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MILITARY TOPOGRAPHY.

By Major WILLOUGHBY VERNER, Rifle Brigade.

PART I.

THE Council of the Royal United Service Institution have done me the honour to invite me to give a lecture on Military Topography, and I must admit that I feel some little difficulty in approaching this subject, inasmuch as I have not only published various books and pamphlets on most matters connected with military topography, but have, during the last year, given two lectures before the Irish Military Society, which have been printed and had some circulation. Thus it is that I have nothing new to say about military topography, so far as regards new methods or appliances for sketching, since I last lectured on it, and, in consequence, I shall to-day simply reiterate my views as to what I believe to be the proper course of instruction for our officers in this most important branch of military art. But I shall do so with the more confidence, for not only are there signs that public opinion has been awakened on this subject, but further, because I have very good reasons for believing that what I have always said, and said again last April, as regards the system of instruction hitherto adopted in our army, has not been entirely without result.

In recent years the processes of scientific surveying, more especially as regards *rapid* work, have advanced enormously, and it is my object to-day to show how the rougher processes, commonly styled "military sketching," have likewise made great strides.

Before launching forth into the subject I cannot too strongly insist on the wide difference between *military surveying* carried out with scientific and elaborate instruments, generally of considerable weight and bulk, used with due care and without hurry, where an error of a few feet is considered careless work and where the essence of the work is absolute accuracy, and *military sketching*—the rough-and-ready work done sometimes even without any instruments, or, at best, with portable or easily extemporised ones—carried out in as rapid a manner as possible, where a hundred yards error more or less is immaterial and where the essential factor is *time*.

I do not intend to-day to deal with the recent developments in scientific surveying; they are essentially the affairs of our trained surveyors. To those interested in this branch I would recommend an admirable little work styled "Preliminary Survey and Estimates," by Mr. Theodore Gribble, C.E., one of the "Text Books of Science" series.

I start, then, with this postulate, namely, that we want to train our officers to a sound knowledge of military topography, and to be more or less expert in military sketching—I say more or less with intent, for I thoroughly disbelieve in making, or rather in trying to make, all men artists; I simply refuse to admit that the value of the work produced by some men who have no natural turn for using a pencil is in the least degree commensurate with the time and trouble spent by them in attempting to learn to draw.

Let us, before going any further, clear the ground by asking ourselves the *object* of teaching men this "military topography." The answer is obvious enough, and may be broadly given as follows: (1) to give them a tactical knowledge of ground, (2) to enable them to make full use of existing maps, (3) in some few exceptional cases to teach them to make a rapid reconnaissance sketch and report of a road, river, or, very rarely, of a position.

It is obvious that the first two are absolutely essential, and are daily and hourly required by all soldiers, whereas the third is, at best, only a possible eventuality.

Now for many years the be-all and end-all of instruction in military topography has been to force every officer, no matter how helpless he might be with a pencil, to "make a sketch" with a prismatic compass sketching case, protractor, and clinometer.

I am, of course, aware that of late years the cavalry sketching case has also been taught at our educational establishments.

In addition to this delightful occupation of making a sketch which he, the operator, well knows will probably be absolutely of no use to anybody—a melancholy satisfaction at best—there has been, and is, a theoretical examination, without passing which no man can ever expect promotion. This entails the solving of various problematical and, generally speaking, extremely unlikely conundrums, commonly based on some person having foolishly or carelessly made a map with no scale on it, or on conveniently finding a "dead Russian officer," who had obviously with malice aforethought, before he was shot, stuffed his pockets with maps, which neither he nor anybody else could possibly have used, and which were clearly intended solely to annoy and irritate British officers attending garrison classes and other examinations. As regards the first part of this course—the prismatic compass sketching—whenever I have raised my voice against this supposed infallible process and pointed out the small benefits derived from it, I have been met with the reply: "Granted that we do not expect to succeed in making many men draw, but still it is the best way to make them study ground, and so appreciate its value for tactical purposes." Here I join issue at once, for it is easy to demonstrate that this prismatic compass sketching is the most

laborious and the worst possible way of giving men a tactical knowledge of ground, since 19 out of 20 who attempt it are so engrossed in the processes of shooting angles, and subsequently plotting them, that all ideas of the "general run of the ground" they are working on, for tactical purposes, are inevitably forced into the background. Secondly, the process in no way whatever teaches map-reading; and lastly, it is a most indifferent way of making a reconnaissance sketch, as I shall proceed indisputably to show. Destructive criticism is, as we all know, easy; it is, therefore, my task to show what better methods are at hand.

I will start with the first and most important object of military topography, namely, to inculcate a tactical knowledge of ground, and briefly outline the method of instruction which experience has proved to me (and, I am sure, to many others before me) to be the most effective. To give the first instruction in this, a large scale shaded and contoured map of some accessible bit of ground, such as this one of Dover, should be fixed on a plane-table and taken to the portion of country it represents. Here the table should be "set," and various objects identified. I will not waste time in going through this obvious course of professional instruction, but content myself by saying that, by degrees, a man can be shown how to find his place on the map by the various processes of resection, and how to set his board with and without a magnetic compass; also how to estimate and measure, by scale or extemporised scale, such as the span of one's hand, &c., the distances of various objects, and perform for his own information, and actually in the field, for practical purposes, the various processes, such as determining the visibility of points, which for years have been considered to be in the exclusive domain of theoretical examinations.

The next step is to supply a map with certain omissions, and get the student to fill them in—working plane-table fashion. From this more advanced stage of map-reading or map-revising to making a rough plane-table sketch is so easy a transition that few men would realise the exact point where they had ceased to read a map—and commenced to make a map.

All this time the process of studying ground, its shapes, and folds and slopes, would have been going on almost without effort.

As to grasping the subject of contours—any 6-in. Ordnance map showing 100-ft. contours can be fixed on the plane-table, and four 20-ft. contours interpolated, roughly by eye, at first by the instructor and subsequently by the student, and I have found from experience that this process teaches a tyro more in one day than he would learn in a fortnight, striving to contour a probably most defective and unrecognisable sketch of his own.

The mere habit of following with the finger on the map, and the eye on the ground, a well-run contour gives a man a good idea of reading a contoured map.

For good tactical study of ground, nothing can equal the plan of issuing hektographed tracings of a 6-in. map, showing some fairly

marked defensive position, and repairing to the ground thus delineated and checking the map well over, interpolating rough 20-ft. contours, and marking in roads, fences, &c. Finally, selecting positions to be held by a small force of infantry and artillery, and marking on the map any shelter-trenches, gunpits or epaulements, or other defensive measures considered suitable.

To make the study complete, arrangements should be made to attack the same position, and a rough report furnished of the dispositions for the attack.

Having got to this point, I would stop so far as concerns most men, since they have only then to practise using small scale maps on the ground and off the ground to perfect themselves in the two main essentials of military topography, viz., a study of the tactical value of ground and the general use of maps.

To those who aspire to sketch, I would go on with a regular good course of plane-table work, followed by a course of sketching with a board and no tripod, plane-table fashion, *with or without* a magnetic compass, and ending, of course, with sketching on horseback with a cavalry sketching case.

By this system of instruction a man is gradually, but slowly and surely, given a sound practical knowledge of ground, the use of maps, and, when required, of the only class of sketching wanted on active service.

Now, with regard to the prismatic compass. It does not teach the study of ground in the way I have just described, because it is disconnected with map reading. It is a feeble understudy of the principles of trigonometrical surveying, which latter do not concern the great mass of officers.

The advantages which the prismatic compass is supposed to monopolise are portability and secrecy, but in the exceptional cases where only rough notes can be taken of a country and "bearings" entered in a pocket-book, by far the best and most practical way is to use a common magnetic compass of the watch pattern thus (exhibited). This compass has a small index marked on its edge, and, when held in front of the breast, the magnetic bearing of any object can be readily taken with sufficient accuracy without attracting attention, either on foot or on horseback. This is no theory, but is the outcome of solid experience, and was used with the most absolutely satisfactory results by Colonel Mark Bell, V.C., R.E., in his adventurous ride of 800 miles through Asia Minor.

