Azimuth.

General Remarks.—The azimuth compass is one of a traveller's most useful instruments. To use it, it is best to make a pile of stones and lay the cover of the compass on the top, with its bottom upwards; this makes a smooth table for the azimuth compass itself to be moved about on. Be on guard against magnetic rocks; it may happen that the bare peaks of high hills, which are the best of places for observing from, and which a traveller often makes great sacrifices to reach, will be found so magnetic as to make compass observations worthless. A small sextant should always be taken up on these excursions. It is of little use in a wild country to devote much time to getting accurate bearings, as the landmarks themselves are rarely well defined: the main endeavour should be not to mistake one hill for another, to judiciously select good angles, and to carry on more than one independent scheme of triangulations at the same time, by comparison of which the accuracy of the whole may be tested. It is surprising how much work may be thrown away by want of judgment; and also how much may be done, with very little trouble, by a person who has acquired a good eye and memory of country.

For true bearing—

The true bearing of a heavenly body may be obtained either from observations of its altitude or from the apparent time. As the formula for obtaining the latter does not appear in many works on Navigation, it is given:—

Time.	Azimuth.	Month	Day		
H. M. S.	° ′	° ′ ″			
		Co Lat.			
		P. Dist.			
		Sum.			
		Diff.			
		½ Sum.		Cosec.	Sec.
		½ Diff.		Sine	Cosine
		½ Hor. ∠		Cotang.	Cotang.
			Arc 1 = Tang.		
Cor.			Arc 2.		Tang. Arc 2
	App. time				
	Hor. ∠		⊙ true Az. (= Arc 2 − Arc 1)		
	½		⊙ mag. Az.		
	½ hor. ∠ in Arc.		Variation.		

Note.—Arc 2 is of the same affection as the ½ polar dist. and Co. Lat.: when one is acute so is the other, and *v. v.*

Add arcs 1 and 2, when polar dist. is greater than Co. Latitude.
Subtract „ „ less „ „

The angular distance between the Pole-star, which is only $1\frac{1}{2}°$ from the Pole, and any object on the horizon, affords an approximate and simple method of obtaining the true bearing: the formula for the reduction of the oblique to the horizontal angle is

Reduction of Angle.

✻ and obj.	Cosine
✻ Alt.	Secant
Red. Angle	Cosine

The bearing of the Pole-star at all times, or any other celestial object, when on the meridian, affords approximate means of attaining at once, without any calculation, the variation of the compass.

Base-Lines.

By Difference of Latitude.—For base-lines the more rapid methods of attainment are alone suitable to the present object. None of these measures is more accurate and speedy than that obtained by meridional altitudes of the same heavenly body (sun or star, not the moon) at different stations by the same observer with the same instruments. If the stations are on the true meridian, or nearly so, their difference of latitude is their distance; and if they are otherwise situated, their true bearing and their difference of latitude give the distance between them. (*See* p. 305.)

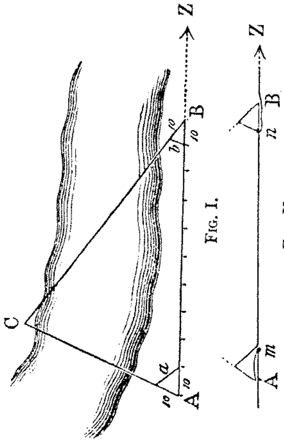
By Micrometer or Sextant, and Short Base.—Should the traveller carry with him an astronomical telescope, it is advisable that it should be fitted with a micrometer for measuring small angles; care is, however, requisite in seeing that the board or object used for the base is accurately measured, and that it is at right angles to the line of sight. In the absence of the micrometer, the sextant will give a very fair approximation; the angle should, however, be measured both on and off the arc. Rochon's micrometer has been used with great effect in the geological survey of Canada.

Table for Rough Triangulation without the usual Instruments and without Calculation. By Francis Galton, F.R.S.

A traveller may ascertain the breadth of a river, or that of a valley, or the distance of any object on either side of his line of march, by taking about 60 additional paces and by making a single reference to the Table on the following page.

TABLE for rough Triangulation without the usual Instruments and without Calculation. By FRANCIS GALTON, F.R.S.

