companies of Mounted Infantry and Cyclists,
2 squadrons of Cavalry,

and a small Cavalry force of :—

1 regiment of Cavalry.
1 battery of Horse Artillery.

The whole force was embarked at Southampton in ten transports; and steamed to the Essex coast in two divisions, each escorted by three cruisers.

The 1st Division disembarked at Little Holland and the 2nd Division at Clacton-on-Sea, the Cavalry force being distributed between them.

DEBARKATION OF 1ST DIVISION AT LITTLE HOLLAND.

By BT.-LIEUT.-COLONEL G. M. HEATH, D.S.O., R.E.

The point selected for the landing consisted of a cliff-bound shore. The beach had a slight slope which gradually flattened out below low-water mark; in consequence boats could not be brought close in at low tide. The cliffs were about 30 feet high, of sand; there was only one road up them, and this was steep, soft and unsuitable for heavy traffic.

On the first day of landing, 7th September, the sea was smooth and the conditions generally favourable. The five transports containing the 1st Division, with the three escorting cruisers, arrived in the early morning; and were anchored soon after daylight, in line, about two miles from the beach.

* Published by permission of the Army Council.

The first boats to put off contained a party of bluejackets without arms or escort. They landed on the beach at 7 a.m., and put up flags as marks to direct the various landing parties. At 8.15 a.m. steam pinnaces arrived, towing rafts and material for making landing stages, and with them about 15 armed marines. At 8.40 a.m. an infantry covering party arrived in five cutters towed by steam pinnaces; this party landed on the beach by a simple plank gangway put out from the bow of each boat.

Meanwhile the Navy were constructing landing stages for disembarking the remainder of the infantry. The first stage was completed at 9.20 a.m., and a cyclist company (the first troops to arrive after the covering party) was at once put ashore. The other stages were finished soon after, and the landing of the infantry proceeded with little interruption.

At about 10 a.m. the sappers of the Field Company, R.E., were landed with their tools and with materials for trestle or floating bridges, to improve the roads and to bridge the dykes in the neighbourhood as required.

At about this time the first loads of field guns, horses and wagons appeared. These were carried in flat-bottomed boats, usually two guns with their limbers, or two wagons, or ten horses in a boat. The boats are constructed so that the stern end can be let down to form a ramp on to the shore. The labour of unloading, which was very arduous, was provided by the Navy, assisted by fatigue parties of infantry. When the boats arrived near the shore, they dropped their anchors and ropes were taken out to them, by which the working parties on the beach hauled them in. It took seven minutes to offload one boat load of guns and clear them from the beach. It took only two and a-half minutes to unload the horses after the gangway had been let down. The first wagons to arrive were not well handled, and it took twenty minutes to half an hour to haul one float ashore and unload it.

Landing Stages.—The landing stages for infantry were three in number, corresponding to the number of cruisers. They differed somewhat in detail.

No. 1 Stage (*Figs.* 1 and 2) was a combination of a floating structure (as pierhead) and a wheeled platform, with gangways between them and to the shore. The floating part was a raft, about 6 ft. × 10 ft., provided with handrails. The wheeled platform consisted of three planks battened together, supported on two spars which were carried on a gun carriage and limber. A boat was anchored end on as shown, and the infantry had to land over this boat on to the raft. This stage took about 1 hour to build. 25 men landed from it in 1½ minutes.

No. 2 Stage (*Figs.* 3 and 4) was all floating except for a short gangway to the shore. The pierhead consisted of two rafts, each 40 ft. × 9 ft., and allowed of two boats being unloaded at once. The rafts were connected by a narrow plank gangway (all floating) to the shore. It took rather over 1 hour to build, but was more efficient than the two other patterns. 80 men landed from this in 1½ minutes.

No. 3 Stage was much the same as No. 1, that is to say a 2-ft. 6-inch gangway floating on casks, terminating with a boat anchored stern on at the off-shore end. The gangway had better buoyancy and was more stable than No. 1. 101 men were landed in 4 minutes over this stage.

RE-EMBARKATION.

There was nothing particular to note in the re-embarkation at Little Holland, and no special gear appears to have been tried as at Clacton. The steepness of the ramps formed by the hinged ends of the boats proved a severe obstacle for loaded wagons. It took 10 minutes to load two guns and two limbers into a boat and get them clear of the beach, and about the same time to load up and haul out a horse-boat.

DEBARKATION OF HORSES AT LITTLE HOLLAND.

By CAPT. C. E. G. VESEY, R.E.

All the horses landed at Little Holland were brought from the transports to the beach in flat-bottomed horse-boats, from 3 to 5 boats being towed in strings or abreast by a steam pinnace.

The boats were each capable of holding 10 horses and from 12 to 16 men with their kits, harness and saddlery; and drew about two feet of water when fully loaded. The bow and stern were square; the stern end was made in two leaves, hinged at the bottom and centre, forming a gangway or ramp when lowered. When fully loaded with 10 horses sufficient space remained in the stern for the men, kits and harness. The bottom of the boat was covered with coir matting and additional mats were carried for the gangway. Each boat carried an anchor and cable in the bow.

The steam pinnace towed the boats as far in-shore as the state of the tide permitted; the towing lines were then cast loose and each boat cast its (bow) anchor off-shore. A line was then passed to the boat by the working party on the beach and made fast to the stern, and the boat was then hauled in stern first by the beach party, the direction being maintained by means of the cable in the bow. The men's kits, harness and saddlery were first passed ashore; the gangway was then lowered and the horses led out singly.

From 5 to 10 minutes were taken to unload one boat from the time it was beached. By lashing the boats 3 or 4 abreast and towing them in this formation the work was expedited, as the whole of the boats in tow of the pinnace could be beached at the same time and unloaded simultaneously. In one instance 4 boats were towed abreast, hauled in-shore together, and the 40 horses with men, kits, etc., disembarked in 5 minutes.

Horse-boats being available there was no practical difficulty in landing horses in the perfectly calm sea which prevailed on September 7th. But the hinged stern considerably weakens a boat when lowered to form a gangway, and the boats used would probably not have stood being beached with any surf breaking on the shore.

Points requiring Attention.—In loading horse-boats the horses should be placed with heads alternately to port and starboard. This was not done in every case.

Much confusion is avoided if saddlery and harness for each horse or pair is carefully packed in saddle blankets and distinctly labelled before leaving the transport. In some units corn sacks containing one set of harness were used for this purpose.

In disembarking transport and artillery the boats containing the teams should be towed ashore at the same time and beached at the same spot as the vehicles or guns to which they belong. This avoids having to man-handle wagons and guns to any distance; if not done much confusion and crowding result, especially at night or where the beach is limited in breadth.

DEBARKATION OF 2ND DIVISION AND HORSES AT CLACTON.

By 2ND LIEUT. A. H. L. MOUNT, R.E.

INFANTRY.

The cruisers escorting the 2nd Division were the *Kent*, *Good Hope* and *Monmouth*. Each ship constructed one landing stage for infantry, the design being entrusted to the naval officers on board.

H.M.S. *Kent's* staging (*Figs.* 5 and 6) consisted of a wooden platform, 3 ft. wide, made of 12-inch × 1½-inch planks held together by cross battens, the whole supported on two naval 12-pr. gun-carriages and their limbers. Its total length was 80 ft.

The wheel base of the carriage is about 3 ft. 6 inches and the diameter of the wheels 3 ft. 9 inches. Each pair of carriages was connected by two 6-inch spars resting on frameworks of wooden blocks fixed to the axles; the necessary depth was thus obtained for the carriages at the sea end of the staging. The cross battens were nailed to the spars when the latter had been placed in position, and the boarding was then nailed down to the battens. The trails of the gun-carriages were lashed up to the spars to prevent them dragging in the sand. The axles were connected with the ordinary rope braces used for man-handling the guns.

The axle of the front gun-carriage in deep water was secured to an 8 cwt. kedge anchor, some 200 yards out, by a rope passing round a single block on the anchor ring and made fast on shore. This carriage was also secured by cables to anchors on shore; and in case of rough weather the other carriages would certainly have to be secured in like manner.

This form of staging is certainly the best, being *all* on wheels. By means of the rope round the block on the anchor it can be easily hauled out as the tide recedes.

H.M.S. *Good Hope's* staging (*Fig.* 7) consisted of a 3-ft. wooden platform of 12-inch × 1½-inch planks on 4-inch × 2-inch battens, all nailed together in lengths of 30 ft. The two shore bays were supported on two naval 12-pr. limbers; the other two bays were supported on two rafts, one of which was an ordinary temporary barrel raft and the other a naval copper punt raft. The bays were 15 ft. long, the total length including cutter being some 110 ft. The head of this staging was supported on a cross spar hung over the stern of a cutter. There were two cables, bow and stern, on each side of the cutter, made fast to anchors on shore. There were also cables on the rafts. A rope handrail was provided, being supported by wooden posts let into slots on the platform. This staging, having been previously fitted together, took 20 minutes to erect from the time the party of bluejackets (about 50 in number) landed with all the materials. 419 men were landed in 7 minutes; 273 men, with cooking utensils and other small baggage, took 11 minutes. The times varied a great deal according to the manner in which the string of boats was manipulated alongside the staging.

The apparent drawbacks to this staging were :—(1). The men had to get out of their boats into the cutter at the head; this is apt to cause confusion and delay, especially when landing the personal baggage, etc. (2). If the sea were at all rough a floating staging would be at a great disadvantage.

H.M.S. *Monmouth's* staging (*Figs.* 8 and 9). This consisted of two sections of 3-ft. wide platform, each 40 ft. long. Each section was in the form of a trussed beam, the struts being two barrels and the ties two strands of 1-inch wire cable. The central support consisted of a copper punt, and the head rested on the stern of a cutter.

A secondary idea of the barrels under the platform was to give extra buoyancy, but as it happened the stern of the cutter and the raft were too high out of the water to allow this object to be effected. The total length of the staging was about 115 ft. It was made fast to anchors on shore, and a rope handrail was provided.

It took 30 minutes to erect the stage with about 50 men. 180 men with personal baggage, etc., were landed in 20 minutes.

PONTOONS.

The pontoons were floated ashore with their carts, etc., complete underneath them; a pinnace towed 4 pontoons. The heavy anchors in the fore-carriages were put in the sterns of the boats, so as to tilt the bows up as much as possible.

To sling the pontoons from the transports to the water, cables were made fast round the axles on each side and brought together above the centre of the pontoon.

CAVALRY.

Six landing places were arranged for receiving the flat-bottomed boats. At each place an 8-cwt. kedge anchor was dropped about 350 yds. out. A single block was made fast to the ring of the anchor, and two other blocks were secured on shore by holdfasts; and a $3\frac{1}{2}$-inch endless cable, 400 fathoms long, was passed round the three (*Fig.* 10).

Four or five of these boats were towed together by steam pinnaces from the transports to the buoys of the anchors. At low tide the cables were picked up by the boats, which were then hauled in, stern first and usually in pairs, by working parties of 30 infantry. When the tide was high the water was deep enough for the pinnaces to come right into shore, and so all this hauling was avoided.

The boats, which were 35 ft. × 15 ft., each carried 10 horses and their drivers and 4 bluejackets. On the average it took 7 or 8 minutes to unload one boat. One squadron landed 60 horses and all its kit in 30 minutes, working 2 horse-boats at a time.

ARTILLERY AND TRANSPORT.

The same system was employed for landing the Artillery and the General Service wagons. Each boat carried 2 guns and 2 limbers or 2 G.S. wagons. The guns and wagons were man-handled out of the boats by drag ropes, etc.

It should be noted that when loading the boats from the transports the poles of the wagons should point to the stern of the boat. This was not always done, and time was thus lost in getting the wagon out.

RE-EMBARKATION. 13TH TO 15TH SEPTEMBER.

Infantry.—The same stages were erected again, and the procedure was simply a reversal of the debarkation.

Cavalry.—No difficulty was experienced in getting the horses into the boats, though it took rather more time than the landing.

Loading Wagons into Horse-Boats.—First Method (*Fig.* 11).—The horse-boats were towed ashore and made fast to one of the kedge anchors 250 yds. out. The wagon was then hauled aboard backwards by 4 horses pulling on a cable which was passed round a single block in the bows of the boat and made fast to the rear axle of the wagon.

After a few experiments with this method it was found not altogether satisfactory. The horses could not be made to stop pulling at precisely the right moment, and so the wagons jammed. In fact it took just as long to get them on by this method as by man-handling.

Second Method.—At subsequent high tide, when there was no room for the horses, the wagons were partially unloaded and manhandled on board; they were put in pole first, as it was easier to guide them in this way.

It was found that the tailboard or ramp sagged considerably at the hinge when under the weight of a wagon; the consequence was that the gradient up to the boat was increased.

(N.B.—Separate ramps, which appeared to be heavy and clumsy, had been brought ashore with these horse-boats; but for some reason they were never used either in landing or re-embarking).

Loading Battery of Field Artillery.—Three boats were brought up alongside each other, and 2 guns and 2 limbers were loaded into each. The guns were brought up as in *Fig.* 11, and loaded on by bluejackets; the horses being unharnessed and taken on for loading on to their own boats at the same time. One team was kept till the end loading one boat by the block and tackle method; but this method was again found to be no quicker than man-handling.

From start to clearing the beach the whole battery with its G.S. wagons and 79 horses (in 8 horse-boats) was embarked in 35 minutes.

GENERAL REMARKS.

By BT.-LIEUT.-COLONEL G. M. HEATH, D.S.O., R.E.

On the first day of landing, the first party to reach the shore consisted of an officer with a few bluejackets, unarmed, who began to arrange landing stages. A covering party did not appear until 1½ hours afterwards.

It seemed to me that the small floating landing stages would have been useless in any but quite calm water. Undoubtedly the best type was the one which was carried entirely on wheels, thus making a stable platform in anything but very rough sea.

The stages as a whole seemed to me to be too small; they were only suitable for landing infantry. But infantry could have been landed on the shelving beach more easily and much more quickly by rowing the boats, line abreast, right on to the beach, and then putting out simple plank gangways over the bows, as was done for the covering party at Little Holland. (Possibly this method would not have done for the large boats which contained 100 men, but it would have been applicable to all the cutters).

If landing stages are made at all it would seem that they should be substantial structures (say 8 feet wide) to which several boats can be brought up, alongside, at one time; and that they should also be capable of use for off-loading stores of all sorts. It would not be difficult to design a stage consisting of trestles, road-bearers and chesses, the trestles being adapted to take wheels so as to allow of the whole structure being pushed out or pulled in according to the flow of the tide.

The steepness of the hinged gangways which formed part of the flat-bottomed boats was very noticeable. A pair of troughs (say 10 feet long) to guide the wheels, clawed on to the end of the boat, would have made the embarkation and disembarkation less laborious.

The Navy took charge of landing operations up to high-water mark. Their beach party consisted of a senior officer as Beach Master, and under him officers and working parties of bluejackets. At Clacton and Little Holland there were not enough bluejackets to carry out the off-loading, and their working parties had to be supplemented by fatigue parties from the troops already landed. I was told that, in theory, the fatigue parties from the Army would not be available, as they would be required with their regiments. In practice I should think troops would always be required to help at the landing of their transport wagons.

On the first day of the landing the combination of bluejackets and soldiers was not worked to the best advantage. Want of organization was evident, and in consequence labour was wasted. For instance, at Clacton I saw about 150 men on a single rope pulling a wagon out of a boat, while other boats which were ready to be off-loaded were waiting for labour; probably 50 men would have been ample on each boat. It seemed to me that things worked much better in the re-embarkation, when I believe a senior military officer was deputed to work with the naval Beach Master. The former officer should, I think, be one with experience of handling working parties; he would then know how to distribute the available labour to the best advantage.

After the wagons were landed there was often delay in getting them away from the beach. As noticed by Capt. Vesey, guns and their horses should be (and I think generally were) landed together. Compliance with this principle in the case of transport wagons is probably impossible with the large number accompanying an invading force. The only solution would seem to be to have fatigue parties of horses told off for beach duties; the horses would park the wagons in a suitable place clear of the shore.

The method of landing and re-embarking the pontoons as described by Lieut. Mount was most satisfactory. In re-embarking care must be taken that the wagons are not driven into the sea fully horsed. This was done by the first pontoon wagons, with the result that the leaders got out of their depth and there was some difficulty in unhooking them.

The nature of the landing place at Little Holland emphasised the necessity of disembarking Engineers early in the operations. The only road up the cliff was in bad order; also a trestle bridge had to be made across a dyke to facilitate the movements of the guns; this bridge was constructed by the 7th (Field) Company, R.E., in 45 minutes.

SEARCH LIGHTS IN RECENT NIGHT OPERATIONS AT CHATHAM.

SOME very interesting operations took place at Chatham on the nights of 10th October and 21st November, 1904. The special idea resulted in attacks on Fort X. The Training Battalion, R.E., under Bt.-Colonel A. Graham Thomson, formed the defending force; whilst the attackers, under the command of Bt.-Lieut.-Colonel G. M. Heath, D.S.O., R.E., comprised the Service Battalion, R.E., the 1st Batt. Welsh Regt., the 2nd Batt. Oxfordshire Light Infantry, the 4th Batt. Rifle Brigade, and the Chatham Division of Royal Marine Light Infantry. The defenders were given two days to prepare their position, and made full use of their inventive talents in the shape of barbed wire entanglements, trip wires with flares or rockets (representing mines), etc. The most interesting lessons were in the use and effect of search lights.

REMARKS BY MAJOR F. BAYLAY, R.E.,
Instructor in Electricity, S.M.E.

So far as this report is concerned the operations on each occasion consisted of a night attack upon Fort X from the eastward. Search lights were used both with the attack and with the defence.

On each occasion the principal attack was delivered on the right (or south) flank of the Fort, under cover of the steep bank on that side. The attack made use of smoke-producing bonfires, lighted on the slope referred to, the smoke from which drifted in a northerly direction right between Attackers and Defenders, and formed a highly efficient screen so far as the search lights were concerned. This screen was particularly effective on 10th October, and was on that occasion assisted by the black powder used by some of the Attacking force. On the 21st November the strong wind blew the smoke away more rapidly, and the screen was, I believe, far less effective.

OPERATIONS ON 10TH OCTOBER.

On this date the operations lasted from 6.30 p.m. to 9.15 p.m. The night was fine, overcast, slightly hazy and dark, with a gentle breeze from the southward; quite dark at 6.30 p.m.

With the Attack was employed the Wolseley Pack Transport plant and 30-c.m. projector, the whole mounted in a G.S. (R.E.) wagon borrowed for the occasion and drawn by two pairs of horses. The projector was one of those returned from South Africa and was a General Electric Co. (U.S.A.) outfit ;—30-c.m. Mangin projector, 8° diverging lens, 10 to 15-ampère automatic horizontal lamp. This outfit has no plain glass door, but the night was so still that it was possible to use the light without the diverging lens.

The Wolseley set got into position about 1,200 yards east of Fort X, at 7.5 p.m., with instructions to dazzle the Defence as far as possible. It took 15 minutes to "get ready"; but for some reason, not ascertained, it took one hour to get the plant running; once fairly started the engine ran well until the end of the operations.

It was at once seen that the light, either with or without diverging lens, was far too weak to be of any value at that distance; and after running for about 20 minutes, the plant was moved to 400 yards from the Fort. As great difficulty had been experienced in starting the set it was considered undesirable to stop it, and with some persuasion one pair of horses was yoked in without shutting down the engine but with light switched off.

The light ran for half an hour at the second position. At this distance an observer close to the projector (diverging lens on) could just distinguish the parapet of the Fort *during the operations*. A few minutes after operations ceased the smoke cleared off and the parapet could be seen with great clearness. I am informed that the blinding effect of this light upon the Defence was negligible, and my own opinion is that the light was useless. (*Vide* General Conclusions).