But in this class of rough reconnaissance, as indeed with *all exploration work* not carried out with surveying instruments, the inevitable errors in a day's work should, where possible, be checked by astronomical observations by night. It is here that a knowledge of the stars and proficiency in the use of the sextant and artificial horizon is so useful. Colonel Bell thus checked his work in Asia Minor (working at the rate of 25 miles a day—the rate of advance of his caravan) with a result of an error of only ten miles in longitude and *nil* in latitude, and this in 800 miles!

I need hardly dilate upon the value of a reliable aneroid for ex-

ploration or reconnaissance work. With this small instrument, which has a magnifying glass forming part of the protecting glass surface, I have frequently read differences of level in a day's work of near 3,000 ft. to within 10 ft. of the corrected heights.

I freely admit that, under some exceptional circumstances, a prismatic compass is of great use to an explorer—thus, to note the changes in direction of a winding river amongst mangrove swamps—or to take long shots at very distant landmarks. But I object to a soldier being expected to carry an instrument which can only be considered as superior to a good magnetic compass for very exceptional purposes. The watch compass will do the ordinary work well enough, and when it is required to “observe and record bearings” an ordinary magnetic compass can be easily made to do this work with all reasonable accuracy. Here is my own compass which by means of a slit in the lid as a “foresight” and a notch in the handle as a “backsight,” and by a saucer-shaped card of aluminium clearly engraved along the edge, enables bearings to be taken *near enough* for all military purposes. In every instance in which I have thus introduced innovations, I have, before advocating them, assured myself from practical experiments that they were *sound*. That diagram (indicated) will show you this compass can be used by any officer to take a bearing with sufficient accuracy.

But where secrecy is not of vital importance, it is unquestionable that by far the best reconnaissance sketches and most comprehensive reports can be done by working direct from nature, “plane-table fashion,” with a “cavalry sketching case.” The reason is simple enough, for the actual features of a country, as seen before the operator from hour to hour and day to day, are then and there drawn on his board as they successively come under his observation, and such work must always be as infinitely superior to prismatic compass or even watch compass data entered in a book and subsequently plotted, as is a portrait from life superior to one done from written notes descriptive of an individual.

PART II.

I shall now deal with the successive steps by which military sketching is advanced from the elementary stages to those processes most suited for active service.

Of course we start with the class of sketch done on foot with a plane-table or with a board and no tripod, and with or without a magnetic compass, in which either a base is paced or measured with a range-finder or a succession of traverse lines are paced. This is the A B C of military sketching, as we all know.

Where a plane-table is available with a good trough compass and long sight-vane such as this one (exhibited) there is hardly any limit to the accuracy of the work which can be turned out. Failing a regular table, a capital cheap form can be knocked up by means of a piece of board fitted on a light stand, such as this French camera-stand which only costs 7s. or 8s. altogether. Or again, a tripod of

this description (exhibited) is admirable, since it can be levelled by means of the wooden eccentrics at the top of each rod.

For a plane-table top, this roll-up board is a good and portable substitute, and the paper can be fixed on it by means of the metal clamps which serve to hold it rigid (exhibited).

When no regular sight-vane like this (exhibited) is available, this small pocket one will be found to do all that is required for military sketching (exhibited). It has a small compass in it and also a rough clinometer with which the angles of elevation or depression may be noted, also profiles of hills taken. This diagram (indicated) will show you the amount of accuracy obtainable with this little instrument—not very great as you see, but quite near enough for our work.

I call that small instrument the *complete sketcher*, since it embodies four separate functions usually performed by four separate instruments, viz., compass, clinometer, sight-vane, and protractor.

When all else fails and you are without any instruments, good and accurate work can and has been done with a top of a biscuit box as a board, three rods and a ring off a head collar, for a tripod and a sight-vane ruler made out of a strip of wood into which is stuck a pen nib and a pin (exhibited).

Now let us advance a short step and work in plane-table fashion with a board held in the hand, *thus*. Here, in order to set it without laying it down, and looking out for a fixed station, a compass is invaluable. With a compass such as this one of mine (exhibited) furnished with a slit in lid and notch in handle to adjust it on a meridian line drawn on the paper and with a *friction ring* below to prevent its sliding (exhibited), much good and rapid work can be done.

For smaller rough sketches done in this fashion nothing can equal a pocket book of *decent* size, ruled in squares and with a small compass inserted in the drawing block *thus* (exhibited): this one is of waterproofed Willesden paper of a light green colour. Besides its capacity for resisting wet, it is a great comfort to the eyes when working in bright sunlight. Some years since I was completely put out of action for a time—not abroad, but in Kent—after sketching for six or eight hours on a white piece of paper in bright sunlight.

Next we come to working on horseback with Colonel Richards' cavalry sketching case. In using the sketching case, the directions of objects are observed by a straight-edged ruler working under a band, or by an attached ruler as here shown (exhibited). Here is one of Colonel Richards' original boards: it is the one with which all these extended reconnaissances in Nubia, and the Soudan, were carried out, and I would like to say here that no man has done more for advancing practical military sketching than has the inventor of this board. It is no exaggeration to say that, without its aid, none of that work (exhibited), and much more like it by others, would possibly have been done at all. There are very many different sorts of cavalry sketching cases at present made. This board (exhibited) is my own particular pattern. It has an attached ruler of simple construction and capable of universal movement in the plane of the

board and also a clinometer on the back, which latter I first introduced about 1887. I understand that it has been found to be useful and that the Royal Military College contemplate adopting it, or something very like it. Various patterns of the attached ruler have been tried by me and others, and this one is perhaps the simplest and most effective, but for more expert sketches there is a vastly superior plan which I shall describe later on. For more careful work the cavalry sketching case can be used dismounted as a small plane-table.

In order to train cavalrymen, or reconnoitring officers, "how to observe and what to report," nothing can equal the system of "skeleton routes," which I believe I first introduced at Shorncliffe, in 1886, and which has since produced much good work.

An enlargement of an existing map is made to a scale of 2 in. to 3 in. to a mile, showing simply the route to be followed and a few landmarks such as cross roads, rivers, and railways. Such a map is put on a cavalry sketching case, and the line indicated by it is ridden and the skeleton route filled in with all details, such as widths of road and lateral roads and other useful information, especially tactical information. At the end of a day's ride these rough notes enable a good report to be made in a systematic manner. The practical advantages of this system of instruction are (1) a man is relieved from constantly observing and drawing in changes of the direction of the road, (2) he is not incessantly engaged in counting his horse's paces, and (3) being clear of these two vexatious mechanical processes, he is able to work far quicker and consequently cover treble the amount of ground in a day, and (4) this gives him an enormous amount of practice at seeing and reporting on a new country and thus training him. It is a class of so-called "sketching" which might properly form the climax of the system of map reading and the study of ground for tactical purposes which I so strongly advocate, and might really be scheduled under those heads. I have often and often taken out good men who could not draw at all, and who at the end of a day's ride of 20 to 30 miles have assured me they have learnt more in that day of the tactical importance of ground, such as selecting good outpost lines, or suitable positions for small rear-guards or advanced guards to occupy, than in all their previous career. The best example on record of this class of work is a reconnaissance from Shorncliffe to Woolwich, carried out by a party of the 14th Hussars, in two days. The return journey of over 60 miles being performed on the third day, and the sketches and reports given to Sir Baker Russell the same day at 7 p.m. A very real difficulty on service is often to get such work finished up owing to the light failing. Here is a useful aid in such an emergency. It is an eminently portable pattern of lantern, which was brought from the Tyrol by Colonel Howard, of my regiment, and which he informs me is much used by the hunters there.

For regular sketching on horseback the distances are measured by the horse's paces, either from a special scale, constructed beforehand, or, in ordinary cases, by using an eminently simple method which I

introduced some years since, and which I style the "penny ruler system." Having ascertained the number of rises in the saddle you make whilst your horse covers a mile, you proceed as follows. The average paced horse makes between 540 and 600 "double trots" in a mile, and supposing yours is 584, you can take the ruler and call 600 trots equal to 1,800 yds. Thus, to make a sketch at about 3 in. to a mile, each inch can be taken as 200 trots or 600 yds., and each $\frac{1}{2}$ in. as 50 trots or 150 yds., and there you have your scale. This diagram illustrates this method, and these sketches by Quartermaster W. D. Short are admirable examples of what can be done in this line.

