when the sun is shining and the distance is great, a rod cannot be read unless the sun is shining upon its face, and so only one of the rods can be used for measuring side-shots, according to the direction of the sun. The rodman who is not giving side-shots along the shore can be engaged taking soundings from the boat, while he also gives side-shots to stations on islands.

When no astronomical observation is taken, the instrument is oriented by means of the compass, or rather by the magnetic needle, reading the azimuth of magnetic North deduced from previous readings or from astronomical observations taken from a magnetic map.

It is highly important for the rodman to understand the significance of holding the rod vertical; to ascertain if it is hidden; and how to select a new instrument station. The face of the rod should be turned slightly towards the sun when by so doing the sun can be made to shine on the graduations. A system of signals should be arranged with the rodmen for directing them to stop, or to start again, or to indicate that the rod is hidden. Some signals can be made with the arms, or a flag may be necessary at great distances. Before the rodman leaves the instrument it is well to indicate to him as nearly as possible where the next station is to be. It is more important that the surveyor himself act as front rodman, or at least be with him at instrument points or stations, and leave the transit-man at the instrument. I' is also well to read the three wires for both the front and rear instrumental stations as a precaution against errors.

When the instrument is but a few feet above the water it is not necessary to record vertical angles along the shore; when, however, the inclination exceeds $1^{\circ}-30'$, the vertical angle should be recorded and the proper correction applied to the distance read between instrument stations always, and frequently on side-shots if the vertical angle is large.

Reading the Rod .- For reading distances, set the lower wire on an even chain or foot-division on the rod, count the number of feet, tenths and hundredths to the upper wire and estimate the fraction. Distances read by means of the whole interval are twice as accurate as with the half-intervals. The length of courses between stations should always be measured with the whole interval when the distance is less than 1,300 feet, or 20 chains; the readings with the half-interval will necessarily have to be made at distances greater than 20 chains, as the limit of any 13-foot rod is but 1,300 feet with the wholeinterval reading, and 2,600 feet reading with the halfinterval. When the sum of the readings of the halfintervals equals the reading of the whole interval, the check is significant. The constant of each instrument is anywhere between one and two feet, and this sum must be added to the reading.

As an example of instrument No. X., for which the wire interval factors are: Upper interval 197.19, lower interval 211.53, whole interval 102.18; a reading of 200 ft. with the upper interval corresponds to 197 ft., to which has to be added the constant. With the whole interval, a reading of 1,000 ft. corresponds to 10.22 +.02 (constant). A reading of 2,000 ft. with the lower interval corresponds to 21.15, to which the constant .02 must be added. The correction to the reading is, therefore, + 115 + 2, or + 117; that is to say, the reading both of the rod and the constant is 117 greater than the actual distance.

These directions are tabulated and used for plotting when extreme accuracy is demanded. Usually they may be overlooked. In inclined sights the reductions of distance may be quickly reduced by means of the slide-rule. When the difference between the starting and closing corners differs more than 5% from the distance in an original survey, if any, the error should be located by retracing with the stadia.

For Soundings.—For obtaining contour lines on lakes, or shore lines 5 ft. deep, 10 ft. deep, etc., procure a quarter-inch hemp rope, attach a 2 or 3-lb. lead to the end and mark every 10-ft. with a strip of red and every 5-ft. with a strip of blue bunting. Always tie the loose end of the rope to the boat before leaving the shore. Soundings can be made in shallow water with the rod, though this method of taking soundings is not recommended. After completing the survey of a lake enter in the notes the nature of the water, whether fresh or alkaline, the sources of supply, the outlet, and such other



data as may be of interest. A determination of the magnetic meridian should be made if the weather permits making an astronomical observation, but this will not always be necessary.

Plotting the Survey.—A rough sketch of the survey should be made or plotted on the right-hand page of the field book before leaving the locality, or as the work proceeds. Two field books may be used consecutively, one being left in the office or camp while the other is in use on the survey. Make the plot, first, at least, in pencil, preferably on paper ruled to a scale of 10 chains to the inch. Commence plotting carefully the instrumental stations and work in pencil the north and south points of each station.

Plot the side-shots by means of the protractor. Then enter on the plan the soundings taken, and all other information that has been collected.

The Field Book.—The left-hand page of the field book is for the notes; the right-hand page for a sketch of the survey. Two stations are designated by numbers; the side-shots by letters. In the first column of the lefthand page enter the letter of the side-shot or the number of station sighted upon. The second column is for the distance read or estimated; the third column for the bearing; the fourth column for the vertical angle, and the remainder of the page for remarks.

S	t	a	t.	N	0
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		1	
or	C1/	de	-
UI	21	uc	-

	shots.	Distance.	Bearing.	Vert. angle.	Remarks.
	(1)				Inst. set Comp. north.
	(a)	150	307.00	6.40	Top of bank.
	(b)	350	115.30	82.45	Foot of bank.
	(c)	457	31.25		
	(d)	1423	224.51		Creek, 10 feet wide, 2 feet deep.
	(2)	1343	122.26	85.50	Marshy shore.
St	at. 2-	Inertifi Arresta	in the Reacher		water-
	(e)	918	46.40		
	(f)	987	238.12		
	(g)	1423	224.51		