I see no reason to think that the plant could not have been got into the first position in actual warfare. (See also below). When there, since it served as little better than a "beacon" so far as concerned Fort X, it might possibly have been disabled by gun fire even at that distance. During the advance to the second position, the wagon was in the (diverged) beam of the defence light nearly all the time. Those with the wagon appeared brightly illuminated to one another, but so far as I have been able to ascertain the advance was *not* observed by the Defence. Possibly the Defence may have casually observed a wagon moving in the field and have imagined it to be a farm vehicle. It seems rather impossible to think that the wagon could really have been advanced at the walk; and even if the light had been got to the second position, I fancy it could not have been operated there for long.

With the Defence was employed the Thornycroft Automobile plant and 90-c.m. Crompton projector. The projector, on its 2-wheeled vehicle, was placed outside the extreme right flank of the Fort, so as to look over the parapet of the outwork there. The projector had a 90-c.m. palladium reflector in good order and a 90-ampère automatic horizontal lamp; and arrangements had been made to fit a 30° diverging lens, which was used throughout the operations.

The Thornycroft wagon drew itself and projector vehicle from the Electrical School, but the projector vehicle had to be manhandled across the field behind the Fort. There was some difficulty in starting up the engine again; this was traced to insufficient charge in the ignition battery; once started the ignition can be, and usually is, effected by magneto. The light was started about 6.45 p.m. and ran well till 9.15 p.m., when, just at the end of operations, a bearing seized in the gear box and the engine pulled up; this laid up the engine for some days.

Owing to a hedge running across the front of the Fort at from 400 to 700 yards distance, the Defence light could not illuminate the *ground* east of these hedges, so that anything beyond them, less than about 4′ 6″ high, was not lighted up. While the Attack light party was getting into its first position from the main road it was in the beam from the Defence light. Rifle fire had only just commenced; smoke bonfires had not yet been kindled. The Attack party and wagon, from 4′ 6″ upwards, were brightly illuminated. I have however been unable to ascertain that they were observed by the Defence. The Defence light was principally used to illuminate the ground close to the front of the Fort, and for that purpose was considered to have been efficient. Assuming that the attack got to within 300 yards of this light (this was the sort of range at which it was used), I do not believe it would have been really practicable to have kept the light going. (*Vide* General Conclusions).

OPERATIONS ON 21ST NOVEMBER.

On 21st November the operations lasted from 5.30 p.m. to 8 p.m. The night was clear, full moon, brisk breeze from S.S.W. The wind freshened during the operations and the sky clouded over until, at about 8 p.m., there was a strong breeze, and at 8.15 p.m. the rain came down in torrents for half an hour or so.

The Attack had the Thornycroft Crompton set at the first position of the previous occasion; and the Wolseley plant, with 60-c.m. Siemens projector, in an advanced position about 400 yards south of the former second site and 500 from the Fort. The Defence was provided with two 60-c.m. Coast Defence type Schuckert projectors on the two flanks of the Fort, both supplied off a service 16-unit dynamo, mounted in a heavy traction engine tender behind the gorge, and belt driven by a large Fowler traction engine.

The Thornycroft plant drew its own equipment complete from the Electrical School, leaving there at 3.45 p.m., and the engine was kept running without a stop till 9.20 p.m. The engine ran quite satisfactorily. The ground in the fields was hard and dry, but it was necessary to unlimber the projector and manhandle it into position for the last 50 yards. The light was started without difficulty (time not noted), and ran very well until stopped about 8 p.m. The heavy rain storm, previously referred to, came on shortly before the projector vehicle was limbered up.

The "train" started homewards satisfactorily; but in trying to get on to a cart track, the hind wheels of the Thornycroft wagon got into a slight dip in the ground and skidded, and the procession halted. For an hour efforts were made to get clear, but without success. The heavy rain on the hard dry ground made the clay-like top surface extremely slippery, so that the driving wheels could not get sufficient grip. The weather cleared up during the night, and next morning the ground was frozen. This enabled the plant to get itself out after about 2½ hours' labour (four men). One and a-half hours of this was spent in heating up the vapouriser, a by no means easy operation with the strong cold wind blowing at the time. This incident, and the inability of the Thornycroft set to pull itself and projector vehicle into position on the previous night (and on 10th October) over a fair track with a gradient of about $\frac{1}{50}$, are worth noting as points against mechanically propelled portable plant, particularly if engine power is scanty. Mechanical transport enthusiasts will perhaps argue that the vehicle would have come out all right on the night 21st—22nd November if "so and so" had been done. As the rear axle of the Thornycroft wagon is "live," my own opinion is that the vehicle could have pulled itself out had there been available a few fathoms of 2-inch manilla rope and a 56-lb. anchor.

As the first position was 1,200 yards from Fort X, I deemed it desirable to start the light there as a concentrated beam, with its right-hand limit aligned on the northern Defence light. Allowing for three degrees divergence the beam would be about 65 yards wide at the Fort, and might, it was anticipated, have a dazzling effect upon the Defence. The upper portion of the parapet of the Fort was illuminated by this beam well enough to be fairly visible to an observer at the second position (400 yards from the Fort), but I am informed that the dazzling effect on the Defence was negligible. I was unable to return to the first position until after the cessation of operations, so the light there ran as a concentrated beam all through.

The Wolseley plant was horse drawn to its site, started up under the cover of a hollow there, and manhandled into final position. The wind was so strong on the edge of the ridge, that it was only with difficulty that the blow lamp (required for heating up vapouriser) could be got to work at all. However, as soon as the vapourizer was heated the engine started at once. Unfortunately the lamp operator (one of a class under instruction) allowed the lamp carbons to come together while the wagon was being manhandled into position, and the engine was pulled up. The cold wind cooled down the vapourizer so quickly that, before the engine could be re-started, the blow lamp had to be got going again. The engine was on its best behaviour, started again promptly, and ran well and steadily, giving about 25 to 28 ampères (rather over normal full load).

As this plant had on 10th October given too weak a beam, I decided to commence with a concentrated beam. The beam obtained with 25-ampère arc in 60-c.m. projector was very good. A high building, 1,400 yards off, could be seen very clearly by an observer alongside the projector. My intention was to use this beam to dazzle the defenders in the neighbourhood of their right light. I believe this object was in no way attained, although the distance between the opposing lights was only 500 yards. I do not believe it would have been really practicable to work this light at such close range. The gear in the wagon was so cramped that I deemed it undesirable to attempt to change to diverging lens with engine running. (*Vide* General Conclusions).

The Defence lights were each given by a 60-ampère Schuckert horizontal automatic lamp in 60-c.m. projector, fitted with 16° diverging lens. They worked admirably as it happened; but had the rain come on sooner, there would certainly have been trouble with the belt drive between engine and dynamo.

Both Defence lights were principally, if not entirely, used for short range work (about 300 yards), and for that purpose were considered to have been efficient. I do not believe it would have been possible to keep these lights going if the Attack had got within that range. (*Vide* General Conclusions).

GENERAL CONCLUSIONS.

I was unable to attend the conference after the operations of 10th October, and have not heard what comments, if any, were then made about the search lights. At the meeting on the morning of 22nd November opinions were expressed that the Defence lights had been very useful in lighting up the Attacking forces; but that the Attack lights were valueless to the Attack and their beams at times served as an illuminated background against which the Attackers stood out and were then visible to the Defence. The Attack lights were considered not to have been used to the best advantage, the advanced light being handled in a particularly eccentric manner.

I believe it was thought that the Attack lights would have been better employed had they been placed on the flanks of the Attack, and arrangements made to throw their beams across the front of the Defence, so as to form a brightly illuminated screen behind which the Attackers could operate. Having regard to the formation of the ground and to the short distance between the Defence and the Attack working parties, I do not think it would have been possible to use the Attack lights in that manner; although, had it been possible, the screen would, no doubt, have been effective, particularly as the driving smoke would have given "body" to the screen. As an alternative, it has been suggested that the Attack lights would have been more effective had they been kept flashing backwards and forwards across the front of the Defence; if this had been done, it would not have much mattered if the Attackers had been momentarily lighted up by their own lights. I think this is a more practical suggestion than the other.

For the Defence, search lights are of undoubted utility. With a concentrated beam it may be possible for trained observers to detect movements of troops at considerable distances, say 1,000 to 1,500 yards; and from these distances it is believed to be difficult to hit the projector. It is however at the short ranges that Defence lights are likely to be of most value. For short ranges a diverged beam gives a sufficiently intense light, and for that purpose a parabola ellipse reflector would seem preferable to paraboloid reflector and diverging lens; the former would render practicable, for such positions as Fort X, the use of bullet-proof protection for projector and reflector, without absolutely preventing the beam from being traversed. I believe some such protection would be essential for a light operated at short ranges.

The utility of search lights for the Attack is less obvious. Unless the Attack is so deliberate that appliances similar to those used by the Defence can be employed, it is probable that Attack lights must always be used at relatively long ranges; hence concentrated beams are required. A concentrated beam is a cone of light rays with a divergence of about 3 degrees. When operating over flat country, like that to the east of Fort X, it is only practicable to usefully employ the bottom part of the cone; otherwise the Attackers are lighted up by their own lights. This means that a comparatively small portion of the beam is usefully employed, the greater portion of it passing over the heads of the Defence. (This was noticeable on the 10th October and on 21st November; particularly so in the case of the advanced light on the latter date). This drawback would be greatly eliminated if it were possible to place the projector some 10 or 15 feet above the general ground level; failing this, Attack lights would probably only be of value when they operated over ground that was concave. Unless the section of the ground over which the beam was used were concave, a diverging lens would not help matters much, if at all, even if the Attack light got close enough to the Defence for a diverged beam to give the requisite intensity of illumination.

Although, speaking generally, such lights may be of doubtful utility for field use compared with their use for coast defence, some of the continental powers, Germany in particular, have made provision for quite a number of portable Electric Light sets for field use. Such plant to be of any value should, I consider, furnish not less than a 60-ampère light in a 60-c.m. projector.

REMARKS BY BT.-COLONEL A. GRAHAM THOMSON, R.E.

The Defence lights were, I think, sited to the best advantage to meet the existing circumstances; but their full value could not be tested owing to buildings and numerous hedges in close proximity to the line of defence, which would all have been certainly demolished in actual warfare. It must also be remembered that it is very doubtful whether Fort X itself would have been strongly held at the outset of operations; probably much more use would have been made of low relief entrenchments in advance of the Fort itself. These entrenchments would not have shown up as a mark for the enemy's artillery and would have been little damaged by it; with a cleared field of fire, and with obstacles immediately in front, they would have been most difficult and costly to assault.

Getting as close to the Defence lights as the Attackers actually did, it is doubtful whether the lights would not have been hopelessly out of action. But taking for granted that the ground in front had been cleared, it would in reality have been a much more difficult operation at night to locate the lights exactly and put them out of action. It would, however, appear that some kind of shield is required to give a certain amount of protection against shrapnel to the operators and to the lights themselves.

There is no doubt that the smoke raised by the Attack on the first occasion was most useful to them; but as the men engaged on this operation could be clearly seen at times, they would probably have all been shot down. The high wind in November dissipated the smoke to such a degree that the resulting fog was practically innocuous to the Defence.

The small search light with the Attack in October was quite useless, as it did not either dazzle the Defence or light up the ground to its disadvantage. I might mention that its position at about 400 yards was accurately found by a range-finder in the Fort, and it would no doubt have been early out of action.

The search lights with the Attack in November were, I consider, of much more advantage to the Defence than to the Attack; as on several occasions they showed up the enemy's advance and their working parties without dazzling or annoying the Defence to any appreciable extent. This was particularly noticeable where a canvas screen had been erected, the Attackers behind it being clearly silhouetted on the screen.

I am of opinion that where it is possible to use the Attack lights on the flanks, there would be the most suitable place for them. At the same time the flashing backward and forward would no doubt be disconcerting and I should like to see the effect actually tried at manœuvres.

The Defence lights shewed up the wire-cutting parties of the enemy so distinctly that their losses must have been very heavy, and their success somewhat limited.

REMARKS BY BT.-LIEUT.-COLONEL G. M. HEATH, D.S.O., R.E.

The value of search lights in Defence is obvious.

Search lights for Attack purposes can, I think, seldom be of much value in the close attack unless the configuration of the ground happens to be favourable. They must however be a great help in reconnoitring the Defender's position by showing up obstacles and works, thus to a certain extent guiding the Attacking parties.

There will always be some danger of the Attack lights showing up their own side, and for this reason they must be intelligently directed by officers who are cognisant of the proposed operations. Each light should, if possible, be in signalling or telephone communication with the officer directing the Attack. I doubt whether it would often be possible to use the lights on the flank of an Attack so as to throw a screening beam across and in advance of the Attackers.

Smoke forms an effective screen when wind and weather are favourable. The simplest way of producing the smoke seems to be by means of sandbags stuffed rather tightly with dry straw, the ends of the bags being left open and the canvas slashed here and there to allow the smoke to get out. They should be lit in the centre of the straw by pushing in a port fire. Such bags can be carried with working or covering parties and thrown to the front; they burn for about 20 minutes.

I think the whole subject of "lights" in attack and defence requires more study than it gets, also more practice.

A Search Light Company has now been organised at Aldershot. This will work tactically with the troops and much useful information should be gained.

THE ARMY SYSTEM OF CORRESPONDENCE.

By Capt. H. Musgrave, R.E.

It is unhappily no rare occurrence to hear complaints of the trouble and delay involved in conducting business in the Army through the medium of correspondence, and it is to be feared that such complaints are not always without justification. The object of these notes is to show that much of this creaking of the wheels of the military machine is due to the method of correspondence adopted, and that much good would result from the substitution of the ordinary system employed in civil life.

In the Army the usual system of official correspondence is the minuting system; in the conduct of civil business the method of separate letters and replies is adopted. In the latter system the sender of a letter takes a copy of it (if he requires one) before its despatch (employing mechanical means, such as carbon paper or a copying process, for the purpose), and the recipient guards the letter and sends a separate reply, of which he, in his turn, keeps a duplicate, both parties being thus automatically provided with a complete record of the negotiation.

Generally speaking, communication by writing is employed in lieu of verbal conversation only with one or both of the following objects;—firstly, for the immediate purpose of concluding a piece of business in spite of the impossibility of, or without the inconvenience of, or the risk of misunderstanding and oversight incident to, verbal negotiations; secondly, for the ulterior purpose of providing for future reference a permanent record of the transaction. In the humble opinion of the writer, the minuting system is, in comparison with the ordinary civil one, a far more laborious and tedious method of fulfilling the first-named purpose, and incomparably inferior as a means of accomplishing the second. Further, it is submitted that the minuting system exercises what may be termed a vicious influence, by lending itself to slipshod methods of conducting business.

To proceed first to establish the charge of inefficiency in the fulfilment of the essential objects of correspondence as defined above.

As regards the first-quoted object, viz.: the immediate purpose of concluding a question as speedily and satisfactorily as possible, the following are the principal defects of the system:—

(*a*). The facts of a case under discussion are presented to the reader in the form of a bulky collection of minutes; many of these contain much that is immaterial to the last reader; many convey no meaning except when read in conjunction with other minutes, and in exactly the proper sequence with respect to such other minutes; and, further, a large number, consisting only of such words as "passed," "forwarded," etc., furnish no information whatsoever. All this matter has to be waded through and sifted out before a clear grasp of the essential points can be obtained when first dealing with the case, and even, to some extent, when it is merely a question of refreshing the memory. If a file comes round more than once, it is often a matter of some trouble to discover what has been added to it since it was last seen.

All this demands a far greater amount of time and trouble than if the points requiring the attention of the reader were concisely stated in one clear letter without any irrelevant matter at all. In the minuting system, moreover, every person to whom a file goes has independently to go through this laborious process of wading through and mentally summarising the contents; whereas in the business system, if a fresh party has to be consulted on a case he receives a single clear statement of the necessary information, and this can be readily drafted by reference to the last letter summarising the subject matter up to date.

(*b*). Much needless mechanical labour is involved in making copies, or *précis* in registers, of minutes which have to be returned; such *précis* are often very badly made and frequently useless. This is one of the worst points of the system. In any correspondence of importance it is essential to keep records of the contents of communications which pass. In the minute system this has to be done by making *précis* or copies of all fresh minutes which reach an office, as well as of those written from the office. In the business system, where the sender keeps a duplicate of what he has written and does not expect the return of his letter, there is practically no copying whatever, since the duplicates of outgoing letters are provided by mechanical devices with little more trouble than if the letters were written in single, whilst the incoming letters are not copied but are retained. The minuting system also gives much unnecessary labour in "noting and returning" communications which, in the ordinary way, would need no acknowledgment at all.

(*c*). When, as sometimes occurs, two or three different batches of minutes on the same subject are going the rounds simultaneously, there is almost certain to be confusion and working at cross purposes, owing to the habit engendered of only considering a minute in connection with papers actually pinned up with it.

(*d*). Except at times when the batch of minutes on a question happens to be passing through the office, it is difficult to readily verify the existing position of affairs, unless, of course, the laborious recording referred to in (*b*) has been very completely carried out on loose sheets of paper pinned up together to form a duplicate file and not scattered in the orthodox way throughout the pages of a cumbrous register; such recording work is usually impossible. This is frequently an inconvenience, as, for example, when an interview, concerning a question under discussion, takes place at an office where the file does not happen to be resting at the moment.

(*e*). It often happens that several different points in a case might be dealt with simultaneously. Under the minuting system this is discouraged. The file is started round to clear up one point and nothing is done as regards any others until the return of the file, when it is sent on another journey in connection with a second point. The principles of "one thing at a time" and "out of sight, out of mind" are thus combined in a most pernicious manner, and lead to a vast amount of needless delay. A similar and very common case is when several persons have to be written to on precisely the same point, and the file is passed round to them all in turn, whereas all might have been written to direct and simultaneously.

(*f*). When, in the course of a correspondence, a "fresh hare" is started, it is a fortunate and rare occurrence for the original question to get settled at all until the fresh one has been thrashed out,—simply because the minutes on the first matter get dragged about with the discussion on the new question, to the complete neglect of the former.

(*g*). Though without any direct bearing on the question of efficiency, it may be added that the minuting system causes the despatch by post of a very needlessly large weight of paper.

As regards the second object which has been ascribed to correspondence, *i.e.*, the provision of records, the shortcomings of the minuting system are equally serious,—except when the established practice of confining the records of passing correspondence to entries in a register is departed from, and the clerical labour referred to under (*b*) above is carried to the point of making complete duplicates of files, an undertaking which is impossible with the usual clerical establishments of the smaller offices. Excluding the case of the office where the file ultimately finds its resting-place (generally, by the way, a head office, because, no matter where the discussion originated, the tendency is for the head office to arrange to have the file sent to it in the end, as much to save the trouble of making careful *précis* there as to centralise what records exist), the only record in any of the offices concerned consists of the *précis* which are supposed to be kept in the Correspondence Register. Owing to the labour involved in making *précis*, and also to the fact that the number of clerks is small who can be trusted to make clear intelligent ones without omitting any essential points, these digests are as a rule badly compiled.

It may here be noted incidentally that, under the *précis* system, the evil effect of the temporary employment of a bad clerk is irremediable, whereas, under the system of guarding letters, any disorder the correspondence may get into can easily be rectified at any time. Again, even if the *précis* in the register are well kept, with cross references and index, they form a very cumbrous record. It is a trying business to hunt out the course of a correspondence by referring to entries scattered throughout a massive book. The sole readily available record comes, in practice, to be the memory of the staff in the office, and when the staff changes all knowledge of the matter disappears for practical purposes. Even in the office where batches of minutes are actually filed, it is almost impossible to guard and index a batch, in which several subjects have been dealt with, in such a manner that any one new to the office will be able to lay his hands readily on all matter bearing on any question which may come up again.

This absence of readily accessible records leads to great want of continuity; questions are uselessly raised anew which have in fact already been thoroughly discussed and settled, and instructions are neglected simply through ignorance of their existence. Waste of labour and loss of efficiency must naturally result.