The next step in advance is to sketch on horseback "by time." Here the rate of advance must be known, and suppose it to be 2 miles an hour, to sketch at 2 in. to a mile, $\frac{1}{2}$ in. on the foot rule will represent a $\frac{1}{4}$ mile of country, or 15 minutes' march. This is the most practical and most generally useful class of sketching. This diagram is an example of this class of work.

This long map is the route from Wady Halfa to Dongola, about 240 miles or so of river.

Those maps there (indicated) represent Sir Herbert Stewart's march across the Baynda Desert, all the detail there shown was done exclusively by "time," based on the rate of advance of the column, and given to Sir Herbert at the end of each day's march.

A very convenient aid for sketching in this manner is shown on this diagram of the "traversing pencil," which is fitted with a couple of wheels; one acts as a roller, and the other, the toothed wheel, marks off equal intervals as it runs along the paper, and by aiming the pencil at a distant object, and pushing it forwards (thus), the exact direction is also indicated on the paper by a series of dots, Every fourth dot is double, and, supposing it to be taken to show a division of 100 yds., the other dots will be at 25 yds. interval. It immensely simplifies the process of sketching on horseback, for, however unsteady a horse may be, you can always get a shot with it in a tenth of the time taken to adjust a ruler. For time sketching, each dot can be called five minutes' march, and every fourth double dot 20 minutes' and 12 dots one hour. This gives a scale of 3 in. to one hour's march.

This system of "time" sketching can be used under various conditions. Here, for example, is a river sketch made from the "Safia," one of General Gordon's steamers, and represents 10 days' work on a portion of the Nile, between Metemneh and Khartoum.

Time will not admit of my further illustrating this branch of topography, but I trust I have demonstrated how, starting with the plane-table, the same system can be successively and successfully adapted to all and every condition of active service, and eventually enable work of that description to be done with the greatest ease under what I venture to think were, taking into consideration the amount of fighting and marching which had to be done, to say the least, hardly "favourable conditions" for military sketching.

PART III.

I will now deal with a branch of the subject of Military Topography which has of late years attracted considerable attention—namely, night operations. For the successful conduct of these, a good practical knowledge of the use of the magnetic compass, and also of the “general movement of the heavens,” as it is styled, are indispensable. I will not to-day enter into the tactical aspects of this class of work, beyond remarking that no matter how skilled or successful a man may be at guiding troops at night, good staff arrangements for keeping the following body of troops in good order and prevent straggling or confusion are absolutely vital.

No amount of good leading will atone for bad following; this has been proved over and over again.

Now as to the leading.

The system I advocate is one of adjusting a movable index-bar or meridian line on top of a compass, to indicate the magnetic bearing of the required line of advance, as shown on a graduated collar *outside* of the compass. On this model the graduations are thus shown. The compass card is prepared with luminous paint, and a line of the same is painted on the lid. When the black north point (indicated), which shows up well on the massed luminous paint on the card, swings and remains under the black index bar, the luminous white line points like a finger in the required direction. This gives a good definite line to move on, and one capable of being prolonged. For example, you want to go N.W. You adjust the index to that point on the external graduated ring, and, placing the compass in the palm of your hand, held in front of you, turn round your whole body, until the N. point and index coincide, when they do the luminous line points N.W.

It is generally easy to tell if an invention is a success, by the fact that it is sure to be adopted by some other “inventor,” and this has been the case with this system of setting the luminous line as advocated by me. Up to date I have not heard from my various disciples; possibly I never shall.

So much for the compass, which has thus indicated the direction you wish to move in. The next thing is how to move in that direction. First, suppose it to be a starlight night, this is the best and easiest of all, and most accurate to work by.

It is an invaluable aid to know a few of the best marked star groups, such as Orion, Pegasus, &c., and also to have a good general knowledge of the so-called movement of the heavens—very easily acquired, by the way. Suppose, now, you look in the direction of the white line in your compass and note that it is pointing towards Orion's Belt. Your knowledge of the heavens will tell you whether that star group is rising, traversing, or declining at that hour, and this enables you to judge how long you can, with safety, march on that particular point. Roughly speaking, every 15 to 20 minutes it is well to take out your compass, halt, and take another bearing. As

Orion works to his right, you take some other convenient star, no matter the name, to the left of Orion, and so on; say, for example, later on you get on to Sirius and then on to some star to the left of him. The most convenient stars for this purpose are those whose altitudes are less than 30° .

When no stars are available, and especially if moonlight enables you to easily see the outlines of distant terrestrial objects, you select these and march on them as they successively present themselves on your sky-line, which, be it remembered, will constantly change if your course is through undulating and broken ground.

Lastly, you can get a pitch-dark night with clouds and rain. Here you must either halt and look at your compass every few yards, or, if possible, send on an assistant with a slab of luminous paint, at least a foot square, slung on his back (such as this). This is visible for about 100 yards, and after he has gone on that distance, in the direction he imagines to be the right one, he halts and you observe the true direction with your compass and, then moving up, place yourself on his right or left at where you roughly judge he ought to be, and so eliminate the error as you go along. It is slow work, but experience has proved its accuracy.

In a close country, with roads and fences, luminous maps are useful. You prepare a map drawn in thick lines on transparent cloth (exhibited) and place a slab of luminous cardboard below. To use it with effect, you must keep your dead reckoning by pacing between all cross roads or landmarks—this is most essential.

One last word on conducting night marches. The essence of success is careful reconnoitring by day and the exact recording of the magnetic bearing of the line of advance to the objective, and also of its distance in yards, this can generally be easily ascertained with a range-finder. Failing this, the next best process is to work off a good, reliable map, but such is not always obtainable.

Did time permit, I could give you many examples of long night marches I have carried out in various countries, but chiefly in the wilds of Southern Spain, when shooting or ornithologising, and upon which most of my deductions are based. I will only allude to one, the historical march after the battle of Abu Klea and before the action of Gubat in the Soudan. Here we marched upwards of 24 miles across a country totally unknown to us, through a dense scrub, which delayed us many hours and reduced our rate of advance to three-quarters of a mile an hour; and in spite of every difficulty, I had finally the honour of leading that column down to the Nile almost exactly opposite the point of the island which Sir Herbert Stewart had told me he wished to reach. I am concerned solely with the topographical aspect of the affair, that is to say, the leading. Taking into consideration the enormous difficulties of that task and the confusion which reigned amongst the thousands of camels which were supposed to follow, but which in many cases overlapped and encircled the front, and further remembering that there were no luminous compasses nor well-organised paraphernalia for simplifying the arduous process of leading that forlorn hope, if I may venture

to call it so; I shall ever look upon it as not the least successful part of Sir Herbert Stewart's daring march across the Bayuda Desert, and it will ever be the greatest pride in my life that I was permitted to bear a small share in that attempt.

PART IV.

I now come to my last topic, namely, the changes which recent inventions have exercised on the methods of carrying out topographical work.

It has always been an admitted advantage if a good pictorial representation of ground could be made in addition to mapping it. For this some advocate photography, but, much as that science has advanced in recent years, it does not exactly, so far, lend itself to the rapidity so essential for reproducing sketches. But there are unquestionably many instances in which the Intelligence Branch of an army in the field might derive much valuable assistance from the camera.

When a man is a quick freehand draughtsman a useful sketch can be knocked off in a few minutes. Here is one (exhibited) drawn and coloured on the spot before the action of Abu Klea, and here is the same enlarged to illustrate another matter. But many men cannot sketch quickly, and for them this invention, styled the "Philograph" (exhibited), might perhaps in some instances prove very useful. It is, I believe, the joint invention of an English lady, Miss Osborne-Moore, and a French artist. The difficulty would obviously be to carry it about. This is the most portable form at present made. The principle is absurdly simple, as I shall show, and the results incontestably good. The draughtsman places his eye at any convenient distance from the transparent pane of glass or sheet of celluloid, and, *keeping his eye steady* at that point, draws on the surface the outline of the objects he sees in the distance as projected on it. Anybody who chooses to stand opposite a window and look across a street can realise at once the process. It is extremely rapid, and the perspective is admirable. I have drawn groups of men, such as this group of the band of my battalion at practice (exhibited), and made highly complicated sketches of buildings in true perspective, mechanically, with its aid in a few minutes. Some modification or development of the system might be used with advantage by many people, including even expert draughtsmen.