a		ANGLE. °	′	5: 0	5: ½	6: 0	6: ½	7: 0	7: ½	8: 0	8: ½	9: 0	9: ½	10: 0	10: ½	11: 0	11: ½	12: 3	12: ½	13: 0	13: ½	14: 0	14: ½
5	0	28	58	57	60	64	67	70	73	75	78	81	84	87	89	92	95	98	101	105	109	113	118
	½	31	56	55	59	62	65	69	72	74	78	81	84	87	90	93	96	100	103	107	112	116	122
6	0	34	56	54	57	61	64	68	71	74	77	80	84	87	90	94	97	101	105	110	115	120	126
	½	37	56	53	56	60	63	67	70	74	77	80	84	87	91	95	99	103	108	113	119	125	132
7	0	41	0	52	55	59	63	66	70	73	77	81	85	88	92	96	101	106	111	117	123	130	139
	½	44	4	51	55	58	62	66	70	73	77	81	85	89	94	98	103	109	114	121	128	136	146
8	0	47	10	50	54	58	62	66	70	74	78	82	86	91	95	101	106	112	118	126	134	144	156
	½	50	20	49	53	57	61	65	70	74	88	83	88	92	98	103	109	116	123	132	141	153	
9	0	53	30	49	53	57	61	66	70	75	79	84	89	94	100	106	113	121	129	139	150		
	½	56	4	49	53	57	62	66	71	76	81	86	91	97	103	110	118	126	136	147			
10	0	60	0	48	53	57	62	67	72	77	82	88	94	100	107	115	123	133	145				
	½	63	22	48	53	58	63	68	73	78	84	90	97	104	112	120	130	141	154				
11	0	66	44	49	53	58	64	69	74	80	86	93	100	108	117	127	138						
	½	70	12	49	54	59	65	70	76	83	89	97	105	113	124	135	147						
12	0	73	46	50	55	60	66	72	79	85	93	101	110	120	131								
	½	77	22	50	56	62	68	75	81	89	98	106	117	128	141								
13	0	81	6	52	57	64	70	77	85	93	103	113	125	138	155								
	½	84	56	53	59	66	73	81	90	99	109	121	135	150									
14	0	88	52	55	62	69	77	85	95	106	118	132	148										
	½	92	56	57	65	73	81	91	102	114	129	145											
15	0	97	10	60	68	77	87	99	110	126	143												
	½	101	36	64	73	83	95	108	123	141													
16	0	106	16	60	79	90	105	121	140														
	½	111	12	76	88	103	120	141															



To find A C and angle A:—Enter with *a* at the side and *b* at the top.

To find B C and angle B:—Enter with *b* at the side and *a* at the top.

Suppose he is travelling from A to Z (Fig. I.), and wishes to learn the distance from A to C; and, it may be, also the angle A. Let him proceed as follows (referring now to Fig. II.).

1. Leave a mark at A. 2. Walk 10 paces towards Z, and make a mark, calling the place *m*. 3. Walk back to A. 4. Walk 10 paces towards C. 5. Walk to *m*, counting the paces to the nearest half-pace. (This gives the measurement of the line *a* (Fig. I.), which is the chord of the angle A, to radius 10). 6. Walk 80 paces towards Z; make a mark, calling the place *n*. 7. Walk 10 paces towards Z, calling the place B; this completes 100 paces from A. 8. Walk 10 paces towards C. 9. Walk to *n*, counting the paces to the nearest half-pace. (This gives the line *b*, which is the chord of the angle B, to radius 10.)

Now enter the Table with *a* at the side and *b* at the top, and read off the distance A C, and the angle A if also required.

If the Table be entered with *b* at the side and *a* at the top, it gives B C (and B).

Of course the units need not be paces: feet, furlongs, miles, hours' journey, or anything else will do as well; and the units of A B need not be the same as those of *a* and *b*. Also any multiple or divisor of 100 for A B may be used, if the tabular number be similarly multiplied.

EXAMPLES.

a (in paces).	*b* (in paces).	A B.	A C.	Angle A. °	′	B C.	Angle B. °	′
5	6½	100 paces	67 paces	28	58	53 paces	37	56
5	6½	50 miles	33½ miles	28	58	26½ miles	37	56
10½	7	100 paces	68 paces	63	22	92 paces	41	0
10½	7	1000 paces	680 paces	63	22	920 paces	41	0

Particular care must be taken to walk in a straight line from A to B. It will surprise most people, on looking back at their track, to see how curved it has been, and how far B *n* is from pointing truly towards A. It is always well to sight some distant object in a line with Z when walking towards it.

The triangle A B C must be so contrived that none of its angles are less than 30°, or the chords of the angles at A and B will not be found in the Table. These cases cease to give reliable results when the measurements are rudely made, and have therefore been omitted.

Should a traveller have no Tables by him, he can always *protract* his measurements to a scale on a sheet of paper, or even on the ground, and so solve his problem. If real accuracy be

aimed at, it is clear that it may be obtained by careful measurements of the base and chords, combined with a rigorous calculation, as was first suggested by Sir George Everest, formerly Surveyor-General of India. (See 'Journ. R. Geog. Soc.,' 1860, p. 122.)

On a Composition for Keeping Watches or Compasses Watertight. By James Brock, Chronometer Maker, 21, George Street, Portman Square.