In the above remarks attention has been confined to the inherent defects of the minuting system and their effect on the conduct of business. It may, perhaps, be worth while to consider also certain ways in which the system may tend to influence the manner in which work is approached, even though such influence may not be inseparable from it.

Since it is the custom to deal with correspondence by adding a minute to the previous remarks of others and then forwarding the file again, a feeling is apt to be engendered that no one is responsible for doing anything, in regard to a question under discussion, except the individual who happens to be in possession of the file for the moment. Such a view would undoubtedly be welcomed by anyone wishing to shirk trouble; the system provides him with a ready means of getting rid of a question and shifting the responsibility by just minuting the papers, on any pretext, to someone else; and after having done this he would consider himself in a position to reply indignantly to a reminder on the subject, by stating that the papers were "passed to the X.Y.Z. on such and such a date." It is almost like some parlour game; the thing is to avoid being caught in possession of the file; so long as one can do this, though it may not expedite the settlement of the business, one can have peace with honour—can shirk trouble without incurring rebuke for inaction.

The custom of passing on correspondence often leads to the result that officers, who might take an active and helpful part in the settlement, fail to do so, not altogether intentionally, but through sheer force of habit. Thus it may happen that the decision of a question which is being discussed along a chain of command may be really only influenced by the highest and the lowest in the chain, the officers in between not taking any active part. This may sometimes be right; but in certain cases it must tend to an undue amount of work and responsibility being thrown on the lowest subordinate in the chain, who perhaps does not possess all the information necessary to decide it in the best way. In this manner the interpretation of the precise meaning of ambiguously worded instructions may fall on some one very far removed from the office from which they originated, instead of the ambiguity being cleared up at the first step. Much needless paper work also results from this forwarding on of minutes which might be dealt with where they are.

The habit thus leads to three distinct evils,—wrong division of labour, loss of efficiency through the abilities of intermediate officers not being brought to bear, and unnecessary clerical work. If officers, instead of minuting on the minutes of others, had themselves to redraft in full all their letters, these evils would be avoided, because they would then pay more attention to the clearness, conciseness, completeness, reasonableness and necessity of their communications.

In conclusion, the following point is perhaps worth consideration. The power of marshalling facts and expressing opinions in clear, concise and unambiguous language is undoubtedly of great value to officers, and should be developed in every way possible. It can be confidently stated that a system of correspondence by single letters would do more to cultivate this power than the present system, under which officers are confined to expressing themselves in disjointed comments, conveying nothing to a reader until he has first laboriously mastered a mass of equally laconic contributions evolved in the earlier stages of the discussion.

THE THAMES BARRAGE SCHEME.

A. Plea for Suspended Judgment.

By Brevet Colonel O. E. Ruck, R.E.

Of the many complex engineering schemes which now and again suggest themselves to the fertile imaginative brains of the pioneers of progress, this scheme must be classed as amongst those of the most alluring type.

Analogous to those fascinating projects, already foreshadowed out of the mists of the distant future, such as the Clyde and Forth Ship Canal, the English Channel Overhead Bridge, and the like, the Thames Barrage Scheme appears to be one well worthy of leisurely consideration at the hands of all those practical authorities whose technical experience may shed some degree of light on the general question, now wrapped up in partial obscurity.

It is owing to its extraordinary complexity that this scheme presents such varied interest to the public at large. Many men, who would, as a rule, prefer to rank themselves on the side of the angels, and hold aloof from an intricate expert engineering problem such as this presents, are finding themselves drawn in and freely ventilating their opinions, with a degree of warmth quite unusual in such nebulous matters. And why should this be so? unless it be that, as in questions concerning theological doctrines or spiritualistic conundrums, so few clearly defined practical data are accessible from which to form a sound judgment; and the field for elasticity in argument is so vast, presents so tempting an arena for the naturally combative logician, that discussion becomes irresistible. Most men, those in the street and those without, merchants and their clerks, railway men, dock men, shipping men, engineers (amateur, civil and military), landowners, farmers, pilots, bargees and politicians, each and all seem anxious to have their say in the matter. In fact the question is a national one.

In the absence of previous engineering experience of works on a small scale similar to the proposed Barrage, all who may be concerned have a right to contribute to the discussion the results of their own personal experience; more especially so, as the life of the Thames has been from time immemorial so intimately bound up with the life of the nation itself.

In the erection of such a work as a Great Barrage, it is advisable to look not only for a means which will present the fewest elements of uncertainty during construction, but still more for one which will be most convenient and will give most satisfaction to the greatest number of interests. As to the controversial side which has been evoked by the suggestion to construct a Barrage, many obscure points have been discussed with commendable vigour. Some of these, in fact the majority, can only be decided by actual trial; very little, if any, evidence has been taken based on previous experience of similar structures, for the excellent reason that they do not exist. The barrage over the Charles River at Boston, U.S.A., has been quoted, but the case is not on all fours with that over the Thames. Each criticism has been academically, if not practically, met in argument, but no hard solid facts have been adduced in support.

The exploiters and their critics have gravitated into two hostile camps, and the one side has only to assert an affirmative to be at once countered by the other side with a direct negative. Ordinary geese are magically converted into prime swans, dressed up, decorated and consigned, ready cooked, for the particular market aimed at.

The pro-Barrage exponents affirm that dredging has the effect of causing serious damage to the riparian owners, by the subsidence and flooding of their land; their anti-Barrage opponents carefully explain how river banks cannot be expected to hold up the lacustrine water of the dammed-up Thames basin, without letting it through in fathomless oceans to inundate the adjacent property. This is in reality a simple matter of ordinary engineering experience, and can be decided without argument.

The paramount question as to whether the Barrage should be constructed at any particular point on the river's course (say at Gravesend), or whether it might not be more advantageously placed at some other point lower down the Thames—say half-way down the Lower Hope Reach—does not appear ever to have been broached; there is much to be said, looking forward to the future, in favour of the latter site. The anti-barrage party criticise nothing but the plan, the actual original plan for a barrage at Gravesend, with its four midstream central locks; no modifications or alterations to meet alternative conditions or sites are apparently permitted.

No evidence seems to have been elicited, as to the economical handling of goods in bulk alongside river jetties scattered over a long length of lineal quayage, as compared with the dealing with a similar quantity of goods unloaded at open docks on a large scale, such as would be the case if the large area of marshland on the lower Kent and Essex flats were dockised. This concentration of open docks could be effected most readily were the barrage to be sited lower down the river than at Gravesend. Some capital has been made of the danger of interference with the tidal column and the disturbance of the normal sequence of the laws of nature; but the science of engineering has many times before now crippled the powers of nature for mischief, directing them into well-defined channels and subjugating them to its own will.

The military aspect of the question is also one which appears to be open to many shades of opinion.

As regards interference by the Barrage with the navigational facilities now afforded by open water, the number of craft passing a given point in the twenty-four hours is considerable, and will in the future be a constantly increasing quantity, especially if all sorts and sizes are included; but no suggestion has been made to relieve the pressure on the central locks by alternative methods. This would seem to be a comparatively simple matter by the construction of bye-passes, in the form of short ship canals through the marshes and round the shore ends of the barrage. A brief study of the plans of the Mersey docks and the Harbour Board inside the docks at Liverpool and parallel to the river walls will at once shew what a large amount of traffic can be dealt with expeditiously in this way. The continuous concentration of dredging on to one well-defined channel, such as in the Queen's channel and on the bar of the main approach to the Port of Liverpool, also shews how much can be done in this line to keep the main channel clear for vessels of the deepest draft, in case of a tendency to silting.

The present state of affairs on the Thames appears to have arisen from a curious combination of circumstances pressing for some united action and decision. The Royal Commission, appointed in 1901 to enquire into what is known as the Port of London question, found that in the next ten years the sum of £2,500,000 must be expended in improving the river channels and £4,500,000 on improving the existing docks and constructing new ones; they also recommended the formation of a central controlling authority. But as no less than 56 more or less rival authorities were concerned in the management of the Port at the time, the question assumed a thorny and complicated aspect, especially as an entirely novel and taking scheme for constructing a barrage over the river pushed itself to the front and claimed attention. It is therefore not surprising that the delay to shipping, want of dock accommodation, and expense in handling goods still continues. In the meantime the increase of tonnage of vessels clearing and entering the port steadily goes on.

The Barrage scheme, which has been estimated at various sums under £5,000,000 but based (so far as can be determined) on somewhat intangible data, was originally proposed with a view to saving the very large amount of dredging necessitated under other schemes. The Barrage would also save the London County Council, as the central authority for a Port of London Commission, from the necessity of purchasing the existing docks and warehouses at a cost of about

32 millions, which would have the effect of increasing the dues of all using the Port as well as adding to the usual rates. Whilst these complicated questions are under consideration, the traffic of the Port will tend to increase, that is up to a certain point; meanwhile the technical problems involved in the Barrage scheme, the Improved Deep Water River Jetty schemes, and any others, may be thought out. But after a certain amount of time has elapsed, the shipping authorities will begin to find that the existing conditions are becoming unbearable; the traffic will tend to diminish; and unless a fair modicum of improvement is constantly going on, other ports will become the ultimate beneficiaries to the detriment of the Port of London.

But as everything in this world is subject to the laws of perpetual change, in engineering as in other matters, time will probably bring its own solution in disentangling this irritating *impasse.* The stern law of necessity will enforce its potent sway. Money spent in dredging, training-walls and jetties will not be wasted. And if the barrage scheme, by virtue of living examples of similar structures on a smaller scale, can eventually assert its undoubted claims for practical consideration, it is thought that the Port of London will still continue to hold its own in the prominent position it now occupies as the Premier Port of the world's carrying trade.

The *pros* and *cons* of the details of the Great Thames Barrage scheme at Gravesend will be found argued out in full, to the extent of our present knowledge of the subject, in the following pamphlets, etc.:—

(1). *The Great Thames Barrage*, by T. W. Barber, M.INST.C.E., St. Bride's Press, Fleet Street.

(2). *Remarks on the Proposed Barrage Scheme*, by Mr. J. G. Broodbank, Secretary, London and India Dock Company, 54, Threadneedle Street, E.C.

(3). *Public Works* Magazine, Vols. IV. and V.

(4). *The Royal Engineers Journal*, January and April, 1905, in articles entitled "The Future of London," by Lieut.-Colonel J. Winn, late R.E., and Colonel H. P. Knight, late R.E.

(5). *Daily Mail Year Book* for 1905, page 177.

TURBINES ON ATLANTIC STEAMERS.

By Colonel L. F. Brown, late R.E.

Perhaps the following particulars of the latest adaptation of the turbine engine to an ocean steamer may prove interesting to the readers of the *Royal Engineers Journal.*

I write this on board the Allan Line R.M.S. *Virginian,* now just completing her second voyage across the Atlantic between Montreal and Liverpool. She is a vessel of 12,000 tons, and fitted with Parson's turbine engines of 12,000 horse-power. At her trial trip she developed 15,000 H.P. and made 19·8 knots, but she runs her course across the Atlantic at a steady 16 knots, whether it be in the smooth waters of the St. Lawrence or in the wild rollers of the Atlantic.

The first thing that strikes one when on board is the total absence of any sense that there is any engine power on the ship; there is no throb of engines nor any vibration. Several times when we were going at full speed, passengers asked "Are we going along?" In the rough seas also there is no racing of the screw, nor that unpleasant wagging of the tail that one feels in most ocean steamers. I remember once, coming home in the *Teutonic,* that it was impossible to read or write on account of the excessive vibration.

The *Virginian* has three screws actuated by three turbines. The centre turbine is high-pressure and the steam passes from it to the two outer turbines which are low-pressure; from these latter it passes to condensers, and thence is forced back as water into the boiler again. When going at 16 knots the high-pressure turbine was supplied with steam at 125 lbs. pressure, and the three turbines were making from 240 to 250 revolutions a minute. The two low-pressure turbines revolve outwards, and the centre turbine revolves in the same direction as the starboard one. The shafts of all three screws are 12 inches in diameter, and the screws are of less diameter than those of an ordinary steamer, which would be going at about 80 revolutions for the same speed. The steam enters at the forward end of each turbine, and thereby takes most of the thrust of the screw shaft.

The blades of the turbines, which number altogether about a million and a-half, are all $\frac{3}{4}$ inch wide and increase in length from $\frac{3}{4}$ inch to 8 inches as the pressure diminishes. They are all of gun metal or phosphor bronze, and it is estimated that each blade has to stand a pressure of about 1 lb. The turbines are each about 8 feet long. The diameter of the central turbine is 5 feet 6 inches and that of the outer ones 8 feet 6 inches. The two outer turbines have an extension under the same jacket of about 4 feet; this contains the reversing turbines which, when not in use, act as a fly wheel to the driving turbines. The central screw does not reverse. The supply of steam to the engines is regulated by the usual governor balls.

In the engine room nothing seems to be moving except the various small engines that are doing work inside the ship, and the room is cool, in fact almost cold. A gentle humming can be heard in the turbines, but that is all. There are no men anxiously oiling various moving parts; the only thing to oil is the screw shaft, and that is oiled automatically. One man was in the engine room.

As to whether the turbine is more economical than an ordinary engine in an ocean passage, it is difficult yet to say. The only figures I could arrive at on this question is that a fully laden steamer of 12,000 tons can be driven at 16 knots on from 180 to 200 tons of Canadian coal a day.

As far as the passengers are concerned a turbine steamer is far more pleasant to travel in than an ordinary one. I am writing this in a heavy gale and there is not the slightest vibration or racing of the screw to be felt in the ship.

R.M.S. *Virginian*, 2. 6. 05.

TRANSCRIPTS.

ANCIENT DEFINITION OF AN ENGINEER.*

Engineer, in the military art, an able, expert man, who, by a perfect knowledge in mathematics, delineates upon paper, or marks upon the ground, all sorts of forts, and other works proper for offence and defence. He should understand the art of fortification, so as to be able, not only to discover the defects of a place, but to find a remedy proper for them, as also how to make an attack upon, as well as to defend, the place. Engineers are extremely necessary for these purposes: wherefore it is requisite that, besides being ingenious, they should be brave in proportion. When at a siege the engineers have narrowly surveyed the place, they are to make their report to the general, by acquainting him which part they adjudge the weakest, and where approaches may be made with most success. Their business is also to delineate the lines of circumvallation and contravallation, taking all the advantages of the ground; to mark out the trenches, places of arms, batteries, and lodgments, taking care that none of their works be flanked or discovered from the place. After making a faithful report to the general of what is a doing, the engineers are to demand a sufficient number of workmen and utensils, and whatever else is necessary.

* We are indebted to Major M. A. Cameron, C.M.G., late R.E., for this transcript from *A New and Complete Dictionary of Arts and Sciences*, by a Society of Gentlemen. Published by W. Owen, at Homer's Head, in Fleet Street. 2nd edition. 1763.

An identical article appears in *The British Encyclopedia, or Dictionary of Arts and Sciences; comprising an accurate and popular view of the present improved state of human knowledge*, by William Nicholson. Published by Longman, Hurst, Rees, & Orme, Paternoster Row, 1809.

HOSPITAL TRAINS IN WAR.*

Classification of Trains.

The hospital train service, as used during the campaign, may be classified as follows:—

1. *Hospital Trains.*

Specially fitted, equipped, and staffed as such, for conveyance of lying-down cases; corresponding to the Austrian "sanitätszüge." Of these there were two kinds—

(*a*). Converted ordinary trains. The following (all, in fact, save the "Princess Christian") belong to this category—

No. 1 Hospital Train.
No. 1A " "
No. 2 " "
No. 3 " "
No. 4 " "
No. 5 " "
No. 6, an abandoned Boer train.

(*b*). One specially built ("Princess Christian").

2. *Improvised Hospital Trains.*

As a rule, first-class corridor car trains, unaltered, often with a kitchen car, for conveyance of less severe cases and convalescents, corresponding to "krankenzüge." A Medical Officer, provided with medical comforts and a small stock of medical and surgical materials, accompanied each convoy of sick, but there was no permanent staff.

3. *Ambulance Coaches.*

In addition, there were a number of specially-fitted carriages placed at convenient intervals on the railways. These were used to pick up small parties of sick from the various posts along the lines, and were attached to passing trains for conveyance to the nearest hospital. Many of these had a regular service, usually twice a week up and down their own stretch of line. Some of these carriages were provided with the usual iron frames for support of the service stretchers. Others were similar in construction to the converted hospital train carriages.

Staff.—As a rule, one N.C. Officer and one orderly were attached for duty to these carriages, and the Medical Officers along lines of communication attended to the wants of the sick as the carriages passed the various posts.

* Extracts from *Report on the Medical Arrangements in the South African War*, by Surg.-General Sir W. D. Wilson, K.C.M.G.

HOSPITAL TRAINS PROPER.

Construction.—No. 1 Train was prepared in Natal and was ready at the outbreak of the war. A little later No. 1A was also got ready. These trains were not elaborately prepared, and very little expense was incurred in their preparation. Ordinary passenger carriages were selected; these were not gutted nor supplied with new fittings; only very slight alterations were made. The doorways were left unaltered, and there was no through communication from end to end of the trains. Special narrow stretchers had to be used for conveyance of the patients into and out of the carriages.

Hospital Trains Nos. 2, 3, and 5 were constructed at Cape Town. Nos. 3 and 5 carried 92 lying-down cases in addition to staff; No. 2, 96.

The following description of No. 5 will serve for all three; the only difference between the trains consisted in the fact that the ward-cars in No. 5 were all converted passenger cars, in the others, partly passenger, partly post-office cars. As passenger and post-office cars were much the same size and shape, and both had to be completely gutted of all internal fittings before conversion, the distinction is of slender importance.

Like all the ambulance trains employed during the war, with the exception of the "Princess Christian," No. 5 Ambulance Train was improvised from ordinary railway rolling stock. The train was made up of seven coaches with through communication from end to end, arranged in the following order:—

(1). First-class saloon car, for medical and nursing staff.
(2). Kitchen car, with pharmacy and orderlies' room.
(3). Ward of 24 beds.
(4). " "
(5). " "
(6). Ward of 20 beds, four of which were screened off for Officers.
(7). Pack and steward's store car, with space for guard.

The train carried 92 lying-down patients, and a staff averaging 22. All the vehicles, with the exception of the kitchen car, were converted Cape Government Railway "bogey" coaches; (1) being a first-class corridor saloon car but little altered; (3), (4), (5), and (6), third-class corridor cars, which had been completely gutted and fitted up with two double-tiered rows of wooden bunks, arranged longitudinally with central passages; (7), an ordinary luggage and guard's van, one end of which was fitted with a steward's store-room and meat safe, the other with shelves and lockers for kits. With the exception of (7), 20 tons, the tonnage of each car was 24, making a total of 164 tons, a weight requiring a "first-class" engine for most parts of the South African lines and two engines for certain long, steep gradients such as the Hex River and Lootsberg passes. The tonnage of a train, in connection with the hauling power of the engine and the gradients of the line, is one of the most important factors to be taken into consideration in the construction of ambulance trains; every increase in weight through elaborate iron or other weighty fittings must mean a corresponding reduction in carrying power.

Only two cars—the staff and kitchen car—were fitted with tanks. These tanks, six in all, cylindrical, carrying some 1,800 gallons, were placed under the cars, and were easily filled from tanks or taps at the various stations; the water was passed through Berkefeld field filters before use. All water required in the cars used as wards had to be carried from the kitchen car, involving almost continuous labour on the part of the already heavily-worked orderlies. The provision of tanks to each car would be undoubtedly the ideal arrangement (as carried out in the "Princess Christian" train), but here again the ideal must be sacrificed to the practicable; filling tanks on every car is a lengthy process. It took about two hours in the case of the "Princess Christian" train, and is more often than not impossible in a crowded station in war time.