But the instruments which have really revolutionized all the former processes of military sketching are unquestionably range-finders.

With a good reliable and, above all, portable and durable range-finder, an officer on service has a friend with him which, apart from its value for tactical purposes, will solve many of the most vexed topographical problems, and entirely eliminate the necessity of even considering many others.

For with the range-finder a suitable base line can be accurately measured between convenient points which subsequently will serve to

form plane-table stations, and all the old worries about "level ground," "no obstacles," &c., are banished in a moment and for ever.

The point to bear in mind is that even expert military draughtsmen do not aspire to pace 100 yards with a less error than 2 per cent., and on rough ground very often the 2 becomes 4 per cent. or more. Hence a base of 1,000 yards would commonly be paced as 950 or 1,050, whereas with a range-finder 980 to 1,020 yards could be reckoned on, and if several ranges were taken and the *mean* adopted, almost any degree of accuracy could be attained.

Here is a sketch of a large bit of country, representing a portion of a great plain, Laguna de la Jarda, in Andalusia, where I have shot and birds-nested off and on for the last 18 years. Last time I was out there shooting, on account of the unprecedented heavy rains all my favourite snipe bogs were under water, and sport was almost an impossibility. In consequence I had some spare time on my hands, and one day, from the house where I had established my headquarters, I took the range of a distant *chosa*, or small farm, across this big lake. I then set up an impromptu plane-table, and got sights at all conspicuous objects within 10 miles or so. Later on, wherever I found myself before my time at any point, waiting for the geese and ducks to flight of an evening, I used to take the bearings of conspicuous objects with one of my magnetic compasses (used as a prismatic), and on my return to England this map was compiled by Quartermaster-Sergeant Short, R.E., representing about 24 square miles of ground. The base of 2,400 yards, combined with the plane-table rays, gave it an amount of "stiffening" which stood him well in working out some of my very rough data.

But unquestionably the most valuable use of a range-finder for reconnaissance purposes is to measure the distance between two distant objects which the reconnoitrer considers would best serve him as stations for plane-table work. The principle upon which this is done is very simple, and this diagram (indicated) will perhaps make my meaning clearer. Suppose the observer at A wants to ascertain the distance between the two conspicuous hill tops, E and F, with a view to using EF as a base line. He takes the range of E by means of a proportional base, AB, which is $\frac{1}{10}$ of AE. Similarly he takes the range of F by means of the proportional base AC. Then without troubling himself about the distances of E and F from A, or measuring their bases, he simply measures from B to C on the ground, and BC will give him $\frac{1}{10}$ of the distance EF, or if BC be 100 yards, EF will be 5,000 yards.

Now this admirable process is peculiarly the property of fixed-angle range-finders such as the Weldon, although some "adjustable" instruments can be manipulated so as to act as "fixed" instruments to a certain extent. But whereas the "fixed"-angle range-finder, as its name implies, must give the *true* angle, and in consequence the true transverse range, the adjustable-angle range-finder may be "adjusted" to the wrong "fixed angle," and hence may, and often does, give the wrong range! This is an insuperable objection

to all men who have practical experience of the two classes of instrument used in this fashion.

One common objection to the use of the Weldon is the difficulty of getting a "distant point" to work on. This can be altogether obviated by using it "double handed," as shown on this diagram of the wood and bridge below, in which case the transverse distance is 25 times the base.

Now, as to this double-handed range-taking with the Weldon, in order to simplify the process, I have here single prisms of $88^{\circ} 51' 15''$ mounted separately with handles, thus, and with a couple of these, and no other range-taking appliances, the distance of any object up to the limits of human vision can be rapidly and accurately taken. In this process of reflecting one on another it commonly happens that ranges are taken "over," owing to a man's head affording too broad a mark to aim at. This difficulty I have overcome by teaching any non-commissioned officers engaged in taking a range to draw their swords and slip the range-finder over the ring of the cross-piece and to "recover swords." This provides a fine point with which to obtain coincidence with the reflected image of the object.

In the case of the single prisms I have had a small socket attached which fits into the ring on the sword thus, or into the muzzle of a rifle thus, for very accurate observations. (Explained.) I may add that these single prisms can be used equally well by a man working alone.

Reverting now to these diagrams, I would like particularly to direct your attention to the fact that such work would be impossible with instruments having adjustable angles and fixed bases, since they cannot thus, when used in the ordinary way, take transverse ranges between two distant objects. Of course, with any range-finder, such distances might be eventually worked out either by adjusting the angle to what is *believed* to be the correct "fixed angle," or by calculation, or again by plotting bearings on a sketch; but these makeshifts are beside the point.

But besides these methods of measuring thousands of yards for topographical purposes, there is another use for range-finders, and that is for measuring short distances such as the width of a river, across which it is wanted to throw a bridge. Now, when I talk of measuring short distances, I mean actually measuring them for military purposes, that is to say, within a yard, or even a foot, of their true dimensions.

This can be done with absolute certainty by our small friend the Weldon, by using the second and third prisms only, by which means a base one quarter of the range is obtained. Thus, supposing a reconnoitring officer reached the bank of a river with the object of ascertaining its exact width for bridging purposes, all he has to do is to plant his sword or stick, or better still, get a soldier to hold up his rifle, butt on the ground, about 20 or 30 yards from him; he then reflects any object on the far bank with the second prism, on the sword or rifle, and, *marking the spot*, retires on this alignment until he can again repeat the same process with the third prism; say the

base thus found is 36 yds. 2 ft., the width of that stream is 146 yds. 2 ft. I stated this once, and somebody, who viewed range-finders as toys which would measure 100 yds. as anything between 70 yds. and 130 yds., at once took me up; however, I asked him to place a man out in the barrack square; this he did, and I got a base of 25 yds. 2 ft. 6 in., and gave him the range as 103 yds. 1 ft. The actual chained distance turned out to be about 9 in. different. As a rule, with a definite point to take, anybody can get a distance thus with a Weldon to within a yard, with little or no trouble.

Lastly, in military sketching, the process of taking "offsets" from a traverse line can be performed with absolute accuracy with the aid of the right-angled prism of the Weldon, and, further, a sketcher can place himself exactly in line between any two distant objects (a great assistance sometimes, as the initiated well know) by means of the same prism. If, on looking into its two facets successively the reflections of the distant objects on either side are found to cross in front of the observer, he has to advance; whereas, if they, so to speak, diverge, he must retire, until in either case he finds a spot where the objects on either side are reflected on exactly the same spot to his front, when he is, of course, exactly between them.

But, if a man engaged in topographical work expects to derive benefit from the use of a range-finder, he must adopt a pattern which he can always carry with him as he carries a watch. Further, it must be durable and capable of being used by one man alone.

I have no time to-day to enter into a discussion of the merits of various range-finders. Suffice to say I have tried almost every pattern which has been in the market for the last 12 years, and have come to the deliberate conclusion that the "fixed-angle" instruments, such as the Russian Souchier (exhibited) and Weldon, are the only reliable ones, and that the adjustable ones are practically useless, since, independently of their *bulk* and cost, the former of which renders them totally unsuited for the reconnoitring officer, they work on the faulty system of "fixed bases," thus introducing a fertile source of error.

Lastly, they cannot stand real rough usage.

This diagram shows, far better than can any words of mine convey to you, the immeasurable gulf which exists between fixed-angle instruments as advocated by me, and the *mekometer*, the adjustable pattern which has been chosen by our experts. Moreover, it shows how we in England appear to view an infantry range-finder from a totally different stand-point to all other nations. (How about tactics?)

