versed. All roads, public and private, used or unused, need to be traversed and accurately plotted on the plan or chart. All farm lines and fences are to be measured and shown in their true position. The declination of the magnetic meridian should also be plotted. All of these are shown in the plan herewith (Fig. 1).

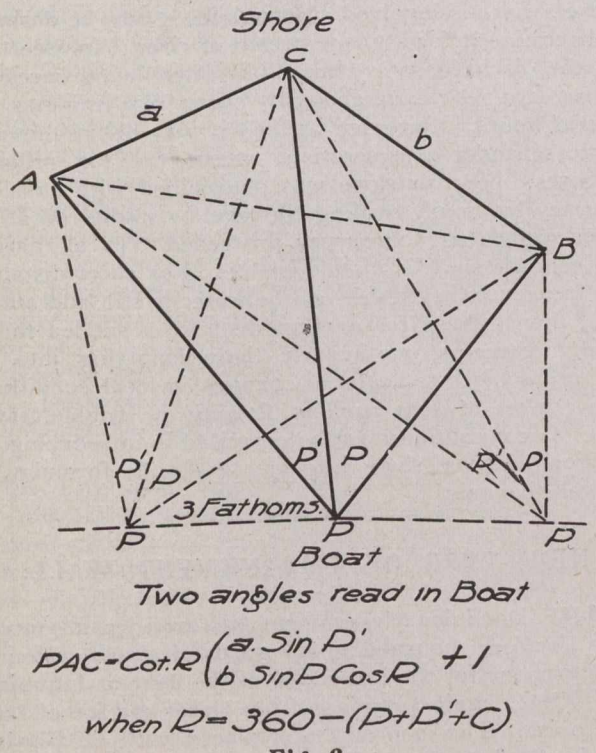

Fig. 2.

Methods.—The location of soundings can be found with reference to visible known points by two angles read at fixed points on shore, as in Fig. 3; or by two angles read in the boat with a sextant (Fig. 2). These are the two principal methods used in work of this kind. Supplementary methods of various kinds are usually brought into use, such as (1) by taking the soundings on a certain range and reading one angle either on shore or in the boat, or by both; (2) by sounding along a known range, or line, taking the soundings at known intervals of time; (3) by taking the soundings at the intersections of fixed range lines; or, (4) by means of chords or lines stretched between fixed points. These methods are variously adapted to different conditions.

Two angles read in the boat to three points on shore whose relative positions (see Fig. 2) are known. This is called the 3-point problem. Let A, C, and B be the three points on the shore defined by the two distances a and b and the angle C. Let the two angles P and P' be measured at the point P. The problem is to find the distance AP and BP.

The angles are read in the boat with a sextant. There are several methods of solution of this problem, e.g., analytical, geometrical, mechanical and graphical solutions. The latter will only be dealt with here, though the formula for the analytical solution is given in the figure.

The angle may be laid off on tracing paper or tracing linen by lines of indefinite length, and this laid upon the plot and shifted in position until the three radial lines coincide with the three stations, when their intersection marks the point of observation. This is the most ready method of plotting such observations when no three-armed protractor is at hand.

This method has many advantages. In the first place, only one observer is required; there is no time lost in changing stations, and there cannot be any misunderstanding in the work. A large number of points, P, can be taken with the three-station points, A, B and C, on shore. The contour, or fathom-lines, 1, 2, 3 and 4, can all be taken, in a great many cases, in three or more positions, to or from the three points on shore. It is well to check the graphical solutions now and again by the trigonometrical method of solution.

Two Angles Read on Shore.—If two instruments, transits or compasses, be placed at two known points on shore, as A and B, Fig. 3, and the angles subtended by some other fixed point and the boat be read by both instruments when soundings are taken, the intersection of the two pointings to the boat, when plotted on the chart containing the points of observation duly plotted, will be the plotted position of the sounding. This method requires two observers. When there are long lines of offshore soundings to be made, and no fixed point on shore of sufficient distinctness to be observed with the sextant from the boat, this method must necessarily be used. The instruments should both be pointing to zero previous to taking an observation. Ordinary surveyors' compasses answer for this work quite well, though the transit is certainly the more accurate.

A triangulation system along a rocky shore or coast may consist of one line of stations or poles on shore and a corresponding line of buoys. The angles are read only from the shore stations, two angles in each triangle being observed. Good results are obtainable from this method if the weather is calm. If the length of any line in this system is known the rest can be determined by the ordinary methods of plane trigonometry.

Soundings on Fixed Cross-sections in Rivers.—The methods described are only usually adapted to sea soundings, and are not adaptable to river soundings. In the

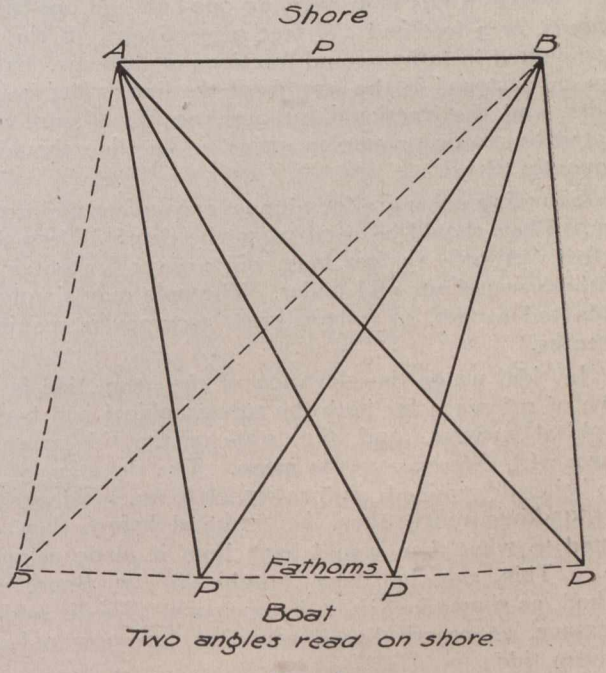

Fig. 3.

chart (Fig. 1) a river is shown, depths or soundings, accurate direction of flow and outline of banks given. Manifestly a different operation was found necessary for obtaining the river soundings, as well as its slope. In