Each car, with the exception of the kitchen and pack-store cars, had a small lavatory, fitted with a hand basin and w.c. of the usual railway type, at either end. During short stoppages in railway stations these were always locked. When the train, as frequently happened, had to remain some hours in station or hospital sidings, buckets with dry earth were placed underneath the w.c. pipes, the station and hospital authorities being responsible for their disposition and removal. A supply of 5 per cent. Izal solution was kept in each lavatory to disinfect the excreta as far as practicable. Bed-pans and urinals were provided for 15 per cent. of the patients, and this provision was always found ample for No. 5 Ambulance Train, which did not run during the early part of the war, and never carried such numbers of helpless sick and wounded as some of the other trains.

A visitor inspecting the train would enter the saloon car first, and from it walk through the kitchen and four ward cars to the pack store, and this is the most convenient order to adopt for a more detailed description of the construction.

Saloon Car.—This was a first-class saloon car of the Cape Government Railway, entered by steps at either end, and communicating with the kitchen car. It contained five compartments, the usual first-class compartments with sliding doors opening on to the corridors, with a lavatory at each end. Two of these compartments at one end, separated by a right-angled passage (fitted up with cupboards as a tiny pantry) from the other three, were occupied by the nursing Sisters. Of the remaining three, two were the rooms of the Medical Officers; the third, next the pantry, formed a little dining room in which four—or, at a pinch, five—persons could have their meals with a fair degree of comfort. The only modifications adopted in this car were the removal of superfluous seats in the Sisters' and Medical Officers' compartments, the provision of racks and hooks for clothes, etc., and the conversion of the right-angled passage between the dining room and Sisters' quarters into a little pantry by means of added shelves. The lavatories, fitted with w.c.'s and basins, were of fair size, and with a little manœuvring and the addition of camp canvas baths could be used as bath rooms.

Kitchen Car.—This car included three separate compartments, extending the whole breadth of the coach without corridors, communicating by doors. The centre compartment, much the largest of the three, constituted the very excellent kitchen, fitted with a large German range and boiler, dressers, cupboards, etc.; the range, a very fine one, occupied nearly the whole of one side of the kitchen, and by its weight tilted the car to that side a few inches, giving the car a somewhat lopsided appearance. On the side next the saloon car was a small compartment used as a pharmacy, with shelves and lockers for the medical and surgical equipment, and four fixed wooden bunks for N.C. Officers and batmen. On the other side of the kitchen was a larger room used as a mess room by the orderlies, which was fitted up with six bunks and a table, thus providing altogether sleeping accommodation for 10 N.C. Officers and men.

Ward Cars.—(3), (4), and (5) cars were all of similar construction, so that one description will suffice for all. The original third-class corridor cars had all the interior fittings removed and replaced by two rows of fixed wooden bunks, each row in two tiers; a central passage extended from end to end of the car between the rows. The continuity of the bunks was broken in the centre of the car by two large doors facing each other, large enough to permit of stretchers being carried in, and, with the help of hinged posts in the corner bunks, carried down the centre passage to any particular bunk or bunks. The transference of a patient from stretcher to bunk was easily carried out by gently lifting or rolling in from the stretcher placed beside the bunk. The bed-cots in the "Princess Christian" train were so arranged that they could be lifted out of the train,—a better plan, of course, as patients could then be transferred from the stretchers on the platform—but on the whole the plan adopted on No. 5 Train worked well, and involved no complicated fittings. The lavatory at each end of the car contained a fixed basin as well as w.c. Undoubtedly the ablution arrangements were quite insufficient in view of the fact that patients were sometimes as long as six days on the train; they had to be eked out by serving out hand-basins to each car. As a rule six basins were thus served out, making, with the fixed ones, eight for the 24 occupants of the ward.

Each bunk was composed of headboard, tailboard and sideboard (the other side being formed by the side of the train), and measured 6 feet 3 inches long by 2 feet 9 inches wide; the bottom was formed of tightly stretched canvas; horsehair mattresses, blankets, pillows, sheets, and pillow-slips were provided. The mattresses were provided by the Cape Government Railway; the other articles were drawn, replaced, etc., in the usual way. The sideboard could be removed to facilitate transference of patients from stretchers and *vice versâ*.

(6) ward car was originally the same as the others, except that eight bunks at one end were screened off for Officers by means of draw-curtains. This arrangement was unsatisfactory, except on the rare occasions when all the Officers were lying-down cases; so the four bunks on one side were removed and replaced by windows, a table, and some easy chairs, thus making a very comfortable bed-sitting room for four Officers, and reducing the number carried in the whole car from 24 to 20. In No. 2 Train this ward car was the same as the others, and carried 24.

(7) car.—The major part of this car was fitted with shelves and lockers, the former for men's kits, the latter for linen, spare blankets, Red Cross stores, etc. The far end of the car was converted into a steward's store, where all wines, spirits and extras were kept under lock and key. A small intermediate passage between these two rooms was used by the guard, and contained three bunks for the conductor and two orderlies, making, with the berths in the kitchen car, sleeping accommodation for 13 N.C. Officers and men.

Each car had a large red cross painted on the outside on a white disc.

Equipment.—The medical and surgical equipment was that of a field hospital,* supplemented as occasion required by other drugs and articles which were always obtained without difficulty from advanced or base depôts of medical stores. All other articles of hospital equipment were drawn and held from the Ordnance—knives, forks, spoons, tin plates and mugs, blankets, etc.

The management and equipment of No. 4 Train were on much the same lines as the above, but its construction differed widely from that of the others, and requires a separate description. No. 4 was fitted out as a hospital train at East London by the Red Cross Society, under the personal supervision of Sir John Furley. The work was put in hand on April 20th, 1900, and the train started on its first journey on June 10th, 1900.

"The train at first consisted of five coaches and a brake van. Later on two additional carriages were provided, making up a total of 114 beds, including six in a separate compartment for Officers. Two small vans were also added for soldiers' kits, pack stores, and guard. A continuous passage ran through the train and each coach had a lavatory. The water for the train was carried underneath the coaches. Folding doors, one each side of every carriage, allowed the sick and wounded to be taken in and out on stretchers. The beds consisted of iron moveable brackets with sheet canvas and hair mattresses and sheets, blankets and coloured counterpanes. As the beds folded up, every facility for airing and cleansing was afforded."†

These beds were arranged in three tiers (a tier too many). Their moveability and capacity for folding up were doubtful advantages, involving frequent repairs and a certain feeling of insecurity for the patients. On the whole the system of fixed wooden bunks is preferable. Tanks under each coach save the train staff much labour, but in war time it is often difficult, sometimes impossible, to fill them all; the process is a very lengthy one, involving delicate shunting work and a considerable length of free line-space, both conditions often unattainable in a crowded station.

No. 4 Train was painted white outside (an undoubted advantage) with red crosses on each coach, like the "Princess Christian."

* Namely, 2 field medical companions, 2 surgical haversacks, 4 field medical panniers, 1 special surgical pannier, 1 field fracture box, and 1 antiseptic case.

† "Report of the Central British Red Cross Committee on Voluntary Organisations in Aid of the Sick and Wounded during the South African War."

The car for the staff and the kitchen car were, speaking generally, of the same type as the corresponding coaches of the other converted trains.

Personnel.—No. 6 carried only 1 Medical Officer, 1 cook, 1 compounder, and 5 orderlies. Each of the other trains had the following *personnel* :—

Medical Staff	...	1 Major, R.A.M.C., in command.
		1 civil surgeon.
Nursing Staff	...	1 nursing Sister, Army Nursing Service.
		1 ,, Army Nursing Reserve.

The numbers of the medical and nursing staff remained unchanged throughout the war.

In the early days of running there were 22 N.C. Officers and men; these, however, had soon to be reduced, owing to the exigencies of the service, to 17.

THE "PRINCESS CHRISTIAN" TRAIN.

On the initiative of H.R.H. Princess Christian the train bearing her name was built in England, at the expense of the Red Cross Society, by the Birmingham Railway Carriage and Wagon Company. For the general design and internal arrangements Sir John Furley and Mr. Fieldhouse (of the Military Equipment Company, Limited) were responsible.

"The train consisted of seven bogie corridor carriages, each about 36 feet in length and 8 feet in width, the passage through the centre being continuous.

"(1) was divided into three compartments for linen and other stores, for two nurses, and for two invalid Officers respectively. The second carriage was also divided into three compartments, namely, for two Medical Officers, a dining room, and a dispensary. (3), (4), (5), and (6) were each constructed to carry 18 invalids and four hospital orderlies. The beds were placed in three tiers . . . and by an arrangement of pulleys in the roof each bed could be raised to the proper level by one man. . . .

"(7) contained the kitchen and pantry, including berths for two cooks and a compartment between for the guard. . . .

"The whole train was light and airy, and the enamelled white ironwork and fittings and the bright draperies produced a very cheerful effect. . . . It was painted white externally from end to end."*

The medical, surgical, and other equipments were on a most extensive but unnecessarily elaborate scale.

Experience showed several defects in the construction and arrangement of this expensive and beautiful train. The position of the linen store was most inconvenient; that most necessary item in any military hospital unit, the pack store for men's kits, was forgotten (a Cape railway van, not communicating directly with the rest of the train, had to be added for this purpose); three tiers of beds are one tier too many; the numbers

* Report of British Red Cross Committee.

carried—two Officers and 72 men—were limited compared with the converted trains. Lastly, the otherwise excellent system of tanks to each carriage necessitated great inconvenience and delay in stations and sidings.

On the whole, the arrangement of the bunks and general construction adopted in the converted trains was preferable; with the addition of some fixed basins, surmounted by a small tank capable of being filled by hand, to each ward car, the type of converted train represented by No. 5 would prove the most generally useful in future campaigns.

The *personnel* of this train normally consisted of two Medical Officers, two nursing Sisters, cook, compounder, and 12 orderlies.

IMPROVISED HOSPITAL TRAINS.

Except that the staff was put on for the journey, the work of these trains was much on the same lines as in the hospital trains proper.

ORDINARY TRAINS.

A very large number of convalescents were sent to the base by this means, notably during the enteric fever epidemic at Bloemfontein. At the time of the Bloemfontein epidemic, the line from there to Cape Town was clear so that trains could run through without stopping at night; hence the want of cooking arrangements on the train was not felt, hot meals could be served to patients at certain fixed stations, and the system, on the whole, worked well. When, however, a line is infested by the enemy, so that train stoppages become irregular and for indefinite times, hospital train units must of necessity be self-supporting.

LAND DEFENCE OF SEACOAST FORTIFICATIONS.

Extracts from an Article by CAPTAIN E. H. SCHULZ, *Corps of Engineers, U.S. Army, in the* JOURNAL OF THE MILITARY SERVICE INSTITUTION, U.S.A. *January—February*, 1905.

It is only within recent years that the land defence of our seacoast fortifications has received extended study. Our older fortifications made provision against land attack, but since the installation of modern armament, in concrete constructions, the matter has been held in abeyance. This is partly due to the fact that our resources and energies have been used in providing the armament itself, which is of recent growth, beginning practically in 1890. During the short space of time that has elapsed, upwards of 800 seacoast guns and mortars have been emplaced.

Up to the present time projects for permanent seacoast defences have been adopted for thirty-one localities in the United States. In addition to these, the defence of the Great Lakes and the St. Lawrence River is under consideration. Twenty-five of the principal harbours of the United States have a sufficient number of heavy guns and mortars mounted to permit an effective defence against naval attack, and during the past four years considerable progress has been made in the installation of an adequate rapid-fire armament, now the matter of first importance.

The existing projects for seacoast defences comprise 364 heavy guns of 8-inch, 10-inch and 12-inch calibres, 1,296 rapid-fire guns from 2·24-inch to 6-inch, and 524 mortars.

Projects for the defences of San Juan, Porto Rico; Pearl Harbour and Honolulu Harbour, Hawaii; San Luis d'Apra, Guam, Manila Bay, Subig Bay, have been approved by the Secretary of War. In addition projects for Cebu and Iloilo, P.I., have been submitted, and others for the defence of our naval coaling stations are under consideration.

It is thus seen that the armament already provided is of immense value, and forms practically a complete defence of our seaports and adjacent cities. The loss in prestige, not to mention the actual loss of armament, would therefore emphasize the great importance of adequate land defence. When we add to the above the auxiliaries of defence, such as range-finder stations, searchlights and torpedoes, the folly of not thoroughly defending them from land attack is evident.

At the present time sixty-six fire and battery commander stations are in use by the artillery, and seventy-seven are under construction. This is but a beginning of our range-finder system. The torpedo defence is in charge of the artillery arm, and its *matériel*, including loading-rooms, storehouses, range stations, presents an aggregate value, when fully equipped, of over three million dollars.

The permanent defences have now reached that degree of completion where the rear defence becomes of paramount importance, and this has been recognised by the War Department. Projects for land defence have already been considered for the most important harbours.

The seacoast fort or battery has a double problem to solve :—

(*a*). It must fight the enemy's vessels, destroying them if possible. (*b*). It must be defended from land attack in the rear, or from landing parties attacking from any direction.

The discussion of an engagement with the enemy on the water may be omitted, as all our emplacements are designed to give the maximum efficiency in such an engagement. Our heavy guns can, however, fire only to the front, with a possible fire of the flank guns of 20° behind the line of gun centres, while to the rear they have no fire.

The rapid-fire guns (in which we may include the 6-inch, 5-inch, 4·7-inch and 3-inch in permanent emplacements) have, in some special forms of emplacements, fire to the rear; but generally, with the exception of the 3-inch, we may consider them as limited to front and flank fire. All the rapid-fire guns can and should be used in repelling land attack in the directions of their fields of fire. The guns of greater calibre cannot be so considered, as their rate of fire, speed of laying, etc., would preclude their efficient use. For such an attack the rapid-fire guns would be more effective and should be provided. It may be stated that, in addition to the above rapid-fire guns, the 6-pr. (2·24-inch) is also considered a gun of the permanent defence. This gun is now provided with a rampart mount; it is, however, the intention to give it a permanent pedestal mount.

In considering the nature and extent of the land attack, several important considerations must be taken into account :—1st. The value of the harbour or city and of the particular fortification in its defence. 2nd. The character of the enemy, and his distance from base of supplies. 3rd. The characteristics of the coast, as to feasibility of landing and intermediate territory to be traversed.

The following may be considered as self-evident :—1st. The enemy will not hazard to force the entrance to our harbours in daylight in the face of our present strong fortifications. 2nd. He will not engage our batteries for the purposes of combat; if he engages them at all, it will be mainly for purposes of reconnaissance. 3rd. He will not engage the batteries at any time except when the odds are greatly in his favour. 4th. His first object will be to capture the batteries and injure the armament beyond use, or else employ them in attacking other batteries, and this will be attempted entirely by land attack.

We thus see that the importance of land defence is as great as the necessity for the permanent defences themselves.

Let us now ascertain the character of a land attack, involving as it does the number of troops and their equipment. The complement of a first-class battleship is about 700, of a first-class cruiser the same, and of the minor vessels proportionately less. Considering a European fleet, manœúvring in the vicinity of one of our harbours, consisting of 2 battle-ships, 3 first-class cruisers and about 8 to 12 vessels of minor size, the total complement would be about 6,000 men; of this number half might be available for a sudden dash against the batteries. The enemy, thus numbering about 3,000 men, would proceed, in light-draft torpedo-boats, launches or ship's boats, under cover of darkness or fog and through unfrequented channels, carefully picking their way over suspected mine-fields, and make a landing in the rear of the works or at some distance on the flanks. In any case, the objective would be to land the greatest number of troops in the safest and most expeditious manner and as close to the works as possible, and then proceed over land to attack and capture the work. The attacking troops would be provided with their own service rifles; and in addition would probably land machine, field and rapid-fire guns up to 3-inch calibre, and in exceptional places 5-inch or other siege guns. The facilities for landing must in the latter case be exceptionally good.

Having made the landing, attack or capture would be certain unless our batteries were protected by proper land defence; for it cannot be assumed that the artillery *personnel* of the battery will be able to cope with an attack in the rear as well as continue a fight with the enemy on the water, especially if no provision for immediate rear defence has been made.

The protection required against the modern Springfield rifle and similar types is as follows:—Sand $2\frac{1}{2}$ feet, earth $3\frac{3}{4}$ feet, soft wood 5 feet, hard wood $2\frac{1}{2}$ feet, wrought iron $\frac{5}{8}$ inch, hardened steel $\frac{5}{16}$ inch. The following are approximate penetrations at muzzle:—U.S. rifle, calibre ·30, 3 feet earth, $2\frac{1}{2}$ feet sand. U.S. field gun, 3-inch, model 1898, 4·5 inch steel, 13 feet sand. U.S. siege gun, 5 inch, model 1898, 6·2 inch steel, 18 feet sand. For calibres over one inch, the relative protections afforded may be taken as follows:—1 inch of W.I. = $\frac{3}{8}$ inches of steel = 30 ft. of sand = 36 ft. of earth.

It will be seen that for absolute penetration unwarranted thickness would be required against field and siege guns. As, however, these guns are seldom used for direct penetration but rather for their shell and shrapnel fire, a protection of 6 feet of earth is considered ample; consequently, in designing fieldworks 3 feet of earth would be sufficient against small-arm fire, and 6 feet against all others.

The effective range of the service rifle may be taken at 1 mile, of the field and rapid-fire guns at 3 miles, and of the siege guns and howitzers at about 4 miles. In planning our fieldworks, then, they should be at such distances as to prevent the enemy from occupying positions within the above ranges of our permanent fortifications.

As a land attack would hardly be undertaken without field and rapid-fire guns, we may consider the zone of danger to be generally taken as 3 miles; and for important harbours, or where landing of siege guns is especially favourable, a radius of 4 miles.

The weight of the U.S. Navy field piece, 3-inch, with carriage, etc., is 1,830 pounds; of the U.S. 5-inch siege gun, without carriage, about 3,630 pounds; of the British 5-inch howitzer, carriage and limber, 5,040 pounds.

We thus see that the heaviest single weights to be brought ashore would not exceed about 3,600 lbs.; an operation which, while almost impossible in certain localities and weather conditions, is yet one which an enterprising enemy would readily attempt under favourable circumstances.

It is manifest that the regular coast artillery will be insufficient to properly care for the land defence. Their time and labour will be taken up entirely in looking after the naval attack. In an emergency they must also take part in the immediate defence against attack from the rear. Our main reliance for the preliminary defence must therefore be placed on the organised militia of the various States, who are fully prepared to act in such an emergency.

We must make such a disposition as will effectively prevent the advanced line from being penetrated or driven back. To this end salient positions of the defensive line must be occupied, including important bridges, roads and heights. These positions should be occupied by field-works of sufficient size and strength to withstand the probable attack; and should be such as to cover to the best advantage the intervening ground, as well as to command the approach.

Assuming that the nature of the terrain would allow and require the use of light artillery and cavalry, as well as of infantry and engineers, a total of 1,000 men would be divided approximately as follows :—

7 companies of infantry,	Or troops acting as such.
1 troop of cavalry,	
1 light battery or company of foot artillery,	
1 company of engineers.	

Four companies of infantry would be encamped near the entrenched positions ready for immediate occupation. They would have scouts patrolling the line between these positions, ready to communicate information at a moment's notice. The cavalry and light artillery would be encamped in rear of the line. There should be cavalry outposts well in advance of the main line on the coast and along important communications. Where light artillery is not needed, foot artillery may be substituted for manning the various field guns. The remaining infantry should be encamped near the permanent works for defence of the shore front, flanks and immediate rear defence. The engineers would be encamped near the reserve infantry and utilized in repairing roads, bridges, obstructions and field defences and on demolitions.

The general character of the entrenched positions may now be considered. A closed work would in nearly all cases be undesirable, since rapid ingress and egress are important considerations. The parapet should be 4 to 6 feet thick, arranged for infantry fire and provided with suitable platforms for the necessary field guns. The trenches should be located on important sites, but well concealed. The intervals between positions should be covered by infantry lines where approach is possible. These lines, as well as the trenches in the earlier stages, should consist of shallow lying-down trenches, deepened to kneeling or standing trenches where time will permit and where drainage is practicable.