This pattern of Weldon is the one I advocate for all military sketchers; it has three crystal prisms set in one above another, enabling a man to take ranges alone and unaided with a base of either

$$\frac{1}{4}, \frac{1}{25}, \frac{1}{50}, \frac{1}{100}, \text{ or } \frac{1}{200},$$

according as he feels inclined or the circumstances of the case render

most suitable. In it there is a small spirit-level—handy for many surveying operations, and, lastly, a small trough compass which enables the eight principal points of the compass to be readily ascertained by the following process (exhibited). Civilian surveyors, wiser than ourselves, recognise the value of the Weldon, and advocate it for “preliminary survey” work. I will now demonstrate to you what *can* be accomplished with the aid of a fixed-angle range-finder like the Weldon, used in conjunction with an extemporised plane-table such as I have here—in fact both instruments are here which were used in carrying out the work I am about to describe. In October last, I proceeded to the Phoenix Park, Dublin, and took the range of a small ruin on the Wicklow Hills, and also of the clock tower of the Royal Hospital; then, by the process already described, I measured the distance between the ends of the two bases, and found it to be a few inches over 224 yds., which gave the distance between the Royal Hospital and the ruin on the hill to be 11,208 yds. or so.

With the base thus measured (explained) I proceeded to make a general reconnaissance sketch of the country near Dublin, and for this purpose proceeded first to the distant ruin (which I have since ascertained is styled “The Hell-fire Club”), and from this elevated point it was easy to get shots at a number of landmarks, and to roughly indicate their nature and relative positions on the sketch here marked No. 1. Amongst these were the Royal Hospital, Lord Iveagh’s Water Tower, and also Killiney Hill. A few days later I went to Killiney Hill, and, setting up my board by means of a line drawn towards the Hell-fire Club, got a series of observations, as on sketch No. 2. Lastly, I went to the top of the Water Tower, and, having set my board by the lines on the Hell-fire Club, Royal Hospital, and Killiney Hill, got a third series of intersections, shown on No. 3 sketch. Exclusive of the journeys, the actual time occupied was about half an hour on each day. I also visited the Royal Hospital, but found I could do without the rays from that point, although they were useful as affording a number of check shots. No instruments were used beyond a drawing board and a straight edge, not even a magnetic compass; subsequently I took a large piece of paper and, measuring off 11,208 yds. to scale at 3 in. to a mile, proceeded to pin the three rough field sketches (explained) at their respective points, as shown by the “setting lines,” and prolonged the “rays” until they intersected one another.

I should mention that two out of the three points I used were not shown on the 1-in. Ordnance map.

I sent the officer commanding the Royal Engineers in the district, Colonel Mark Bell, the transverse distance I had taken as a base-line, and by the same post wrote to Colonel Kirkwood, the Director-General of the Ordnance Survey of Ireland, and told him what I had done in the way of measuring a base-line, and asked him to send Colonel Bell the true distance, and he very kindly had it carefully verified for me at his office, and with the result that the true distance appears to be 11,278 yds., or 70 yds. more than I had taken it with the Weldon. This error of 70 yds. in nearly seven miles is about 22 in. in every 100 yds., or say 0.6 per cent.

I believe I am correct in saying that in the sketch produced the various points fixed are in no case more than 100 yds. out of their true position.

I shall now show you the rough sketch thus produced, and will only add that it does not pretend to give more than the general topographical features, very broadly treated, of about 120 square miles around Dublin. Please remember that this sketch owes its whole existence to the base-line from the Royal Hospital to the Hell-fire Club, measured with the Weldon from the range point in the Phoenix, some 2,000 yds. from the Hospital, and over 12,000 yds. from the Club. (Exhibit sketch.)

I would like here to say that if any of my audience wish to have further evidence on the subject of the superiority of range-finders of the "Weldon" type over those of the Mekometer type for the class of work I have dealt with to-day, I shall be glad to present them with a copy of a lecture given by me before the Irish Military Society last November. It is a large and a technical subject, and I have only had time to deal with the *results* obtained, and to endeavour to discuss it fully here would be to the prejudice of the main principles of topographical study which I have attempted to lay before you to-day. If, after reading this pamphlet and the subsequent discussion, in which Lord Wolseley and several other distinguished and scientific officers took a hand, anybody will kindly communicate with me and give their views and experiences of range-finders used as I therein advocate, I shall be extremely grateful.

I advocate the Weldon and other fixed-angle range-finders solely because very extended experiments carried out by me, and also by Quartermaster-Sergeant Short, working with me at Shorncliffe, but independently, have caused me to distrust the other class of instruments. When a better range-finder is produced I shall equally strongly advocate it in preference to the Weldon or Souchier, which latter is certainly in a rough form at present.

I have not had time to fully exhibit and explain many of the articles exhibited here to-day for facilitating the processes of military sketching. I should mention that they comprise various classes of sketching paraphernalia, ranging from the lightest, such as a compass and a range-finder carried by an officer, to a regular plane-table equipment and portable table for mapping, &c., which would accompany the baggage. That table rolls up round the legs of the table, and is as portable as all the rest of the gear exhibited.

To conclude, I trust I have shown that this all-embracing subject of military topography intrudes itself at every step in a soldier's career. For it is impossible to draw up well-prepared plans for any military operation, either of a strategical or tactical nature, without having recourse to maps, and hence the power of readily reading and intelligently making use of a map is one of the first necessities for an officer.

Again, a good "eye for ground" is one of the greatest gifts a soldier can possess; all great leaders have possessed it, and none more so than Napoleon and Wellington, as a visit to their battle-fields will prove.

To rapidly reconnoitre and intelligently report is an accomplishment which may enable any officer or non-commissioned officer to give invaluable information to his superiors, but it must be rapidly done and still more rapidly reported, else it may be valueless, for here *time* is the all-important factor.

Then as to night operations: a soldier who can with confidence, and without fear of losing his road, lead a night attack on any required point, is possessed of a power which, under favourable conditions in these days of Maxim guns and magazine rifles, may do much to neutralise their deadly effect.

Lastly, in range-finding a man possesses the power of at times previously ascertaining ranges, and thus rendering the fire of his men trebly efficacious. Independently of the value of the range-finder for topographical purposes, as shown this day, the use of it for such makes a man skilled in taking distances for tactical purposes. Some here may say I have drifted into tactics, when I was called upon to deal with topography. I would say in reply that, although I have no objection to be referred to, as Lord Wolseley and other authorities have at times been good enough to refer to me, viz., as a topographical student, I would infinitely prefer to be considered a practical soldier who has taken an especial interest in all matters relating to military topography, and for this reason, that I am profoundly convinced that in an intelligent study of military topography in all its branches we have nowadays the key to all tactical successes in the future.

Lieutenant-Colonel TROTTER, R.E.: I have been particularly asked by General Chapman, who is unable to be present this afternoon, to mention, as an example of the use of the cavalry sketching case, the operations recently carried out by the expedition under Colonel Ellis in Sierra Leone, where Lieutenant Gwynne of the Royal Engineers made a route traverse of over 400 miles through very difficult country, where the narrow, twisting paths made it impossible to get long forward bearings. The work was carried out, very successfully, and closed with remarkable accuracy. I wish also to emphasize what Major Verner has stated about the necessity of verifying the position on a sketch by astronomical observations on fixed points. A military sketch of that kind can never pretend to be absolutely accurate; the circumstances under which it is made do not allow of it; but if it is carefully done, it has a relative accuracy, and if you once obtain fixed points on which to adjust it, it becomes a very valuable work. But when one comes to talk about latitudes and longitudes it is necessary to speak with a certain amount of caution, because nowadays every explorer who goes into an unsurveyed country thinks it his duty to come back with a bag full of latitudes and longitudes often obtained by means which he does not expose, and apparently revealed to him by supernatural agency. Now I think that this class of work ought to be received with very great distrust. The latitudes and longitudes so obtained may hold good until the next man goes to the same place and knocks them on the head with a fresh set, but they only throw discredit on an honest route traverse. The only safe course for anyone making astronomical observations who wishes to be trusted is to bring back an accurate account of his working, and expose them to all the criticism possible. Again, although an observer with very little practice from the mean of a few observations giving results fairly close to each other, may get a very good approximation to the full latitude, yet the longitude is altogether another question. It is very difficult for a military observer with perhaps a single chronometer to depend upon, and very few opportunities of comparing the rating, to get anything like a longitude that can be trusted; yet strangely enough, perhaps for this very reason, it is the commonest thing for travellers to be very tenacious about their longitudes. But even without

ADJUSTABLE ANGLES AND

FIXED BASES.