The method that I should recommend for preventing water from penetrating watch-cases, is the application of a preparation of beeswax and resin to the several parts where it is possible for the water to pass. The preparation I recommend should be composed of equal parts and well mixed. If it is for a very hot climate, the quantity of "resin" should be slightly increased. It may be kept prepared, and when wanted, a portion melted and applied to the several parts with a small brush or feather. If the watch is an ordinary *open-face*, with a snap bottom, the parts that should be attended to are—1st, the glass. Apply the preparation round it, and rub it in with the thumb, by which means it will be worked into any cavity. 2nd, open the glass and apply it round the part of the case upon which the glass shuts (be careful that you apply it to all the joints of the case), close the glass and squeeze it down tightly; what is squeezed out may be cleared away with the nail or a piece of wood. 3rd, open the back (where the watch is wound up) and apply the preparation in the same manner as just named. The case will require a little more force to open it, and the back should be attended to frequently. If the watch has a *hunting* (or double) case, or a *bottom that opens with a fly-spring*, the difficulty of keeping out the water is much increased, as there are so many openings into the case for the springs, &c. I should recommend that the springs be removed (which is easily done, as they are all screwed in), and that the holes through which they pass, also the *screw holes*, be stopped up with the preparation; also *remove* the *push-piece* from the pendant (this is done by taking out the screw, which passes through the bow), and stop up the hole from which it has been taken; but care should be used in doing so, as it is essential that it should be stopped *below* the hole through which the screw of the bow passes. The bow may then be returned. The preparation should now be applied to the glass and the shutting parts, in the manner before described. The hunting cover will keep shut by nature of the preparation.

Silvering Sextant Glasses—

(Extract from 'Nautical Surveying,' by Sir E. Belcher, pp. 9, 10.)

"Before taking leave of this subject it may not be unimportant to describe the operation of silvering the glasses of sextants, as those employed on surveying duties very frequently have to perform the operation.

"The *requisites* are clean tinfoil and mercury (a hare's foot is handy)—lay the tinfoil which should exceed the surface of the glass by a quarter of an inch on each side, on a smooth surface (the back of a book), rub it out smooth with the finger, add a bubble of mercury, about the size of a small shot, which rub gently over the tinfoil until it spreads itself and shows a silvered surface, gently add sufficient mercury to cover the leaf so that its surface is fluid. Prepare a slip of paper the size of the tinfoil. Take the glass in the left hand, previously well cleaned, and the paper in the right. Brush the surface of the mercury gently to free it from dross. Lay the paper on the mercury, and the glass on it. Pressing gently on the glass, withdraw the paper. Turn the glass on its face, and leave it on an inclined plane to allow the mercury to flow off, which is accelerated by laying a strip of tinfoil as a conductor to its lower edge. The edges may, after twelve hours' rest, be removed. In twenty-four hours give it a coat of varnish made from spirits of wine and red sealing-wax. It may be as well to practise on small bits of common glass, which will soon prove the degree of perfection which the operator has attained."

To fill a tube with mercury as a temporary Barometer-tube, for occasional use.

Take the ladle used for melting lead for bullets, and scour it bright with sand. Prop the tube at a slightly inclined angle on the forks of two sticks, planted in the ground, and rake embers of the camp-fire below it. Turn it till thoroughly warm; almost too hot to touch. Strain the mercury through paper twisted into a cone. Boil it in the ladle. Heat some more mercury in a cup; and let everything cool again. When cool enough to handle, set the tube on end, upon a cloth, to catch overflows of mercury. Fill the tube to overflowing. Put the finger firmly on the top and reverse the tube; plunging the end that is closed with the finger, into the cup of mercury. Then remove the finger gently. If, on inclining the tube, the mercury rises to the top with a sharp tap, it has been filled to the exclusion of all air, and it will do. All that now remains, is to measure with a rule from the top of the mercury in the tube, down to the top of that in the cup. It will be found convenient to have two marks scratched on each tube; the one an inch from its open end, and the other at 30 inches' interval from the one below. Then if the lowermost scratch be brought level with the surface of the mercury, the distance from the uppermost scratch has alone to be measured, and this can easily be done.

The operation of filling a tube should be practised at home in comfort, with a properly-made barometer for comparison, and plenty of mercury to fall back upon, before trusting oneself to the difficulties of the open field.

Altitudes, by Thermometer in Boiling Water.

The operation of boiling a thermometer is of the simplest nature in theory, but is often extremely troublesome in practice, without a proper vessel to boil it in. This should have a serviceable wooden handle. The lid should be specially made to hold the thermometer, and to give a vent to the steam. The diagram overleaf shows an effective apparatus. The fire on which it is set should be neatly arranged, and be made of dry wood; it must not be too large or smoky, and it must burn steadily. The saucepan should be set firmly, on stones or sods, or across a narrow trench, that there may be no fear of its upsetting, when the fuel subsides. The observation of the thermometer must be made after the water has been boiling freely, but not too tumultuously, for three or four