A retired line should be constructed upon similar principles. Parapets should also be thrown up between emplacements along the sea front, and also directly in rear and surrounding all the fortifications. It will be noted that no regular redoubts are provided for.

The results thus far of the Russo-Japanese war show that concealment of positions is only second to their proper location. In the battle of Wa-feng-gu on June 16, 1904, the Japanese field artillery made frightful carnage among the Russians, due to a great extent to lack of concealment on the part of the latter. The Japanese field guns numbered 108 and the Russian 64; the range was 3,800 yards, about 2 miles; and within fifteen minutes after the opening of the combat, the Russian guns were completely silenced. From 10,000 to 15,000 shells were thrown by the Japanese and all by the indirect method, firing from concealed positions. In the Boer war the Boers made use of deep narrow trenches, with inconspicuous parapets.

Vertical cover should also be provided, especially for men not actually engaged; and this can best be obtained, where the terrain will allow, by constructing bombproofs under the parapets.

The works should not only allow of good passive defence, but also for an active offence, and to this end the greatest possible mobility must be provided. Machine guns form a most invaluable aid to the infantry against close attack. The artillery should preferably be in independent positions so as not to draw fire on the infantry. The guns should be well separated, and platforms constructed in all good positions, with connecting communications so that the field guns can be readily moved. Even the heavier siege artillery should not be considered strictly fixed, as to some extent these pieces can be moved when desired, though of course more slowly.

The trenches should generally not be placed directly on the brow of a commanding position, but a short distance below; this conceals the position and prevents a sky-line profile. This entire subject is thoroughly discussed and exemplified in *Principles of Land Defence*, by Capt. H. F. Thuillier, R.E.

All the obstacles known to the military engineer should be utilized where practicable; but in all cases of emergency, and especially where other means are limited, a barbed wire entanglement would be at once the simplest, cheapest and most effective obstacle that can be provided. The lines of wire should be located where the terrain will allow, at distances of 50 yards in front of all redoubts, fieldworks and trenches, and again at further distances of 200 to 400 yards. The lines should be as high as can be made consistent with concealment and rapidity of construction, and should not be less than three tiers deep. The intervals between the stakes of the wire obstacles should be covered with small pointed stakes or any other additional obstacles that may be provided.

The number of field guns that would be required in preliminary defence, as above outlined, can only be generally given; allowing four machine guns and four 1-pounder automatic guns to each position (of four), and six field guns, two machine and two 1-pounders for the general defence, the total number would be about forty-two guns of light field type and smaller calibres. Siege guns and howitzers should also be added where required.

The labour involved in constructing the fieldworks and trenches would be performed by the troops, and the cost would therefore be only for the implements used. As the preliminary defences become completed they should be made of a more permanent character, and additional material obtained to facilitate both defence and offence. Under this head would come prominently the use of searchlights, including complete power and transportation equipment. Plotting rooms, telephones, depôts, etc., should also be supplied.

The above general discussion provides for an immediate land defence only, required under great emergency and for defence against sudden attempts to capture the works. Where the attack is to be made by regular siege, or where a large city, depôt or other strategic position is to be defended, the main line must be considerably advanced; and the works placed at intervals should be of a more permanent character, but nevertheless give thorough concealment and mobility.

The importance of having some general plan, well digested and laid out, for this preliminary defence of each harbour is self-evident. The location of the lines of defence and of the works, the nature and number of obstacles and their position, the proper camping places, should all be thoroughly considered and placed on record so that work could be begun almost immediately when required. The inner line of defence, which practically surrounds the fortifications at close range, should be laid out during peace and constructed before the advent of war. It should be a part of the permanent defence of the fortress, and, if funds are available, constructed at the same time. The Russo-Japanese War, especially the attack and siege of Port Arthur, leaves no room for doubt that fortifications in the future will be attacked not from the water but entirely by land; and that we can begin none too soon in establishing a complete system of land defence for each of our fortified positions in this country as well as in our possessions. A preliminary defence as above outlined therefore needs a supplemental land defence of permanent value, which should likewise be prepared and completed as far as possible before the outbreak of war.

REVIEWS.

DIE FESTUNG IN DEN KRIEGEN NAPOLEONS UND DER NEUZEIT.

Herausgegeben vom Grossen Generalstabe.—(Mittler: Berlin. 1905).

It is to be hoped that this work, issued by the historical section of the German General Staff, will find an English translator, for it is a book that all officers would do well to read. It concerns itself little with technical details; its aim is to show what was the influence of fortresses in the chief campaigns of the 19th century, and what lessons for the future may be drawn from the experience of the past. In 335 pages, and with the help of an atlas of plans, it contrives to give the reader a clear account of the operations chosen, and to bring out the bearing of them. We cannot do better than give a short summary of the line of argument.

The wars of the 17th and 18th centuries were mainly wars for the extension of frontiers. The capture of frontier fortresses was the principal object, and to this the field operations were subordinate. Siege-work was reduced to a system, and like fortification it was relegated to experts, who practically dominated the course of a campaign. Frederick the Great was the first to break through this tradition, to regard fortresses as mere means to an end, and to impose terms on his enemy by victories in the field. Napoleon followed his example, and his ampler resources enabled him to better it. He showed the fullest appreciation of the value of fortified posts and places, but he always looked beyond them.

Mantua in 1796 and Genoa in 1800 are the first two instances chosen, and they present a striking contrast. Napoleon could not afford to pass Mantua by, he was ill-provided for a siege, and he had not men enough for a siege army and a covering army. He was obliged to abandon the investment and sacrifice his siege train when the first relieving army, under Wurmser, drew near. Yet the fortress proved a snare to its possessors. The Austrians wore themselves out, and crippled their operations in Germany, by successive efforts to relieve it, and lost it in the end. Genoa, like Mantua, was starved into surrender, but not till it had served its purpose. Instead of coming to its relief, Napoleon placed himself on the Austrian line of communication, and the victory of Marengo won back all North Italy as far as the Mincio.

In Prussia the stress laid on well-drilled battalions and field evolutions had caused neglect of fortresses; and in 1806 the victory of Jena made Napoleon master of all the country west of the Vistula before the Russians could come up. The defence of Dantzig in 1807, though by no means a model, served to show how important a part might be played by a fortress which was accessible from the sea and threatened the enemy's communications.

This was repeatedly illustrated during the war in the Peninsula; and that war also furnishes instructive examples of accelerated sieges, where time is of the first importance. Ciudad Rodrigo was taken by Wellington in 11 days, Badajoz in 20 days; while the French had spent nearly six weeks in taking them. Methodical as he was in field operations, Wellington broke loose from the Vauban method in these sieges, and set a new example. His procedure was defective in details, but "it is not the precise mode of execution which is a model for us; it is the spirit of unhesitating energy which animated it, and the sound estimate of the influences which the general military situation should exercise on the method of attack."

In 1805, in 1809, and again in 1813, North Italy was a secondary theatre of war, and it was Napoleon's plan to act on the defensive there, and to gain time. The fortresses of the Venetian quadrilateral served him well for this purpose, and his elaborate instructions to his stepson, Eugène Beauharnais, deserve study. Those fortresses served the Austrians equally well in 1848 and 1866, when they had to hold their ground against superior numbers. In the latter year, Cialdini proposed to turn the Quadrilateral by crossing the Po lower down, and Moltke agreed with him; but great difficulties and risk would have been incurred by such a course.

The principles inculcated by Napoleon for the defence of North Italy were applied by him in North Germany in 1813. But the field was wider, and the fortresses were ill-fitted for an active defence, so that they exerted less influence on the operations. The very large numbers at the disposal of the Allies made it possible to mask these places without dangerously weakening the main armies; and when Napoleon was driven back across the Rhine, after Leipzig, he left behind him 150,000 good troops in German garrisons, an irreparable loss to him. Not much less was the number of men employed to garrison the fortresses of the French frontier; but these were mostly new levies or men unfit for the field, and the writer holds that Napoleon was justified in not abandoning any of those places. When the Allies crossed the Rhine in 1814, the Austrians had a good deal of hesitation about passing the French fortresses, and left large forces to watch them. The Prussians were bolder, and it must be recognized that it was less important then than it is now to guard the communications of an army against occasional interruption. The want of siege guns prevented the Allies from dealing with these places after Wellington's method.

The Turkish fortresses in Bulgaria—Schumla, Rustchuk, Silistria and Varna—formed a quadrilateral which, though less effective than that of Venetia, has played an important part in several wars. It delayed the advance of the Russians in 1828, and again in 1853. In 1877 they decided to march round it; but the improvised fortress of Plevna enabled the Turks to threaten them on both flanks, and siege operations, which they had hoped to avoid, became a necessity. They had undertaken the war with inadequate forces, their position was at one time very critical, and they were only saved by the incapacity of the Turkish generals.

The siege of Sebastopol (1854–5) presents a very different case. It was for its own sake, and for the sake of the fleet which it sheltered, that Sebastopol was attacked and defended, not as a step to ulterior operations. Russian pride became involved, and the so-called siege was in fact a series of encounters between the Russian and Allied armies under conditions favourable to the latter. There was a want of concert between the garrison and the Russian troops outside, which enabled the Allies to win in the end, in spite of many mistakes.

Two examples are taken from the American Civil War: Vicksburg and Richmond. Both made a stout resistance with improvised works; but it would be a mistake to conclude from these instances, or from Plevna and Sebastopol, that there is no need in these days for permanent works. High-angle fire was little used, and for protection against such fire deliberate construction is important. At Vicksburg the mistake was made of sacrificing an army for the defence of a position, which had lost its value as soon as it was shown that it did not really close the Mississippi.

About one-third of the volume is devoted to the Franco-German War of 1870–1. "Metz," says the writer, "was the grave of the French army of the Rhine, not because it is always hazardous for a field army to keep in touch with a fortress, but because the French leader was not equal to the requirements of the situation, and especially lacked the activity and decision of character which are needed for operating under such conditions against an enemy superior in numbers." Instead of allowing himself to be shut up in Metz, he should have used the fortress as a pivot, as Radetzky used Verona. Even when he was shut up there, he might have broken out towards the south-east; and if only part of his army had got clear away it would have formed a most valuable nucleus for the new levies. As it was, the maintenance of the blockade put a very severe strain on the German resources, and came to an end only just in time. This might have been escaped if heavy howitzers had been available to silence the forts immediately after the battle of Gravelotte.

Similarly in dealing with Paris and with the smaller fortresses, the Germans felt the want of siege guns at the outset. Their field guns were quite ineffectual, their transport was ill-organised, and they were obliged to trust to starvation to bring about the surrender of Paris. The food supply was underestimated, and the four months during which it held out gave the country a breathing time which amply justified the fortification of the capital.

The general conclusions of the writer are that railways have given fortresses a new value, whether as mere barrier-places on important lines or as intrenched camps affording prepared battlefields. Experience shows that, instead of going round fortresses and leaving corps to watch them, it is much better for the invader to try to capture them expeditiously. Wellington's example in the Peninsula, and the storming of Kars by a night attack in 1877, encourage the belief that sieges may be accelerated; but heavy artillery and abundant ammunition must be at hand for this purpose. Fortress warfare must not be regarded in future as a distinct thing from field warfare, and must not be handed over to technical corps, but must be directed by the headquarter staff; and there must be a readiness to incur heavy loss when the importance of gaining time warrants it.

It is for this reason, as is explained in the preface, that the subject has been dealt with in this series of monographs issued by the German General Staff; from the conviction that all branches of the army should take more account of fortresses, and should recognise that sieges are not something quite special, but only one of the many shapes of war. No allusion is made to the war now in progress, but from the tone of this volume it can hardly be doubted that the German Staff does not share the strange views of its brilliant eulogist in *The Times* about the "entanglement of Port Arthur," but would range itself with Capt. Mahan.

E. M. LLOYD.

PROBLEMS IN MANŒUVRE TACTICS.

By MAJOR J. H. V. CROWE, R.A., *p.s.c.*, Chief Instructor, R.M. Academy. AFTER THE GERMAN OF MAJOR HOPPENSTEDT.—(Smith, Elder & Co. Price 6s.).

Major Crowe, R.A., publishes an adapted translation of one of those practical German military works which are so conspicuous by their absence in the British service.

Until the translation, some 8 years ago, of Griepenkerl's *Letters on Applied Tactics*, almost the only means that the English student of Minor Tactics had of practising for himself and developing the principles he learnt from textbooks was to procure old promotion exam. papers, with their sketchy maps, and take his solutions to a crammer for criticism.

The 24 schemes which Griepenkerl worked out with such artistic care and logic, and the excellent maps referring to them, supplied an acute want; and many an English major would have been in a sad plight when preparing for "Tactical fitness," had not our German friend come to his aid just about the time that the test was established. At the same time the "Letters" had a stolid, argumentative, "German" flavour about them, which enforced careful and deliberate consideration and much studious "application."

Major Hoppenstedt now presents 224 problems, in 80 pages, followed by their solutions in 80 pages more. The title "Manœuvre Tactics" prepares us for a much more "Field Training" kind of study and for problems of a *solvitur ambulando* nature. The exercises are chiefly on situations, developments and collisions which would occur during manœuvres, rather than the preparation of elaborate schemes before contact with the enemy. There is a breezy, cut-and-thrust emergency air about them which animates them with a vivid realism and renders them interesting as well as instructive.

The solutions to each problem are only sketchy appreciations to guide the student and stimulate him to observe the tactical principles which the exercise is meant to exemplify; the details are left to be filled in, perhaps differently by each solver, according to his military character.

The author says that the book "is designed to assist officers in self-instruction in Manœuvre Tactics and in preparing for examinations, to provide suggestions in the drawing up of schemes for manœuvres, field days, staff rides and war games, and to familiarise officers with the action of the three Arms when working in co-operation"; and it fully satisfies these aims.

It may be well recommended to the notice of any young officer, who is no longer too proud to acknowledge how little he really knows of manœuvre tactics, and what a sorry figure he would cut if he were suddenly confronted by any one of the situations discussed, especially if there were shells and bullets coming from the enemy's weapons. But he must work out the problems conscientiously himself before he turns to the crib at the end of the book. If, on reading Major Hoppenstedt's solution, he cannot see his mistakes, he can argue the matter out with some of the innumerable "instructors" which the reformed British Army now possesses in the persons of all its officers. Then, furnished by Griepenkerl with deliberate fire and by Hoppenstedt with rapid fire, the aspirant to promotion should be able to defeat any Tactical Examination Board with honours.

The problems are all located near Metz; the ground ought therefore to be familiar to most officers who have dipped into modern military history. There are three maps with the book:—(I.) a hill-shaded map on a scale of 1·58 miles to 1 inch for the general work, (II.) a section of the local General Staff map, 2·53 inches to a mile with 20-ft. contours, on which the mere detailed problems are to be worked out, and (III.) a skeleton map, scale 4·73 miles to 1 inch, to follow out the strategical situations of the larger problems.

Map (I.) is a very inferior production, enough to make the hair stand on the heads of our spoilt generals and staffs who are accustomed to our equivalent, 2 miles to 1 inch, beautiful Ordnance Survey map. The names are most difficult to read, while the black hill shading, which covers the paper without giving any idea of the value of the hill features, and the heavy representation of woods and forests, almost obliterate the detail. However, the student who wishes to preserve his eyesight can of course easily procure and use the maps belonging to the German Official History of the 1870 War, which cover the same ground. It is not perhaps a bad exercise for officers to get accustomed to such inferior maps, which they would have to put up with on active service even on the Continent, and which, scale for scale, cannot compare with ours for clearness and military utility, though they may be superior as expensive works of art.

However, this one defect of Map (I.) detracts only slightly from the value of the work, and the Service owes a debt of gratitude to Major Crowe for bringing the book within reach of the British officer. He has converted the units of the German organization into their English equivalents, which conveniently "naturalizes" the text; and the scales of the maps are in miles and yards. Some day, when the reformed War Office can afford a professional library for the officers' mess of each unit of the reformed Army, this is one of the books that should certainly find a place on its shelves.

G. H. SIM.

REPORT OF THE DEPARTMENTAL COMMITTEE ON INDUSTRIAL ALCOHOL.

In August last a Committee was appointed to inquire into the existing facilities for the use of alcohol without payment of duty in arts and manufactures and for the production of motive power; and to determine the conditions of greatest freedom that could be accorded to its use for those purposes, consistently with adequate safety to the revenue derived from spirit as an article of human consumption. Their report has now been presented to both Houses of Parliament.

It had been contended that spirit for industrial purposes was excessive in price owing to the cost of excise supervision, and that in many cases it was rendered unsuitable for use by the process of denaturing.

The Committee examined a number of witnesses, representative of the industries in which alcohol is employed; obtained information as to the regulations in force, in this and other countries, governing the use of spirit for industrial purposes, and as to the quantities of spirit so used; and sent a sub-committee to Germany to inquire on the spot as to the system and regulations established there.

Hitherto two kinds of methylated spirit have been available for use duty free:—(*a*) ordinary methylated spirit, containing 10 per cent. of wood naphtha, which can only be purchased in large quantities from a methylator; (*b*) mineralised methylated spirit, which is the same as the preceding with an addition of ·375 per cent. of mineral naphtha (petroleum) and can be obtained retail. By the Finance Act of 1902 special processes of denaturing, appropriate to particular industries, could be employed, subject to the approval of the Board of Inland Revenue.

The Report points out that the chief hindrance to the use of spirit for industrial purposes is its cost. The wood naphtha used for denaturing costs more than double the price of the equivalent quantity of spirit, and in some cases makes it less efficient for use; but these objections have to a certain extent been met by the Act of 1902, the provisions of which do not appear to have been well known to manufacturers.

The cost of denaturing is not however nearly such an important factor in the price of the spirit as the conditions and restraints imposed on its manufacture for the protection of the revenue; the enhancement in price due to this latter cause is estimated at 3d. per proof gallon, or an increase of about 50 per cent. on the cost that would otherwise prevail. In order to counterbalance this a "surtax" of at least 3d. per proof gallon is levied on all imported spirit.

The final result upon the price of industrial spirit of all the measures taken to protect the revenue may be stated as follows:—Spirit used in manufacture is commonly about 64 over proof (about 93 per cent. on the continental standard of pure alcohol), and is plain spirit. Therefore, the price of a bulk gallon of the spirit is about 5d. more than it would have been but for the excise restrictions. The cost of methylating may be put at between 3d. and 4d. per bulk gallon; so that of the price eventually paid by the manufacturer, which at present may be taken at from 20d. to 22d per bulk gallon for large quantities at wholesale price, about 8½d. is attributable to precautions on behalf of the revenue.

The Committee took evidence as to the use of alcohol for the production of the following:—Coal tar colours, smokeless powders, pharmaceutical products,—fine chemicals, ether, artificial silk, lacquers and varnishes.

As regards the use of alcohol as a fuel for motor vehicles the Report is rather disappointing. It is pointed out that it is not used in this country at present, nor to any great extent in France and Germany, in spite of the fact that both these countries are desirous of encouraging the use of a material that is indigenous in preference to one like petrol that has to be imported; and further that spirit presents certain special difficulties which require to be overcome, the principal being the behaviour of alcohol in very cold weather, and the tendency of the acids generated by its combustion to cause corrosion of the metal surfaces with which they come in contact. Consequently any question of the use of spirit for motor vehicles is one of price; and as at present the price of petrol is about half the price of methylated spirit, close investigation of the matter may be delayed until such time as there may be a sufficient approximation between the prices of petrol and spirit to create a practical alternative choice between the two.