MEASUREMENT OF A BASE-LINE FOR RAPID
RECONNAISSANCE OF A LARGE AREA.

E. A. B. AND F. A. C. BOTH 90° , ADD TO EACH B. A. F. THEN E. A. F. = B. A. C.,
BUT A. B. IS $\frac{1}{50}$ OF A. E. AND A. C. IS $\frac{1}{50}$ OF A. F. THIRD SIDE B. C. IS $\frac{1}{50}$ OF E. F.

THE SOUCHIER PRISM (RUSSIAN).

OBSERVER AT A. REFLECTS O. WITH No. 1, FACE ON O., AND WITH No. 2, FACET ON O., HE RETIRES ALONG A. B. AND AT B. SEES O. WITH No. 2 FACET ON A. AND O., THEN A. B. IS $\frac{1}{50}$ OF A. O. OR IF A. B. IS 20 YARDS A. O. IS 1000 YARDS.

FIXED ANGLES AND
PROPORTIONAL
BASES.

TRANSVERSE RANGE (DOUBLE-HANDED)

TWO OBSERVERS AT A. AND B. TAKE RANGE OF F. AND AT A. AND G. TAKE E.:
THEN A. C. IS $\frac{1}{25}$ OF E. F. OR IF B. C. IS 35 YARDS FROM VILLAGE TO BRIDGE
IS 875 YARDS.

COMPARATIVE TABLE OF RANGE-FINDERS.

	SIZE.	WEIGHT.	COST.	TYPE.
RUSSIAN.	■	■	■	FIXED.
WELDON.	I ■	■	■	
	II ■	■	■	
AUSTRIAN.	■	■	■	ADJUSTABLE.
FRENCH.	■	■	■	
MEKOMETER.	■	■	■	

attempting to take longitudes, anyone, however little sketching he can do, may do something towards adjusting his work, by being very careful to note the points where he crosses any traveller's route, by getting good cross bearings to any conspicuous object, and also by opening and closing upon and also, if possible, passing through known points. By a little trouble of this kind very useful sketches can be made. Nowadays many officers go to shoot in Somaliland and other countries, and they can all bring back most useful work by following some simple rules. Only the other day a young officer who professed to know nothing about sketching, took the trouble to do just what was asked of him, and he came back and produced most creditable and useful work. There is another point that I have been asked by General Chapman to bring forward, that is the question of scales. According to our experience there is a constant hankering after large scale maps. Everyone thinks apparently that the more you have of a map the better. In a paper I read not very long ago, I believe by Sir Charles Wilson, it was stated that when manœuvres were first started, some commanding officers in reporting on the maps in use, considered that the 2-in. map of Aldershot was not big enough; they wanted a 6-in. map, while others asked for a map of 25 in. to the mile. It was rather unfortunate, I think, that the maps desired were not issued with the request that the officers who wanted theirs should carry and use them for a month, and report on them at the end of that time, for I am sure they would have buried them and the subject too long before the month was over. But even at the present time 6-in. maps are generally looked upon as the great stand-by, and we get constant applications for them for all sorts of purposes. The 6-in. map, however, is not a military map, and never can be. Without going into all the reasons for this, if I point out one it will be perhaps sufficient. If you take as a specimen of a theatre of operations the country south of London, and it is only a small theatre, you will find that to cover that country takes 1,320 6-in. quarter sheets and 450 full sheets, the total weight of which is 2½ cwt. That fact alone is enough to show that for the purposes of a field army the 6-in. map is quite out of the question. This matter, however, has been very carefully considered by the Committee which sat in 1892, composed of the Quartermaster-General, the Director of Military Intelligence, and the Director-General of the Ordnance Survey. After a good deal of discussion, it was decided that the staff map of the country was to be the 1-in., and that this is the map we have now to depend upon for all military purposes. I hope, if the Treasury will assist us, we shall before very long get out the final sheets of this new military map, which is to be printed in colours. But even this 1-in. map can only be issued on service to staff officers. If you take, as an example, the same area, the country south of London, it requires 104 1-in. sheets at a weight of about 11 lbs. to cover it. The 1-in. map is, therefore, clearly too much of a good thing, for the regimental officer cannot expect to have a map on a larger scale than will cover the whole theatre of war in one sheet. In this respect we are, however, better off than other countries. I am not speaking from official sources, but entirely from memory, but I believe the German staff map is on the scale of 1/100,000, that is about 1½ miles to 1 in., the French 1/80,000, the Austrian 1/75,000, all of them smaller scales than our 1-in. Again, as we do most of our fighting in foreign countries, we should generally use very much smaller scales still. In the recent operations in Matabeleland the map used was on a scale of .25 miles to the inch, and in Sierra Leone 8 miles to the inch. We cannot expect in our colonies ever to have maps for general distribution on a much larger scale. Perhaps the largest would be ½ miles to the inch, but the more common scale would be from 8 to 25 miles. Therefore I think it is very necessary that we should try as far as possible to accustom ourselves to the use of maps which must be adopted on service, and deny ourselves the luxury of these fancy 6-in. maps, which cannot be used in war-time; and in this country, at any rate, work as much as possible with the 1-in., which is really the staff map. It is most important also that officers should be trained to sketch on geographical scales of ½ miles or more to the inch. These are the scales most important to us in foreign countries.

Colonel DOONER: I am a little nervous speaking here this evening, as we have just heard from the lecturer the great difficulty in which the officer found himself

at Woolwich when venturing to criticise anything that Major Verner had proposed. There were, however, one or two things in the lecture which I should be glad if he could perhaps make a little clearer to us. He, in the beginning, said that it was very rarely that the reconnaissance of a position would be required. I do not quite agree with that statement, because I think the cavalry screening and reconnoitring in front of an army would very often have to execute a reconnaissance of a position as well as the easy road or river, which is usually made; also in the case of an army retreating positions are, I think, usually reconnoitred, so that when the commander of the rear guard reaches them he may have a fair idea how to occupy them. I consider all officers should learn to report on a position, and I would therefore like the lecturer to tell us why he thinks the reconnaissance of a position is not just as important for all officers, and especially for cavalry officers, to learn as is the reconnaissance of a road, &c. With regard to Colonel Bell's ride in Asia Minor, we have been told that an error in longitude of only 10 miles in 800 was made. I presume the distances were calculated by riding, probably on a camel, but I cannot follow how Colonel Bell managed to work to such a successful result as that. It seems to me a wonderful calculation, and I would like to ask him how it was arrived at, how was the distance travelled each day estimated? That invention that Major Verner has shown us, the fixed ruler to the cavalry sketching board, appears to be an excellent arrangement; most of us I imagine have not seen it before. It has always been to me a difficulty, with the sketching board on your bridle hand and only a small ruler, how to manage to draw the necessary lines accurately. That pencil that has been shown us and that fixed ruler appear to me to have greatly assisted sketching on horseback, and made it far more easy and simple, because with that fixed ruler a little movement of the horse will not matter. With regard to the sketch on the wall—from Hafia to Dongola—Major Verner says it is inaccurate. I do not follow why it should be so. He said it is incorrect, because he found his camel had been going at 3½ miles an hour instead of 4 miles as he imagined. Of course the scale may be inaccurate, but this would not affect the sketch; whatever scale that he was working with, I think the result would be the same. The only difference is, the sketch is drawn to a different scale. Then as to the table of the different range-finders, the diagram shows the approximate size and weight of our instrument, the mekometer, compared to those of other countries. It appears to me the Russians are ahead of us greatly there. The size of their range-finder is represented by that little dot, while we have a large instrument of the size shown in our army. With reference to this question of range-finding, I think, for infantry attacking, we shall seldom require ranges to be found by means of the range-finder at distances under about 800 yds. Range-finding will only be required at about 1,000 or 1,200 yds., as with the Lee-Metford rifle from 600 yds. it will be unnecessary for even a fair shot to put up the sights; at this range the highest point of the trajectory is considerably under 7 ft., and, therefore, with fixed sights and judicious aiming a man will be under fire for the whole range. It must also be remembered that in attacking, fire will seldom be opened, I think, at a greater range than 800 yds. from the position.