The Committee came to the following general conclusions:—

(1). That where spirit is used for general purposes such as heating and lighting, the present mineralised methylated spirit is perfectly satisfactory in respect of character. In respect of price the cost is enhanced by some 40 per cent. by reason of the measures necessary for the protection of the revenue; to counteract this would be merely to relieve the whole community of a burden in one direction by putting upon it an equivalent burden in another. The regulations in regard to its distribution might, however, be appreciably relaxed.

(2). That where spirit is used for industrial purposes, the Finance Act of 1902 provides adequate and satisfactory machinery for securing that the spirit may be used in a condition suitable to each particular purpose.

(3). That something more is required to place spirit used as an instrument or a material of manufacture on a footing satisfactory in the matter of cost.

The several recommendations may be summarised as follows :—

(1). That an allowance be granted to all industrial spirit, whether of British or foreign origin, at the rate from time to time prevailing for the allowance to British plain spirits on export.

(2). That imported methylic alcohol be relieved from the obligation to pay the surtax, and that methylic alcohol be accorded favourable treatment in the matter of denaturing.

(3). That ordinary methylated spirit should contain only 5 per cent. of wood naphtha, instead of 10 per cent.

(4). That no charge should be made on manufacturers for the regular attendance of excise officers to supervise denaturing operations.

(5). That where spirit is allowed to be denatured with special agents, such agents should be subject to official test and approval; and that accounts be kept in detail of the manufacture and use of such spirit.

(6). That the regulations governing the sale by retail of mineralised methylated spirit should be made less stringent and more elastic.

As regards the use of spirit as a fuel for motors, the following remarks from *The Standard* of 6th May are of interest.

"The Report of the recent Departmental Committee on Industrial Alcohol, appointed by the Chancellor of the Exchequer, has not given satisfaction to the motor trade; and the Society of Motor Manufacturers and Traders, being greatly impressed with the possibilities of alcohol fuel, intends to use all means possible to draw attention to the important bearing it has on the future of the motor industry. The Society points out that at present the demand for petrol in this country is under ten million gallons a year. America already consumes all its own supply, and motorists in this country are dependent chiefly on the oil wells of Roumania and the East Indies. The whole production is under foreign control, and this constitutes a grave danger at all times; whilst in case of war, petrol would doubtless be considered as contraband, and would become simply unobtainable. Moreover, with the increasing use of motor omnibuses and vans, the supply is likely soon to be unequal to the demand. London alone has some 5,000 omnibuses; and on the calculation that these, when mechanically propelled, will run, say, 100 miles a day each for 300 days in the year, 150,000,000 miles will be covered, which (at an average of five miles to the gallon) means a consumption of 30,000,000 gallons annually on this head alone. Besides this, other cities will have their motor services, and vans and heavy vehicles will increase the demand—to say nothing of the larger number of pleasure cars."

J. D. MONRO.

THE TIMES' HISTORY OF THE WAR IN S. AFRICA. VOL. III.

The third volume of Mr. Amery's *Times' History of the S.A. War* is distinctly an improvement on Vol. II. The delay in producing it is probably accountable for this; full advantage seems to have been taken of the criticisms on the second volume and of the additional information that has become available, and the general tone of the comments follows that of the German official studies. The style of writing is pleasant and the work is not overburdened with detail, so that it may appeal to the civilian reader as well as to the soldier student. One great charm of the book is the clear printing on non-glazed paper, and its extreme lightness in spite of its bulky 600 pages enables it to be read in comfort.

There cannot be much said in favour of the principle of interspersing portraits, however artistic, in a work of this class; and the editing in this matter shews want of care, as we find opposite p. 528 the portrait of Major-General Sir Reginald Hart, V.C., K.C.B., substituted for that of Major-General A. Fitzroy Hart, C.B. The maps are very clearly printed, though sometimes there is a tendency to overcrowd and confuse them in the attempt to shew too many different phases and situations of the operations. Those that have hill features shewn by contours are far superior to those where "form lines" are used, these latter being indefinite and often misleading as to relative importance of heights. Where contours are not available it would be preferable to adopt some kind of broken hill-shading lines.

The history seems more accurate and reliable than any yet published, and the controversial matters are treated with less acrimony and partisanship than has hitherto been the case.

The "Crisis at Home" after the reverses of Black Week in December, 1899, is dealt with in a calm and critical spirit. In the publications rushed into print during and immediately after the war its gloom was intensified by the exaggerated accounts of neurotic civilian war correspondents; the inefficiency of officers and soldiers was the popular cry, while the spasmodic patriotic efforts of the English people were unduly exalted by the blatant blare of the illustrated and other newspapers. Mr. Amery recounts in a few pages how the British military organization was practically bankrupt when by the middle of December some 85,000 men had been despatched; for though the calling up of the whole of the 1st Class Reserve on December 17th left nominally 100,000 Regulars still in the country, 40,000 of them were useless from extreme youth or deficient physique and the remainder were an uniformed mob without organization or equipment, officers or staffs.

In the Government party politics produced paralysis. Ministers thought chiefly of defending themselves against attacks of the opposition and the press. Salisbury's cynicism and Balfour's complacency were not likely to guide or inspire the nation. Of the opposition a small section were prepared to support the Government; a portion, including the Irish Nationalists, denounced the war or abetted the enemy; while the bulk under Campbell-Bannerman wobbled flabbily hither and thither in their anxiety to share the credit for the patriotism of the one wing, without foregoing any political capital that might be made by the methods of the other.

Finally in its helplessness the Government accepted voluntary assistance, but in such directions as would give them least trouble in the way of organization. The Imperial Yeomanry Committee, working independently, forming in fact a sort of small War Office of its own, produced in all about 10,500 men. The 1,740 men that went out with the C.I.V. was not a very great result to shew for the patriotic energies of a city of five millions. The fault lay not in any real want of patriotism but in the lack of military training in all but an insignificant portion of the whole, in the absence of the conception of the duty of personal service, and in the passive obstruction of the authorities, in other words in the inherent defects of our national organization. In addition to the 6,209 who joined with the Yeomanry and C.I.V., 16,500 Volunteers went out in the Service Companies and some 1,500 on other services, or about 26,000 in all in the course of the war.

Amid the excitement of raising the new forces the 45,000 men of the Militia who volunteered and were despatched attracted comparatively little notice.

As a general result of the enthusiasm in our population of 40 millions, one man in five of the Militia, one in fifteen of the Volunteers, and about one man in a thousand of the untrained and unorganized bulk of the male population of fighting age came forward in this emergency. The lesson is that the voluntary reserve which we have to rely on for great Imperial emergencies will vary directly with the numerical strength and degree of training of the National Defence force in this country.

A dispassionate review of the assistance accepted from "the Colonies and the Empire" shews that the voluntary patriotism of the Empire outside the United Kingdom and South African Colonies contributed over 11,000 men to the Field Force during the most critical months, and over 30,000 in the whole course of the war. In proportion to population New Zealand, the most democratic Colony, stands first with 6,434 out of a population of 772,719. On the same basis Australia would have had to send 30,984, Canada 44,152 and the United Kingdom 340,284; Australia actually provided 16,632, Canada 8,372. Besides these Ceylon sent 125, and India 250. India also spared 7,794 of her white troops, besides contributing more than 7,000 miscellaneous native non-combatants, who were of the greatest service, and 6,761 horses. Considerable sums of money were also provided by the Colonies and Empire, and doubtless the help in men would have reached a far higher figure had the Imperial Government thought fit to accept the offers made. Regarded not from the point of view of efficiency but simply as an index of national sentiment it was a wonderful result; and it is on sentiment that all political organization ultimately rests and of sentiment that it is composed. The war has shewn not what the Empire can do but what an Empire we can make if we but choose. It has tested our material and foundations and the task now before us is to build.

A very important introduction to the intelligent study of the campaign from Black Week to Bloemfontein is supplied in the discussion, in Chapters

IV., V., of the political and military aspirations and attributes of the Boers, and of the situation in the South African Colonies after Stormberg, Magersfontein and Colenso. The first few weeks of the war were productive of so many surprises, and of so many movements of the centre of gravity of both thought and action, that this revision of the situation is of great use in helping the reader to understand the motives of those with whom the future conduct of operations rested and the difficulties with which they found themselves suddenly confronted. The resolute grasp of the existing situation, and the energetic advantage taken of the enemy's moral inferiority, led to rapid and almost uninterrupted successes to the west of the Drakensberg; the lack of such appreciation on the Natal side produced vacillation with inevitable reverses and unnecessary losses.

The historical account of the actual operations in this volume falls into three divisions;—the operations in the Cape Colony, the campaign in Natal, and the evolution of Lord Roberts' plan; and thus brings us up to the Relief of Ladysmith and the occupation of Bloemfontein.

The first of these three divisions and the story of Ladysmith are contributed by Mr. Lionel James, Buller's campaign by Mr. Bron Herbert, and Lord Roberts' operations by two anonymous writers.

The important political effects of French's success in checking the Boers about Colesberg, and thereby preventing the further invasion of Cape Colony and the rising of the disloyal Colonists, are well brought out in Chapter VI. Commencing with almost a handful of troops, and with his mounted force never more than a third of that opposed to him though comprising half his own strength, he succeeded in bluffing the enemy from November 20th to February 12th. The full and continuous utilization of his whole force was the secret of his success; no other general at that stage of the war brought a larger proportion of his men into the firing line at the point of attack or wasted fewer on his communications and containing forces. The moral effect of French's action brought about the strategical result of inducing the enemy to believe that the British advance would be by Norval's Pont and to denude the rest of the Orange Free State of troops so as to reinforce those at Colesberg, thus facilitating the concentration and surprise movements of Roberts' column at the most critical period of the campaign.

In Mr. Lionel James' story of the siege of Ladysmith it is pleasant to find at last the actual practical value of the Naval Artillery to the defence not magnified beyond its true proportion. The importance of Platrand to the defenders seems however to have been underrated by the historian, as it seems also to have been by Ian Hamilton at first. Its capture by the Boers on January 6th would have probably had the most serious effect. The writer says that the permanent occupation of Wagon Hill itself, or even of the southern crest of Cæsar's Camp, would not have involved the fall of Ladysmith. This is rather avoiding the real issue. The permanent occupation of the southern crest would have proved the inability of the exhausted defenders to drive off the attack, and doubtless reinforcements of fresh men would have led to the permanent occupation of the whole hill. From it the English western line of defence from Red Hill to Ration Post would have been enfiladed, while the northern defences from King's Post to Devon Post would have been taken in reverse at 5,000 yards range, and the interior communications of the garrison would have been at the mercy of the enemy's rifle fire. It would seem therefore that the Boers were justified in making a strenuous effort to capture this, the key of the defence, and their failure accounts for the half-hearted nature of the last part of the siege; while it is clear that no efforts or sacrifices on the part of the besieged were too great to retain this vital point in their possession.

Hardly enough credit seems to be given to General Hunter, to whose untiring devotion and resourceful skill the successful maintenance of the defence was unquestionably due, and his portrait might well have replaced one of the less remarkable of those facing p. 166.

In the Chapter on the Tugela operations there is an impartiality about the occasional comments and, generally speaking, a correctness in fitting the boots on the right legs, as well as an accuracy in description of tactical details, which have been hitherto too often conspicuous by their absence. The criticisms are outspoken and the strictures sometimes severe, but the truth is summed up in the remark that "Spion Kop was lost not by Buller or Warren or Thorneycroft but by Aldershot and Pall Mall, by the House of Commons and the nation."

Complete ignorance or disregard of the elementary principles of scientific organization and of staff work essential to the handling of large bodies of troops in the field,—want of confidence by the leaders in their own powers of leadership,—lack of rapidity of movement when surprise was a chief factor,—absence of initiative on the part of the subordinate generals in carrying out the section of operations assigned to them,—unwillingness to push into the fight all the troops available, in other words misconception of the use of reserves,—avoidance of losses carried to an absurd extreme, or the attempt to make omelettes without breaking eggs,—inability of the generals to use Artillery and Infantry in combination,—utter failure and breakdown of intelligence and reconnaissance work,—supineness in transmitting information in the field,—these are all in turn insisted on as causes of failure rather than the deficiencies in the subordinate leaders and rank and file. We may perhaps add to the above the old British manœuvre habit of breaking off the fight in time to be home for tea, sometimes at the most critical moment when victory was just within grasp. "The battle of Vaal Krantz," writes Mr. Herbert, "was lost in the very moment of victory." It is difficult however to understand the severe stricture on the qualities of the British soldier which we find on p. 298. "Neither in skill with the rifle, nor in individual intelligence and initiative, nor in physical and moral endurance was the British soldier equal to the terribly exacting demands of modern warfare. The constant reinforcement of the summit of Spion Kop only increased the overcrowding, added to the casualties and contributed to the demoralization of a considerable part of the force. Yet on the other hand a smaller force of the same men would have been rushed off the summit by the Boers. Spion Kop might have been held against all comers by 500 men, but not by 500 ordinary British soldiers, nor by 5,000." This appears to be a blot in an otherwise calmly and judicially told story. It can hardly be the meaning of the writer to discount the courage of the British soldier, and it would be an insult to Mr. Herbert's intelligence to suppose that he considers 500 heroes of any nation would have held Spion Kop unaided against the attacks made by the Boers on the 24th January. Has he forgotten that the hill was held by the British force there, considerably less than 5,000 men, for 15 hours under heavy artillery and rifle fire from 3 sides; and that this force retired in good order at night under instructions from their properly appointed commander, bringing away all the wounded that could bear moving and the reserve ammunition; and that there was no panic or demoralization among the rank and file at any rate. Nor is the above opinion of the British soldier consistent with the closing words on the Tugela Campaign on page 552. "The deficiencies of the British officer and of the men whom he led were many, and they have been dealt with in more than one chapter. But their deficiencies were, after all, completely overshadowed by their virtues; and it was these virtues that, in the end, broke the Boer resistance and relieved Ladysmith. Their fearless courage, their patient endurance, their imperturbable cheerfulness in defeat, their unquestioning loyalty to their leader lend dignity and pathos to a story, most of which would otherwise be profoundly depressing, and give sure hope of better things. If there is one clear lesson we may draw from the Tugela Campaign, it is that British soldiers, trained as they might be trained and led with courage and science, need fear to match themselves with no army in the world." Probably there is some printer's error which has escaped correction in the sentence quoted from page 298.

The history of Roberts' great flank march and successful advance to Bloemfontein has been written anonymously, but the writing bears evidence of being from the pens of soldiers rather than civilians. There is a more military precision in the details, and less bitterness in the criticisms than in the rest of the book. The plain unvarnished tale of French's charge at Klip Drift reminds one of Henderson's accounts of Stuart's exploits in the American War. Calm and straightforward criticism of Kitchener's and Roberts' tactics and strategy at Paardeberg, and of French's and Kelly-Kenny's over-caution at Poplar Grove, appeal to the military reader with greater force than the mere scathing flagellation of the delinquents on the Tugela. It would be difficult to find eulogy of a great success expressed more forcibly or with more dignity than on page 595. "This was Lord Roberts' work. To him and to no one else England owed this great result. Circumstances may seem to have favoured him; each one of his successes owed much to the skill and determination of his subordinates. But it was he, the man himself, who seized the favouring chance and directed it to his ends, whose bold designs furnished skill with meet occasion, whose quick spirit kindled a responsive fire. Boldness of conception, singleness of aim, fervour in execution, fearlessness of responsibility—these were the qualities Roberts brought to bear on a situation fatally compromised and entangled by original unpreparedness and subsequent failure, and it was by these that he turned defeat into victory."

G. H. SIM.

NOTICES OF MAGAZINES.

BUILDING WORLD.

May 13th and June 3rd.

MAXIMUM LOAD DUE TO A CROWD.—The results are given of some experiments carried out at Harvard University, U.S.A., to ascertain how great a load of people may be crowded within a given space.

With men allowed to face in various directions a maximum load of 156 lbs. per sq. ft. was obtained. With men facing all one way the load was equal to 176·4 lbs. per sq. ft., and with men averaging 163·2 lbs. each the maximum load was 181·3 lbs. per sq. ft.

These figures are greater than those given in Molesworth's, and the R.E. Field Service Pocket Books, which are respectively 120 lbs. per sq. ft. and 133 lbs. per sq. ft.

N. KIRBY.

FORTNIGHTLY REVIEW.

June.

A CENTURY OF EMPIRE is a thoughtful contribution (*written a year ago*) by Major-General Sir Thomas Fraser, K.C.B., late R.E., on the increasingly important subjects of Imperial Defence and Home Defence. The leading newspapers and magazines perform their most honourable duty to the State in publishing such articles as this, but unfortunately the general public seldom reads them; it is only a comparatively small section of the great B.P. that seriously studies the question of Defence, or realises how absolutely vital it may become at any moment to the Nation and to the Empire; the rest—the "man in the street"—prefers to read or hear the misleading though comforting misapplications of principles by influential civilians.

The writer forcibly draws attention to the fact that, whereas a century ago we were the absolutely supreme Naval power, we are now the greatest Continental one, possessing inland frontiers which require protection from most of the great military Powers of Europe, Asia and America. At the commencement of the 19th century our continental footholds (exclusive of India, where we bordered native states of comparative insignificance, and Canada, where we marched with people of our own race) were two in South Africa (the Cape and Sierra Leone) and one in Central America (Honduras). At that time, with a third of our present population, we maintained a million armed men; but after Waterloo the maintenance of this great military strength was no longer necessary, as we were then secure from attacks on land.

Since that time the whole situation has changed. Our share of the earth's surface has grown to $\frac{1}{5}$th of the whole and the populations under our rule to about 450 millions,—far exceeding in both respects the next power in extent, Russia, with $\frac{1}{7}$th of the earth and 140 millions of inhabitants. We now march *on land* with all the great military and naval powers, except Austria and Japan; our frontiers extend from 25,000 to 27,000 miles, bringing us into contact with 1,200 millions of people in three continents, principally under the spheres of China, France, Germany, Italy, Turkey, Russia and the United States. We are thus attackable on land *independently of sea power*.

In the meantime other factors have affected us, mostly adversely, as regards self-defence. The world has shrunk under the influence of steam and electricity. Land transport has relatively gained more than sea transport by the use of steam; railways now permit the transfer of large forces over long distances, and even enable a power deprived of the open sea to transport small war vessels over land. Though steam in place of sails has increased the speed of ships, steam navies, dependent on coal, are tied to the land, to the great trade routes or to the lines of coaling stations; warships are so expensive that they cannot be risked against equally well-armed land defences, and they are now, moreover, more liable to unexpected attacks in open harbours and narrow waters; all of which has rendered less certain the forecasting of results of warfare on sea. Though we are still the greatest naval power at present, other great navies have arisen or are arising to front rank; we have practically reached the limit of expenditure on our navy, but other nations have not; and the strong conscript armies of most of these other nations afford greater support to the offensive power of their fleets. The lax interpretation of the duties of neutrals may enable our enemies to utilize neutrals in such a way as to render nugatory the many advantages we assume that we possess. We are no longer alone in possessing for defensive and offensive purposes the strength afforded by armed forces of our subject races.

And withal our Empire has grown on the commercial lines of least resistance and not on strategical lines; it is relatively scattered, and ill-grouped for defence as a whole. "We sleep in a security that was ours a century ago, but is ours no longer." Three times our present naval strength cannot protect us on land where we can be invaded on land beyond the reach of our naval strength. Conflicts must in the main be decided on land. No navy can relieve us of the necessity of possessing considerable and efficient land forces as well. The great lesson of the present war in the Far East is that decisive results are impossible unless *both* military and naval forces are in proportion to needs.

The theory of the "blue-water school" is that our theatres of war comprise the oceans of the world, our frontiers the coasts of our enemies, and our objectives the enemies' ships. This means that our fleets must be freed for action where required, and the theory may meet the case of Imperial Defence. But can we also count at Home, *at all times and uninterruptedly*, on superior sea power to protect us at Home on land?