Major-General Sir CHARLES WILSON: I am sorry to say I have to leave almost immediately, but I should wish, before I go, to express my very warm appreciation of Major Verner's lecture. It has been most interesting and instructive, and I agree generally with what he has said. As regards instruments, the application of the range-finder to topographical work is quite new to me. It has, I think, a great future before it. I was not aware that such very accurate results could be obtained. In many countries the range-finder would be a most valuable addition to other instruments; but it will always be necessary to observe very well-defined points so as to ensure accuracy. With regard to the instruments that should be used, very good results can be obtained with all classes of instruments. On the North American Boundary Commission we worked with prismatic compass and sextant, and the sextant observations were afterwards, in many cases, verified by observations with large instruments. The distances were obtained by timing the paces of the riding horses. The work proved to be extremely accurate and good, and the sextant observations were rarely out more than 100 to 200 yds. With regard to observa-

tions for longitude, I think that, as a rule, travellers had better leave longitude alone. You cannot obtain the longitude of a place without a long series of observations with large instruments. It would be far better, in most cases, to trust to dead reckoning. In the desert of Sinai we worked with a sextant and a prismatic compass on a stand. It was necessary to use the prismatic compass in consequence of the tortuous nature of the valleys. In Asia Minor nearly all the roads were traversed by the officers attached to me during the three and a half years that I was in the country, and they were sketched in the manner described by Major Verner with a pocket compass and a book or small board. The results were very good. Major Verner carried out some experimental work for the Ordnance Survey, and I have always found his field sketches most accurate and good. His skill with the pencil is well known, and there is evidence of it on the walls. I think the improvements in the instruments that he has introduced will be very useful to field-sketchers in the future.

Lieutenant-Colonel WATKIN: As pointed out by the last speaker, we are greatly indebted to Major Verner for the topographical portion of his lecture, and there is abundance of evidence to show his great skill in the art; but I was not prepared by the heading of the lecture for an attack on the Service mekometer, which is associated with my name, so that I am not properly prepared to protect my offspring. I am not entirely responsible for the size and weight of the mekometer: the one that did best at the trials weighed, complete with its equipment, 2 lbs. 13 oz., against a modified Weldon weighing 5 lbs. 7½ oz. A mekometer could now, to fulfil the same conditions, be made much lighter than my original instrument; but it was thought better to have a larger instrument giving increased accuracy.¹ This is hardly the time or place for going into the merits of this or that range-finder, but I think we, as officers in the Service, should have some respect for the decision of the authorities given after a careful trial. To show the fairness with which the trial was conducted, perhaps I may be allowed to give a brief history of the proceedings. In May, 1888, H.R.H. the Commander-in-Chief authorised the publication of an advertisement giving details of the conditions which an infantry range-finder should fulfil. These conditions had been carefully considered by the authorities, including the School of Musketry at Hythe. It was originally intended that these trials should be conducted by the Ordnance Committee, who had had a large experience in these matters, but when it was discovered that I was one of the competitors, the Adjutant-General (Lord Wolseley) decided to have an independent Committee of infantry officers. Now the composition of that Committee will show that, at all events, there was no bias towards myself, as the School of Musketry was represented by one of their staff, and, moreover, two staff-serjeants from Hythe worked the Weldon range-finder. Troops of all arms were taken out, and the inventors, at a given signal, told to take the ranges—one minute being allowed. These ranges, of necessity, could not be known till after the day's trial was over, when they were carefully measured. The result of these trials was not only that my instrument was recommended, but that there were several others which were adjudged better than the Weldon. The lecturer says the adjustable range-finder type cannot be used for obtaining the distance between two inaccessible points. Surely such an instrument can be placed to any angle you please; and all that the lecturer has shown can be done with the Weldon can be done with greater rapidity with the mekometer. That officers are working in this way is shown from a letter I have received this month from India: "Your instruments are none the worse for a year's wear; the mekometer is capital for sketching, &c." Sir George Colley in Zululand was the first to practically use range-finders for field sketching; his opinion was that their use would revolutionize military surveying, and I am glad to learn from the lecturer how fully he endorses that opinion.

Captain MALONEY: Should not military topography, to be quite up to date, include some method of reproducing maps, so that several copies may be sent

¹ In the diagram shown on the wall the instruments, not the complete equipment, are contrasted, a very different matter. The weights given are those quoted by the Committee.

in, instead of one only? If the General receives only one map, no matter how useful it may be to him in forming his plans, he may still be at a loss in communicating his plans to his subordinates; whereas if he has several copies, he can mark on the plans the positions he wishes his subordinates to take up, or the lines of march, and all chances of misunderstanding will be reduced to a minimum. Besides, in any subsequent operations that may occur, it is important that the subordinates should have plans corresponding to his own, otherwise he may order them to occupy a village or a wood or a farm which is not named or marked on their maps. In the days when reconnaissance was chiefly used for record purposes, one copy might suffice; but if this new system comes in—the system of using the range-finder and the plane table for mapping country far ahead from a few commanding points—surely we shall all want copies of the very valuable plans that have been produced in that way. Then again, just as the range-finder assists topographical work, so the topographical work assists range-finding; that is to say, if you want to know the range of an enemy, it would be a most useful thing to have a good map in your hand from which you could measure off the range on the scale. But for a reconnaissance to be of any use for this purpose, you must have many copies. This copying will be said to take too long; but a great deal can be done with the common hectograph. I have used it myself on active service at Suakim with fair results, while the “black autocopyist” gives excellent results, and I believe their use would only involve a delay of, perhaps, half an hour in sending in the first copy, and after that you might send in 20 or 30 copies an hour. Seeing that men cannot be expected to do in war-time what they have not practised in peace, I submit that a little instruction in some copying process ought to form part of the course of topography, especially for N.C.O.s.

Colonel E. GUNTER: I have listened with the greatest interest to the lecturer, and much appreciate, as I feel sure all officers present will, the ability with which he has treated the subject. I should like to ask him if he has tried the “Bate” Range-finder. I have not had very great experience, but, when I used the “Weldon,” I found it gave very good results, and was far superior, of course, in portability to any other.

Colonel FEATHERSTONHAUGH: I think Sir Charles Wilson took rather an extreme view about longitude. I was at one time on an exploring expedition where it was necessary to explore 50 or 100 miles ahead. The officer who did that duty was in the habit of carrying two or more watch chronometers and a sextant, and his longitude work was done very accurately. Now a watch chronometer is not much bigger than an ordinary watch; it is very easily carried. From a military point of view, therefore, if checks are required for exploring service, astronomy can be used; only officers ought to be trained to do it, because it is not easy to pick up.

Lieutenant-Colonel GOLDSMID: With reference to this very interesting lecture, there is one point that I should like to ask Major Verner, namely, whether any improvement has been made in the last three or four years in the system of obtaining topographical information by signalling or electricity. There is a means that I was instrumental in bringing out when at the War Office, by which we could telegraph or signal information by the use of co-ordinates. A Liverpool volunteer, if I remember rightly, suggested an ingenious system of combinations of three letters, applying the same to co-ordinates, by which means the maximum number of permutations in a given space could be secured. In the War Office we had it embodied in an Army Form on drawing-paper, and the horizontal and vertical co-ordinates being ruled very closely together, practically any point on the paper could be identified by the three letters representing the intersection of the nearest co-ordinates. This enabled an original sketch made on the paper to be transmitted, by signalling or by telegraph, with great rapidity, but the difficulty was how to apply it for correcting or adding information to existing sketches or maps. You can understand how very important it would be in the case of a Boundary Commission. For instance, say in Afghanistan a dispute arose between the English and Russian Commissioners, and each party had to telegraph to its respective Government for instructions. To describe by telegraph the points in dispute connected with proposed new boundaries would result in having to send cablegrams of inordinate

length at enormous expense. It occurred to me if we printed the army form alluded to on tracing linen we should be able to telegraph alterations and additions to existing maps and sketches with great ease and rapidity, and at an enormous saving of expense. This was done, and now all that is necessary is for the sender and receiver to fix the form on the tracing linen in the same position over their maps, after which each spot on the map would be identified by three letters. Thus instead of having to cable "a point one mile and three-quarters S.S.E. of Penjideh," the letters "Tfm" would suffice. I should like to know if there has been any improvement in that system, and if Major Verner has tried it.