There is no alternative for us but to accept the principle of personal obligation to defend our homes. At present the leisured upper classes provide our officers and the least successful in the labour market provide the majority of our men, whilst the great middle class as a whole do nothing personally towards their duty to their country. There is no remedy except the formation of an army at Home, properly organised, trained on one system, and exercised annually. This and this only will meet our requirements and produce the required reserve of strength.

A. T. MOORE.

GEOGRAPHICAL JOURNAL.

June.

THE PROBLEM OF THE UPPER YANG-TZE PROVINCES AND THEIR COMMUNICATIONS is a paper read at a Meeting of the Royal Geographical Society by Lieut.-Colonel C. C. Manifold, I.M.S., describing a journey made in 1904 by himself, with Capts. E. Barnardiston and E. W. S. Mahon, R.E., Mr. C. G. Nix and five Indian surveyors. The exploration was in continuance of journeys made by the same traveller in 1900 and 1901–02 to the Upper Yang-tze, starting in one instance from Burma and in the other from the Yellow River; and extended the information procured by Capt. C. G. W. Hunter, R.E., the late Capt. W. A. Watts-Jones, R.E., Major H. R. Davies, O.L.I., and others. The journey here described was for the special purpose of investigating Se-chuan, the largest and most wealthy of the eighteen provinces of China.

THE IDEAL TOPOGRAPHICAL MAP is a paper read before the Research Committee of the Society by Major C. F. Close, C.M.G., R.E. (head of the Topographical Section of the General Staff). The author considers that a topographical map should possess the following qualities:—

(1). All the information which it presents should be accurate.
(2). It should present as much information as possible.
(3). The information should be presented as intelligently as possible.

The first quality mainly depends upon the methods used in the field.

As regards the amount of information, the governing factors are the scale of the map and the character of the country. It is suggested that the wide margins in common use might be utilized for presenting additional information in the form of photographs of typical scenery and of special objects or landmarks.

Intelligibility rests mostly on the use of colours and the shading of the hill features; as regards the latter, the depth of the shade should vary with the steepness of the slope and should not depend on any imaginary direction of the incident light; there is no satisfactory example of the best system, viz., the combination of contours and shade varying with steepness. Contour intervals should be 50 feet for a scale of 1 inch to 1 mile, and in inverse proportions for other scales.

Various British and Foreign productions are quoted as instances of efficient maps or of omissions and defects.

The paper was followed by an instructive discussion in which Colonel D. A. Johnston, C.B. (Director-General of the Ordnance Survey), Major E. H. Hills, C.M.G., R.E. (late head of the Topographical Section of the General Staff), Mr. Douglas Freshfield, Mr. E. A. Reeves (Map Curator of the Society) and others took part; and resulted in the Committee recommending that the Society should vote £100 for the purpose of producing what might be accepted generally as a typical topographical map that would serve as a guide for, and a standard to be used by, the Society.

GLAREANUS.—Mr. Edw. Heawood, Librarian of the Society, writes of the Geography and Maps of Henricus Glareanus, with special reference to the recently discovered manuscripts of his *De Geographia Liber* (see *R.E. Journal* of last month).

A. T. MOORE.

JOURNAL DES SCIENCES MILITAIRES.

April, 1905.

STRATEGICAL CRITICISM OF THE FRANCO-GERMAN WAR.—*II. Woerth and Forbach.*—By M. A. Grouard.—The writer aims at shewing that at Woerth MacMahon's proper course was to retire to the more advantageous positions behind the Eberbach, along the Gros Wald and about Ingwiller, and not to accept battle on the 6th August. He was outnumbered by the Germans by more than two to one, and expected very insignificant reinforcements. This course had been strongly urged on him by Ducrot, and he had agreed and actually given orders for the retirement; but when the firing commenced, he changed his mind and committed himself to a battle of which the only possible result could be the crushing of his force. Even up to one o'clock MacMahon could have broken off the action at any time; but after the envelopment of the French right through Morsbronn, the failure of Michel's grand cavalry charge to extricate the right of the 4th Division, and the development of the close fight in the Niederwald and at Elsasshausen, an orderly retreat was no longer possible. The tactical discussion of the principal phases of the battle is directed towards establishing the time up to which it was possible to retire in good order.

At Forbach (Spicheren) on the other hand, the French had at first a quite inferior force of the enemy opposed to them, and this could only be reinforced gradually after crossing a difficult river, the Sarre. The cause of defeat in this case therefore lay in the conduct of the action itself, and not in faulty strategy as at Woerth.

EVOLUTION OF FRENCH INFANTRY TACTICS FROM 1791 TO 1905.—This is the third and concluding article of the series and deals with the developments from 1901 to 1905. The Infantry regulations of 1894 were superseded by the provisional issue of 1902, and again improved up to date in December, 1904. It does not appear that the principles differ materially from our own field training. Volley firing has practically been abolished. As far as possible all formations and movements which are inapplicable in war are to be excluded from peace training. The initiative of captains of companies and section leaders is encouraged. The battalion commander in the attack indicates the front of action (not generally to exceed 300 yards for 800 men), tells off the companies for first line and support, gives all officers full instructions as to objective and direction arranges for the scouting sections if the country is not too open, and for ammunition distribution and replenishment, and then leaves the carrying out of the fight to the subordinate leaders. The chief principles insisted on are that :—

Initiative is everything, and the offensive is the grand function of Infantry. The defensive is only to be assumed temporarily as preparation for resuming the offensive.

Fire is but an auxiliary to movement, and it is the advance only that is decisive and irresistible.

The direction of the fight is always in the hands of the leading sections. Subject to the general instructions received and the co-operation of those on each flank, the section leaders must be fully independent, and must use the ground features intelligently and seize opportunities on their own initiative.

At the commencement of the regulations appears this important order :—" It is forbidden to curtail or to expand by more precise detail the instructions contained in these regulations, which prescribe the method of training the different units and of leading them in action."

ARTILLERY ESCORTS (*3rd Article*).—Cavalry escorts should send scouts well in advance of field batteries, keeping the main body in hand on the exposed flank, ready to charge attacking cavalry if inferior in strength or use dismounted fire if the enemy is in force. With horse artillery the cavalry escort should send scouts far ahead during the advance, the remainder of the escort preceding the batteries to use vigorous action against any opposition, so as to enable the guns to come into action. When the batteries are in action the main body of the escort can be withdrawn and rejoin the Cavalry unit, for if the horse artillery has timely intimation of attack it can meet it with its own fire.

Artillery ought to be able to protect its own front against a frontal charge even up to close quarters, with shrapnel fused to zero; but the smoke produced by the bursting of these shells close in front of the battery is likely to make a screen for the enemy's approach. It seems a pity therefore that the modern equipment has abolished case. Half-a-dozen rounds in the limber might often prove useful.

The great improvements made lately in mitrailleuses have led many nations to attach them permanently to their Cavalry and Mounted Infantry units. It is suggested that they may also prove a valuable form of escort for Field Artillery. Their lightness, mobility and fire power would render them useful during the march to check an attack from any flank or to clear defiles; while batteries in action could have their fronts protected by them from the flanks, or their flanks and dead angles secured. Against cavalry charges they would be efficacious, and also for protection of Artillery in bivouac or park at night, when it is very exposed to attack. They can generally fight from concealed positions and so minimise their vulnerability; or, if provided with steel shields, can even be used in exposed positions. Each battery might well be provided with its own mitrailleuse. This would go far to solve the difficulties of the provision of Cavalry or Mounted Infantry escorts except for scouting purposes. Mitrailleuses might be specially useful in preventing the enemy's infantry occupying a position, such as the edge of a wood, whence they can annoy the artillery; for it must be remembered that, if the enemy can bring infantry fire, even in small amount, within 1,000 yards of a battery, he can put it out of action without any actual attack.

G. H. SIM.

RECENT PUBLICATIONS.

Instructions for Practice Seawards: Royal Garrison Artillery, 1905–06. (8vo. Official).

Instructions for Practice: Horse and Field Artillery, 1905. (8vo. Official).

The Soldiers' Handbook for Use in the Army of the United States. (12mo. Washington).

The Science of War, by the late Colonel G. P. R. Henderson, C.B.; edited by Capt. N. Malcolm, D.S.O., with a memoir of the author by F.M. Earl Roberts, V.C. ($8\frac{3}{4} \times 5\frac{3}{4}$. 14s. Longmans).

Vierteljahrshefte für Truppenführung und Heveskunde, 1905. Heft 1 and 2. (8vo. Berlin).

Unsere Militärische Lage und die Wehrreformen, von einem offizier. ($9 \times 6\frac{1}{4}$. Freytag und Bernat, Vienna).

Mouvements et Transports. Sections de chemins de fer de campagne et questions connexes. (8vo. 1 fr. Lavanzelle, Paris).

Napoleon: The First Phase, by Oscar Browning. (10s. 6d. Lane).

Etudes sur les Armées du Directoire. 1re Partie: Joubert à l'armée d'Italie; Championnet à l'armée de Rome (Oct., 1798—Jan., 1799). (8vo. 10 frs. Chapelot, Paris).

Le Victoire à Sedan, par Alfred Duquet. (8vo. Paris).

History of the War of 1812 *between Great Britain and the United States of America*, by James Hannay, D.C.L. (8vo. Toronto).

The Times' History of the War in South Africa, 1899—1902. Edited by L. S. Amery. Vol. III. (9×6. 21s. Sampson, Low, and Marston).

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RECENT MEASUREMENTS OF THE SUN'S DISTANCE.

EROS CAMPAIGN 1900-01.
DISTRIBUTION OF OBSERVATORIES

FIG. 1.

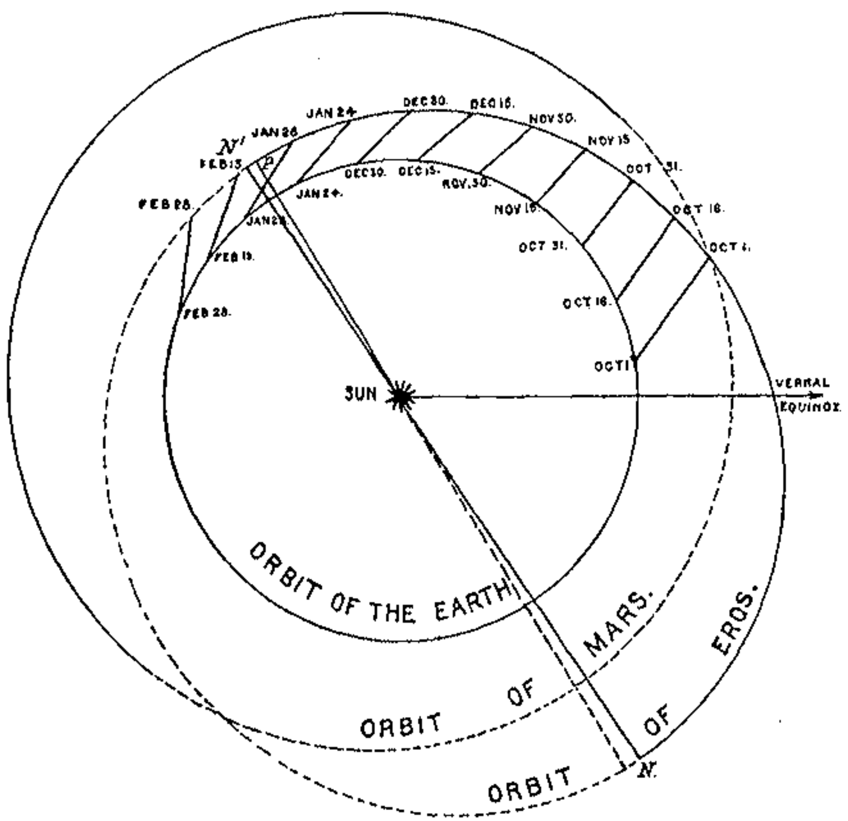
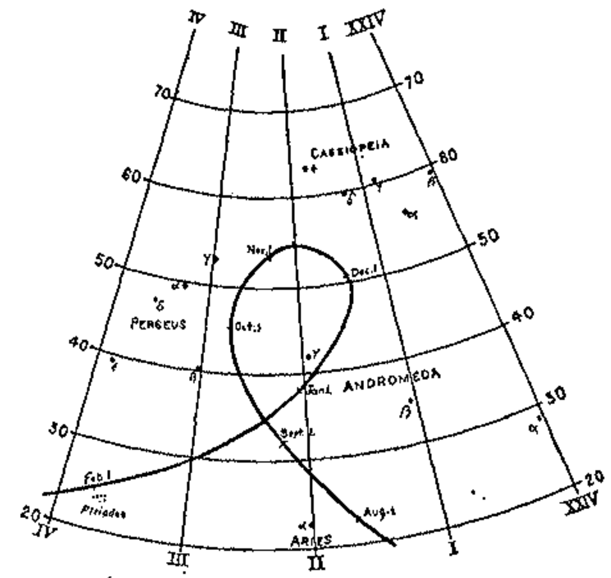


FIG. 2.—Relative Positions of EROS and EARTH from Oct. 1st, 1900, to Feb. 28th, 1901.



PATH OF EROS, 1900-01.
FIG. 3.

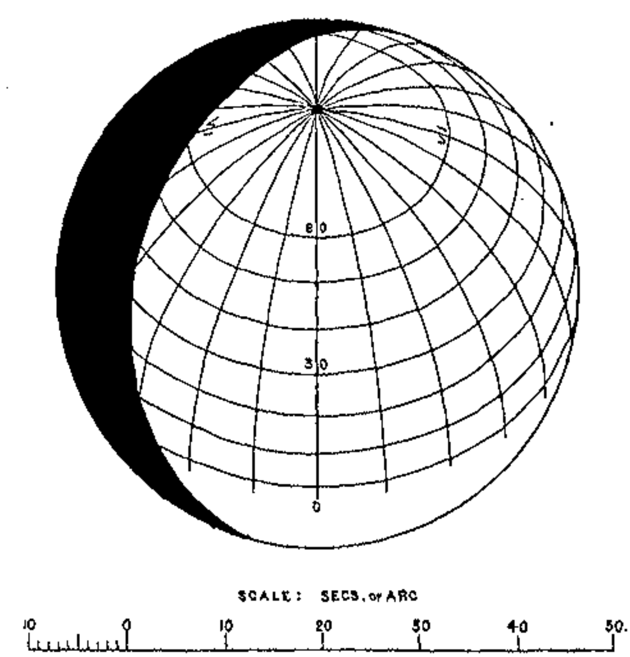


FIG. 4.—Meridians and parallels of latitude of the Earth as seen from Eros, Dec. 2, 1900 (negative). The blackened portion represents the bright crescent of the Earth, the planet being more than a month past opposition.

FIG. 5.—LIGHT CURVE OF EROS. Whole period 5h. 16m.

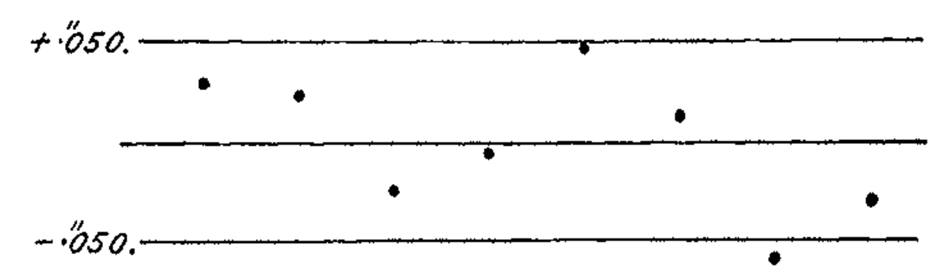


FIG. 6.—Residuals grouped in eighths of the whole period.

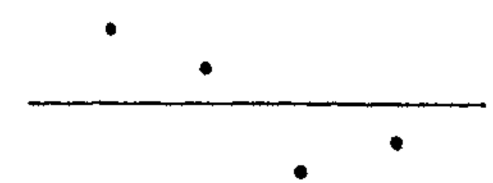
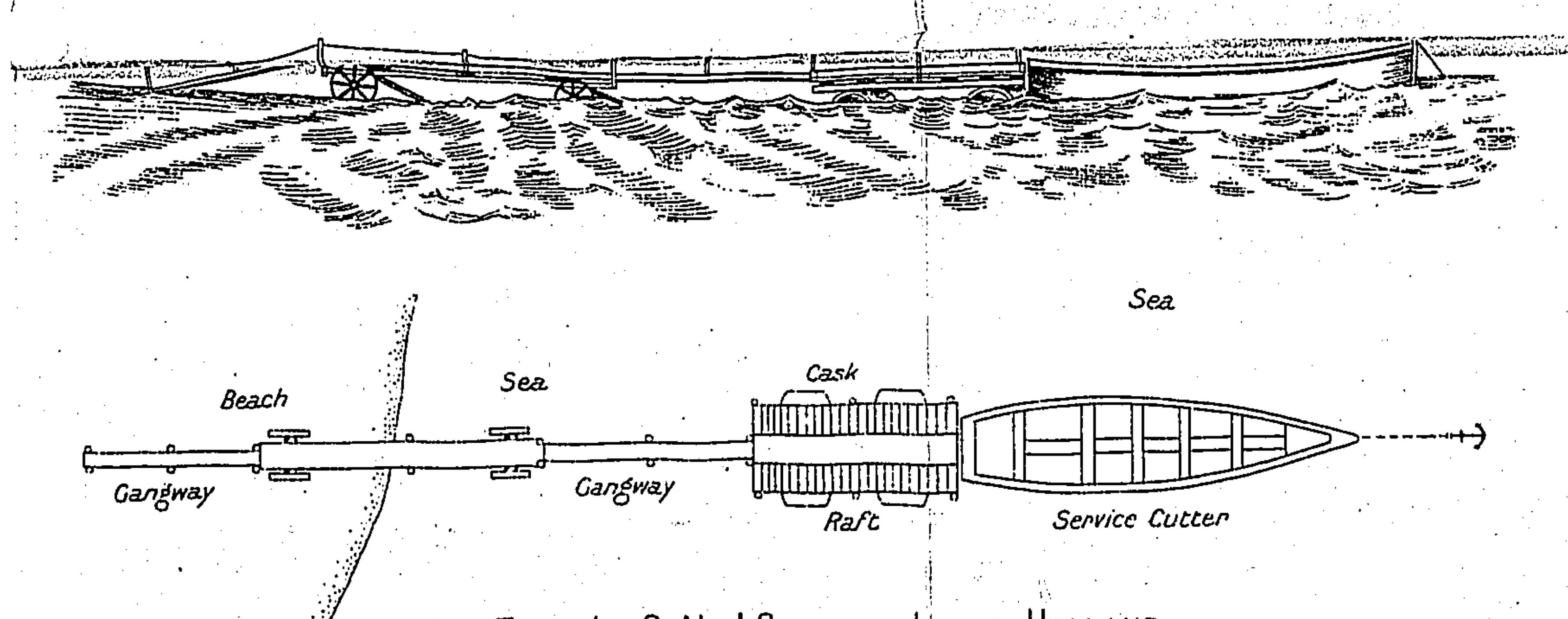
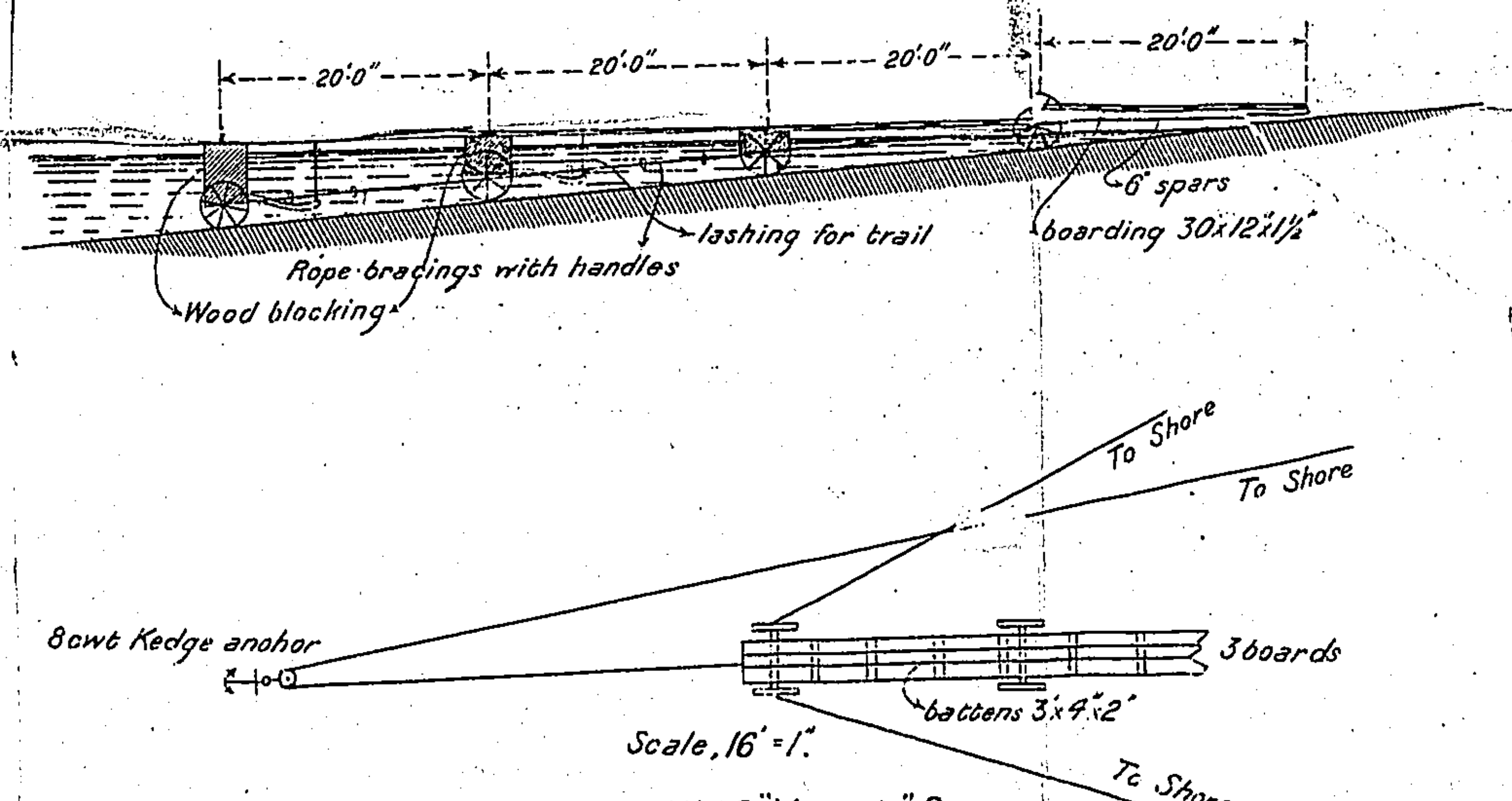


FIG. 7.—Residuals grouped in quarters of the half period.

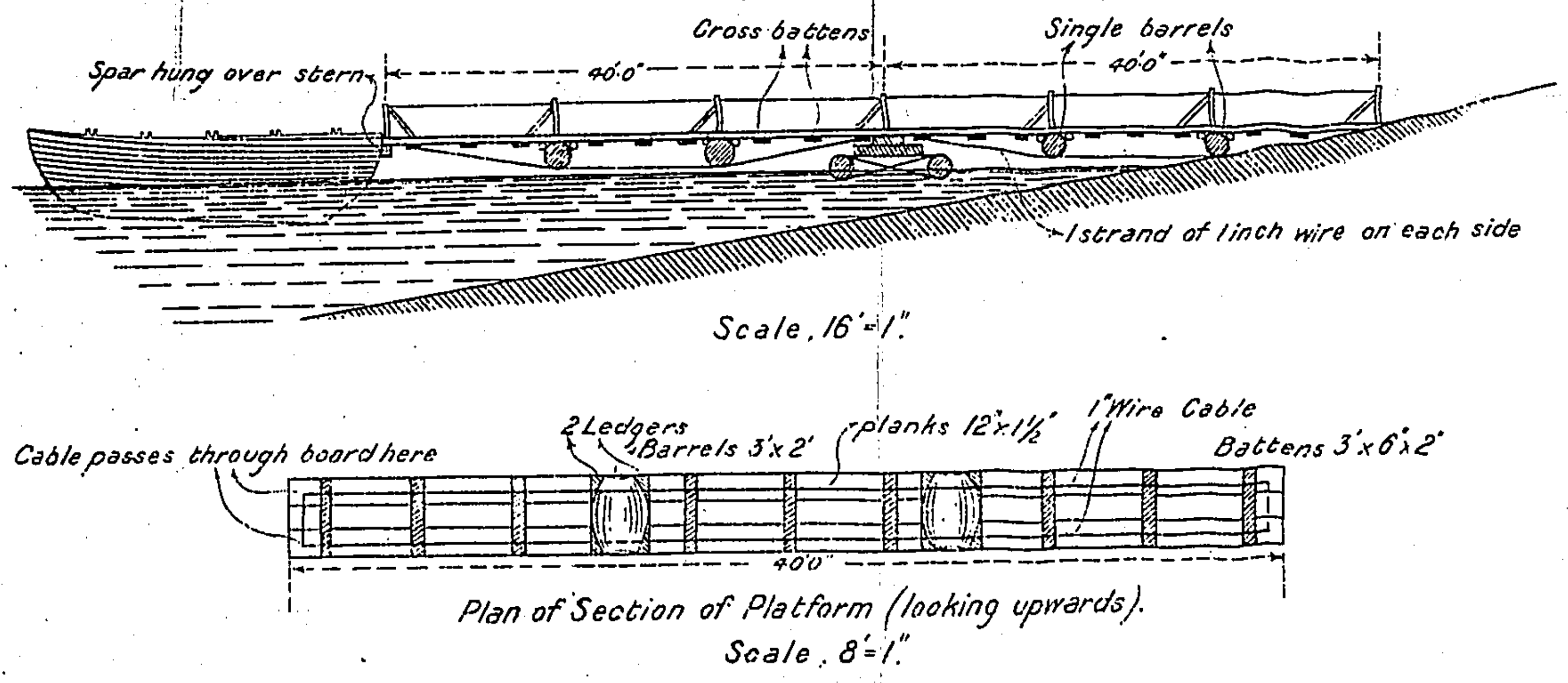
Landing Operations at the Essex Manœuvres. 1904.



Figs. 1 & 2, No. 1 Stage at Little Holland.



Figs. 5 & 6, H.M.S. "Kent's" Staging.



Figs 8 & 9, H.M.S. "Monmouth's" Staging.

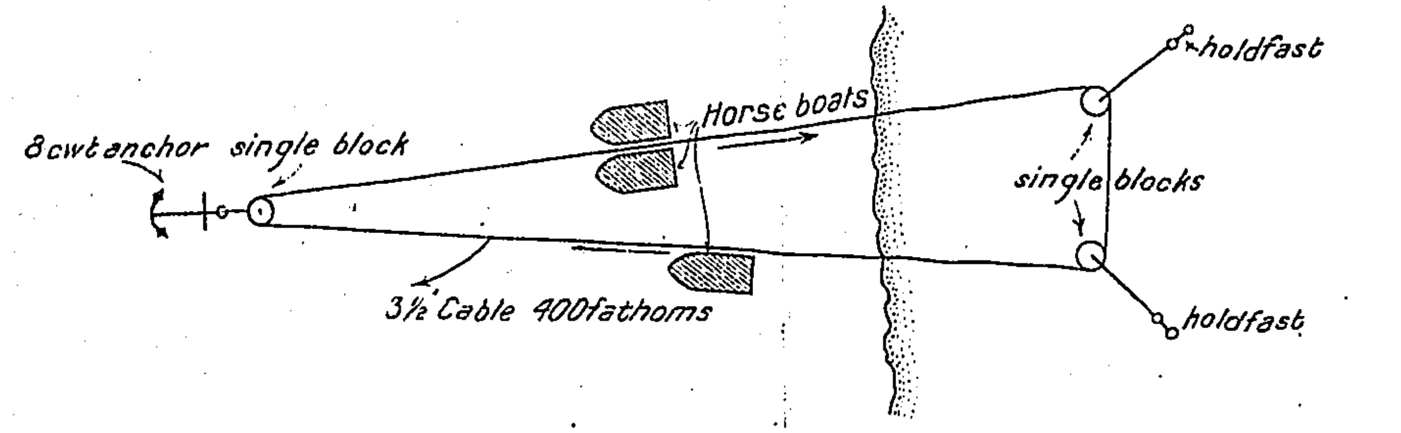


Fig 10, Disembarking Cavalry.

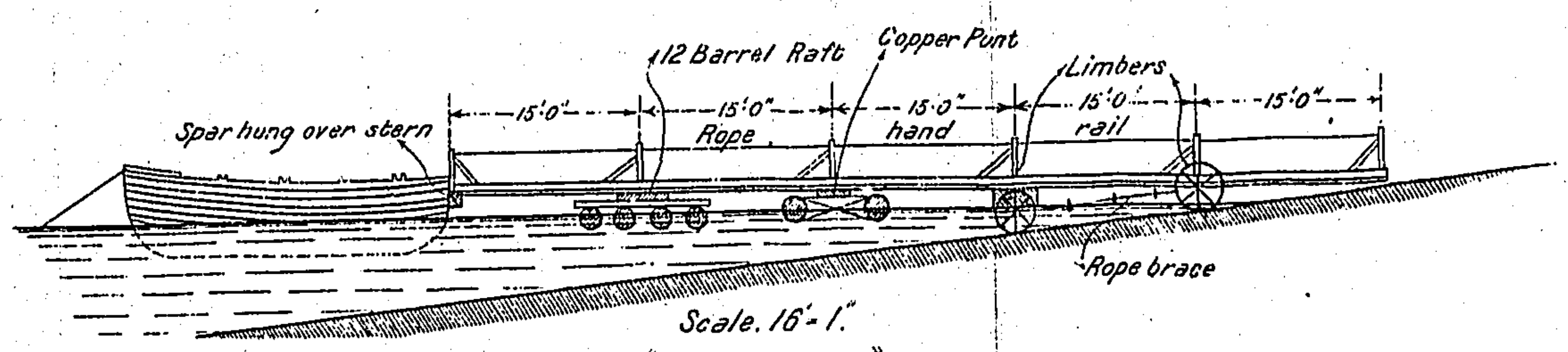
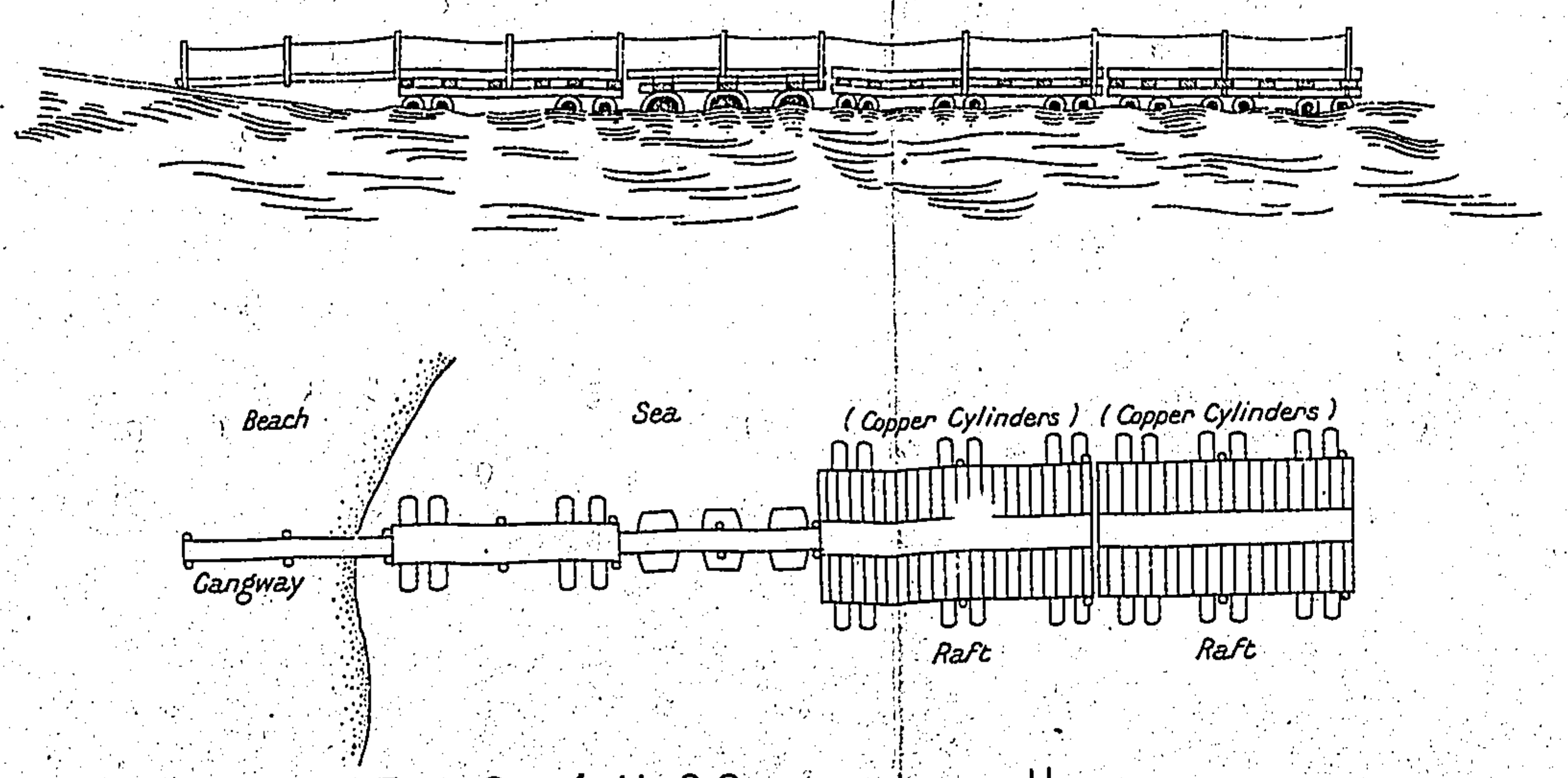


Fig 7, H.M.S. "Good Hope's" Staging



Figs. 3 & 4, No. 2 Stage at Little Holland.

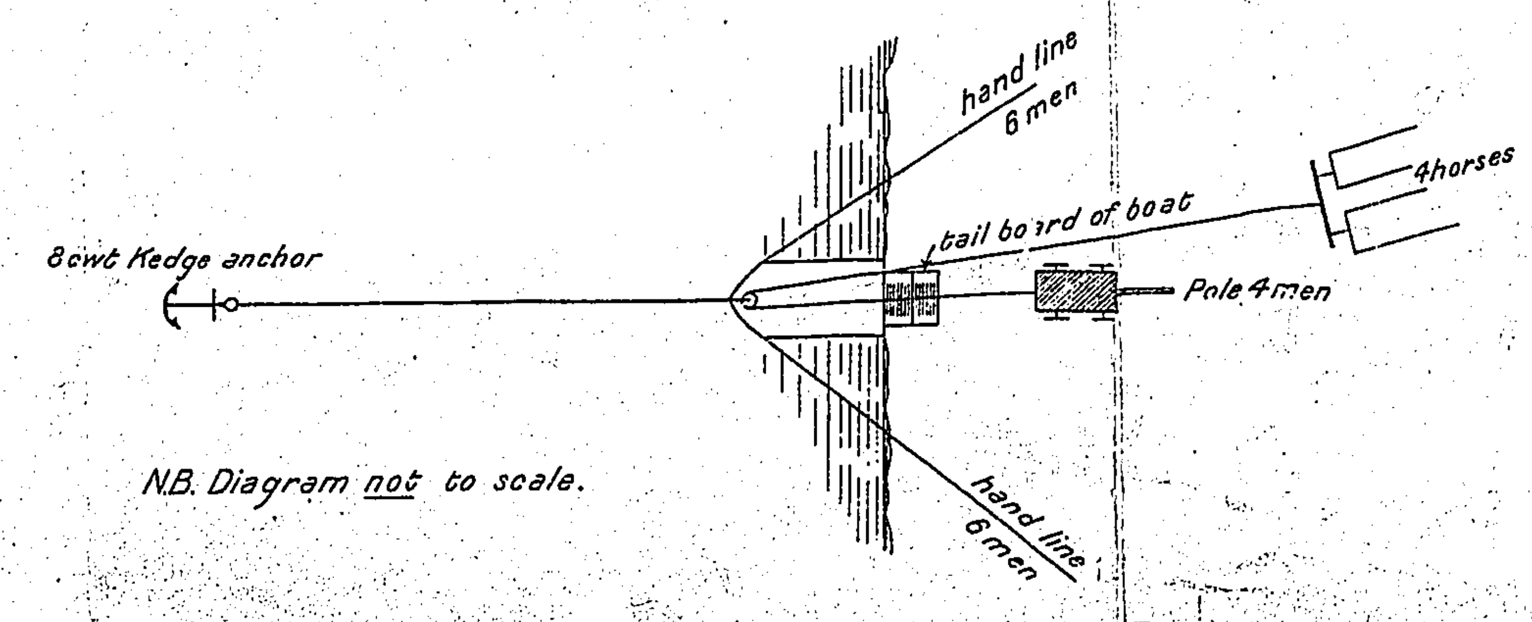


Fig 11. Embarking Wagons on Horse Boats.

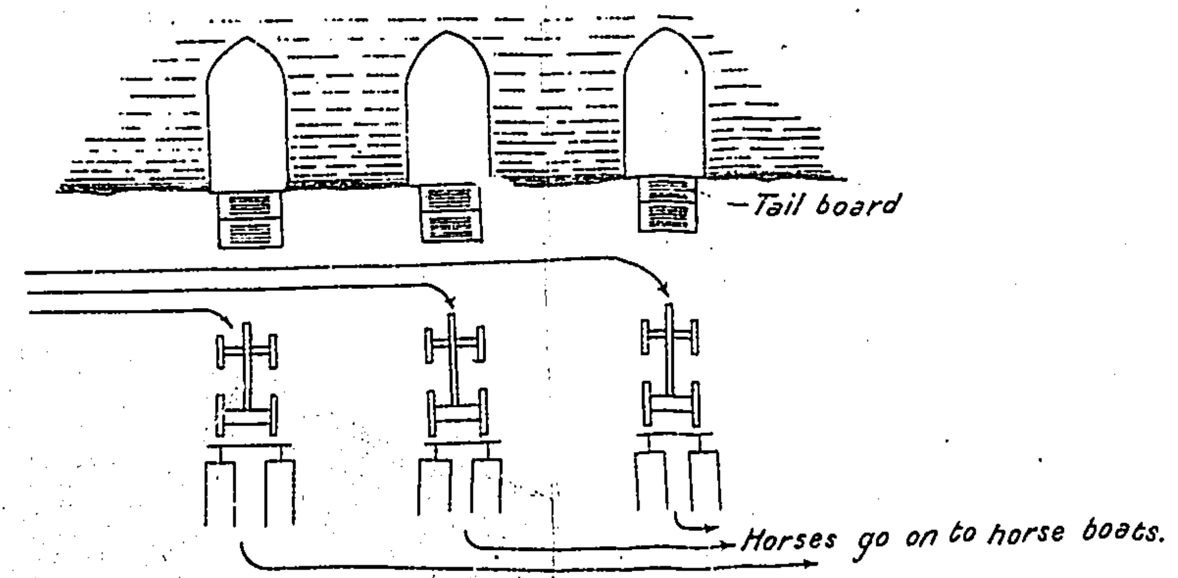


Fig 12. Embarking Artillery.

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