Colonel BOYLE: I hope I am wrong in thinking that Major Verner, so eminent an authority as he is on military topography, being quite a master of the art, holds cheap an old friend of mine with whom I have been associated for a great many years, who has always been of great use to me. That old friend is the prismatic compass. I maintain that the prismatic compass is an instrument the value of which should never be overlooked. I had great experience of it in Canada, and afterwards in South Africa, and in both cases it did everything I wanted well. In Canada I was out four months surveying the country between Prescott and Kingston on the St. Lawrence, and I think the valuable qualities of that instrument ought not to be overlooked in teaching young officers coming on to join the army of the present day.

Major VERNER: In reply to some of the remarks that have been made, it gave me very great pleasure to hear from Colonel Trotter that my own pattern cavalry sketching case which, since I worked it out, has only been used by myself in peace-time, has been found to be so useful in a wild country under "Service conditions." I quite agree with Colonel Trotter about the danger of depending on sextant work in the hands of inexperienced people. With regard to the scale he advocates for manœuvring maps, I had the honour of being examined by the Horse Guards Committee on that subject, and I then gave my opinion, as Colonel Trotter knows, that I thought the 1-in. map was the one that was desirable. Then again about scales; Colonel Trotter advocated we should sketch at 4 miles to an inch. I would only say that if that Dublin "range-finding" map was done on the small scale of 4 miles to an inch, instead of three inches to a mile, the errors would be so small that they would be inappreciable. Colonel Dooner asked why I said we should not sketch positions? My answer is because I am strongly of opinion that the British Army want their cavalry to go out and find the enemy, and report, and, if necessary, fight him; but it is not wanted to go out and draw pictures of every position which might possibly be suitable to fight a battle on some day. I do not believe in it. I know I am in the minority here, but I do not believe that our cavalry should go out and try and sketch the whole country. A General might say, "I want a position covering so-and-so reconnoitred and mapped out"; but in such a case you would always find that an officer with a talent for sketching would be picked out to go and do the job, and you cannot hope to make every officer go and sketch a position, which is a very technical operation. Sir Charles Wilson talked about the necessity of defined points for range-finding. That is no doubt very right, for without defined points you cannot use any R.F., but in that particular case in that valley (indicated) which represents, as a matter of fact, the valley of Abu Klen, there were defined points, because there were clusters of the enemy on the heights, on either flank, which would have given capital points to range on. In rapid reconnaissance work, I have found it a good plan (particularly with lancers) to send a man to gallop up and mark a point on a hill, which can subsequently be identified and used as a plane-table station. When Sir Charles Wilson described how good work was done with prismatic compass, it must be remembered that he said he used it on a stand. That is just one of the points. It is a vastly different thing carrying out work with a compass mounted on a stand, and, as many of us have done, holding it up to the eye, when the thing goes round like a firework, and, very often, it won't come to rest for a long time. Colonel Watkin made several statements which I must absolutely traverse. No doubt he made them not quite realising one or two points, which time did not admit of my discussing more fully. He talked of the Weldon weighing several pounds, over five, I think he said. The Weldon, as advo-

ented by Colonel Weldon, weighs between an ounce and three ounces. Colonel Weldon is here, and will say whether that is right.

Colonel WELDON : That is quite right.

Major VERNER : Of course, it is impossible to enter into this big subject to-day, but if Colonel Watkin will do me the honour of accepting a copy of that lecture of mine, he will see that I have gone into the whole question of his own as well as all other R.F.'s most carefully. I never asserted that if his was ruled out Colonel Weldon's would be second; what I asserted, and still assert, is that I have tried them all, and look upon Colonel Weldon's as the most practical for topographical purposes and use in reconnoitring. The Russian "Souchier" is also useful for such purposes, and equally durable. I do not follow him quite in what he says about the distances of traversing objects, and so on; I talked about the *transverse* distance between two distant objects, not about "traversing." Of course I am aware you can screw down one of those adjustable instruments, and so work it as a fixed angle R.F. at a pinch; but my point is we must have a light and portable and durable instrument. Thus, for example, we could not have had a mekometer weighing 6 lbs. with us the night before Abu Klea, when Colonel Dickson and I reconnoitred the enemy's position; whereas we *could* have had that small Weldon in the pocket; that is just the difference. If you could mobilize the mekometer and march him up to the front, no doubt you could do admirable work with him, provided he was in adjustment. I took the range of base-line with the mekometer within a yard, as I described in my lecture, and I do not think that is a bad record for the mekometer; but it is not suited for the class of work I advocate. I disbelieve utterly in the value of taking moving objects. I have taken them for years. Quartermaster-sergeant Short and I, in our leisure moments, used to amuse ourselves at Shorncliffe by taking the trains as they ran past, and we have even taken the Brussels express! That sounds a big order, but it only runs through there at about 40 miles an hour; and if you can get at about the right distance apart you can always move at 2 miles an hour, which is all that you want to do to obtain the coincidence for a train moving 25 times as fast. As against the letter from India which Colonel Watkin has quoted, saying that they had found the mekometer admirable, I also got one last week from a commanding officer in India, in which he said: "I have used the mekometer for a year. I found the cords so troublesome that I have now given it up, and gone back to my old friend the Weldon." Captain Maloney talked about reproducing maps. I quite agree with him; but it is impossible to deal with all these technical points. Of course maps must be copied. In reply to Major Gunter, I have, of course, tried the "Bate's" R.F.; it is attached to a field-glass, and that is no doubt a very great advantage; but it comes under the adjustable type, and so I do not think it is good for our work. As regards the application of electricity and signalling to surveying, it, no doubt, is an admirable suggestion, but it is of more use for technical surveying than for reconnaissance work; all the same, it is an excellent adjunct for topography. Colonel Boyle alluded to his old friend the prismatic compass. Now, when I first saw Lord Wolseley about this compass question, he used the same words, and said: "The prismatic compass has been a very old friend, and I have found it a very useful servant." As we all know, Lord Wolseley when a young staff officer did admirable work in the Crimea, and in the Mutiny, and in Burmah before that, and he told me he always used the prismatic compass in those campaigns. When, however, I worked out this pattern magnetic compass, and had the honour of showing him how I used it, he ordered the first that was made, and has always advocated it since. He may have found the prismatic compass to be a useful servant, but how many British officers have not found it to be a most disagreeable master? That is the point. I am delighted to hear Colonel Boyle made such a good sketch in South Africa; but another officer who went to South Africa was not so fortunate, for, when he came back, he said "The place was so full of ironstone he could not use it at all."

II R.H. THE DUKE OF CONNAUGHT AND STRATHEARN : Gentlemen, it is already very late, therefore I have no intention of taking up your time by any long remarks. I only hope I shall be expressing the feelings of everybody here present when I say we have all felt great interest in the subject of this day's lecture, and

are very much indebted to Major Verner for the most excellent manner in which he delivered it. We have heard from the discussion that has followed the lecture that there are a great many different opinions on some of the statements made by Major Verner. I am not going to enter into those differences of opinion, but I must say I think Major Verner has spoken very much what is the opinion and feeling of many practical officers of the army. I think he has recognised the importance of having handy and useful instruments, that can easily be carried in any officer's pocket. We know that the larger the instrument, in many ways the more accurate the result; but it is not a question of the most accurate instrument, as I understand it, it is a question of the most practical instrument that will be sufficiently accurate for military purposes. There is only one other thing I would point out, in which I most strongly agree with Major Verner, and that is that every officer or non-commissioned officer is not gifted, has not the talent to make sketches. What you first want is for them to be able to read a map, and I am certain that what we in the Service should devote our great attention to is to make every officer and every non-commissioned officer thoroughly *au fait* with a map immediately you put it in his hand. Another thing which Major Verner also alludes to is the great necessity for inculcating observations from the moment a man enters the Service. I am sure, given the ready knowledge of reading a map as soon as it is placed in your hand, and given the observation—I mean by “observation” observing as you go through a country, wherever you are—observing the different points that would be of use to you to report on to your superiors—I say, given these two things, I am certain, with staff officers who show that intelligence and that perseverance that Major Verner has done, we shall arrive at having the necessary and the simple instrument that will be the most useful for the ordinary regimental officers of our cavalry and infantry regiments.