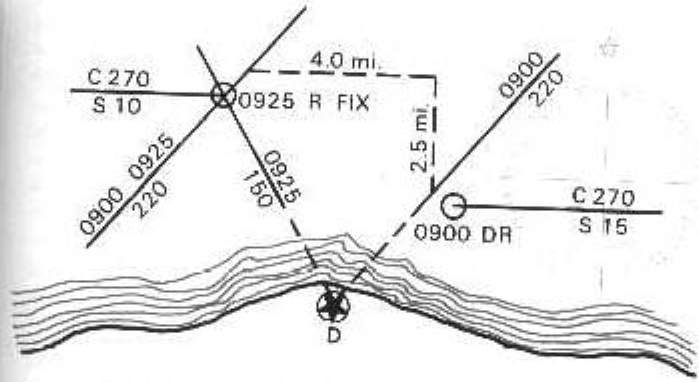

Figure 1112c: A running fix using the DRT.

Solution: Any point on the 0900 bearing line is advanced 2.5 miles north and 4.0 miles west, as indicated by the dashed line, and the advanced line of position is drawn through the point thus determined. A new DR track is started from the 0925 running fix.

Solution by Table 7, Bowditch.

1113. It is possible to solve the running fix by trigonometry; two angles are determined by measurement, and the length of the side between them is determined by the ship's run between the bearings. The distance off at the time of the second bearing can readily be found as can the predicted distance off when the object is abeam. A slide rule lends itself well to this solution.

It is not necessary to resort to trigonometry to obtain the solution. Table 7, Bowditch (Figure 1113), tabulates both distance off at the second bearing and predicted distance off when abeam, for a run of one mile between relative

Figure 1113: Extract from Table 7, Bowditch.

TABLE 7

Distance of an Object by Two Bearings.

Difference between the course and second bearing.	Difference between the course and first bearing.													
	20°		22°		24°		26°		28°		30°		32°	
30°	1.97	0.98												
32	1.64	0.87	2.16	1.14										
34	1.41	0.79	1.80	1.01	2.34	1.31								
36	1.24	0.73	1.55	0.91	1.96	1.15	2.52	1.48						
38	1.11	0.68	1.36	0.84	1.68	1.04	2.11	1.30	2.70	1.66				
40	1.00	0.64	1.21	0.78	1.48	0.95	1.81	1.16	2.26	1.45	2.88	1.85		
42	0.91	0.61	1.10	0.73	1.32	0.88	1.59	1.06	1.94	1.30	2.40	1.61	3.05	2.01
44	0.84	0.58	1.00	0.69	1.19	0.83	1.42	0.98	1.70	1.18	2.07	1.44	2.55	1.77
46	0.78	0.56	0.92	0.66	1.09	0.78	1.28	0.92	1.52	1.09	1.81	1.30	2.19	1.58
48	0.73	0.54	0.85	0.64	1.00	0.74	1.17	0.87	1.37	1.02	1.62	1.20	1.92	1.43
50	0.68	0.52	0.80	0.61	0.92	0.71	1.08	0.83	1.25	0.96	1.46	1.12	1.71	1.31
52	0.65	0.51	0.75	0.59	0.87	0.68	1.00	0.79	1.15	0.91	1.33	1.05	1.55	1.22
54	0.61	0.49	0.71	0.57	0.81	0.66	0.93	0.76	1.07	0.87	1.23	0.99	1.41	1.14
56	0.58	0.48	0.67	0.56	0.77	0.64	0.88	0.73	1.00	0.83	1.14	0.95	1.30	1.08
58	0.56	0.47	0.64	0.54	0.73	0.62	0.83	0.70	0.94	0.80	1.07	0.90	1.21	1.03
60	0.53	0.46	0.61	0.53	0.69	0.60	0.78	0.68	0.89	0.77	1.00	0.87	1.13	0.98
62	0.51	0.45	0.58	0.51	0.66	0.58	0.75	0.66	0.84	0.74	0.94	0.83	1.06	0.94

bearings from 20° on the bow to 30° on the quarter. Since the distance rarely equals exactly one mile, the tabulations are in reality multipliers or factors which, when multiplied by the actual run give the distance from the object at the time of the second bearing and the predicted distance at which the object should be passed abeam.

Arguments for entering Table 7 are arranged across the top and down the left side of each page. The multipliers or factors are arranged in *double columns*. The left-hand column lists the factors for finding the distance at the time of the second bearing. The right-hand column contains the factors for finding the predicted distance abeam.

Whenever the second bearing is 90° (relative), the two factors are the same. In this case the second bearing *is* the beam bearing and the element of *prediction* no longer exists.

In case the second bearing is greater than 90° (relative), the right-hand factor obviously no longer gives a *predicted* distance abeam, but the estimated distance at which the object *was* passed abeam.

There is usually no need to interpolate when using Table 7, even though only the even-numbered relative bearings are given. As a rule it is easy to obtain even-numbered relative bearings if the bearing-taker or navigator exercises a little patience.

Example 1: A ship is on course 187°, speed 12 knots. At 1319 Lighthouse *A* bears 161° and 1334 it bears 129° true.

Required: (1) Distance from Lighthouse *A* at 1334.

(2) Predicted distance at which Lighthouse *A* should be passed abeam.

Solution: (Figure 1113) Difference between course and *first* bearing (first relative bearing or first angle on the bow) = 26°. Difference between course and *second* bearing (second relative bearing or second angle on the bow) = 58°.

Factors (multipliers) = 0.83 and 0.70.

Run (1319 to 1334) = 15 minutes = 3 miles $(12 \times \frac{15}{60})$. (1) 3 × 0.83 = 2.49 = 2.5 miles (distance at 1334). (2) 3 × 0.70 = 2.10 = 2.1 miles (predicted distance abeam).

Example 2: A ship is on course 235° psc, speed 14 knots. At 2054 Light *X* bears 267° psc, at which time the patent log reads 26.7. At 2129 Light *X* bears 289° psc, at which time the patent log reads 34.9.

Required: (1) Distance from Light *X* at 2129.

(2) Predicted distance at which Light *X* should be passed abeam.

Solution: (Figure 1113) Difference between course and *first* bearing (first relative bearing or first angle on the bow) = 32°. Difference between course and *second* bearing (second relative bearing or second angle on the bow) = 54°.

Factors = 1.41 and 1.14.

Distance run = 8.2 miles. (1) Distance at 2129 (time of second bearing) = 11.6 miles. (2) Predicted distance abeam = 9.3 miles.

1114. Certain cases of this problem (two bearings of an object and the intervening run) do not require the use of tables. Some of these *special cases* are as follows: *Special cases.*

The *bow and beam* bearing (Figure 1114a and 1114b) in which the known run between the bow (45°) and beam (90°) bearings equals the object's distance abeam.

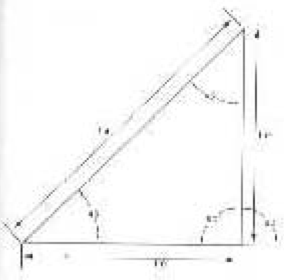

Figure 1114a: Proportion of a right isosceles triangle.

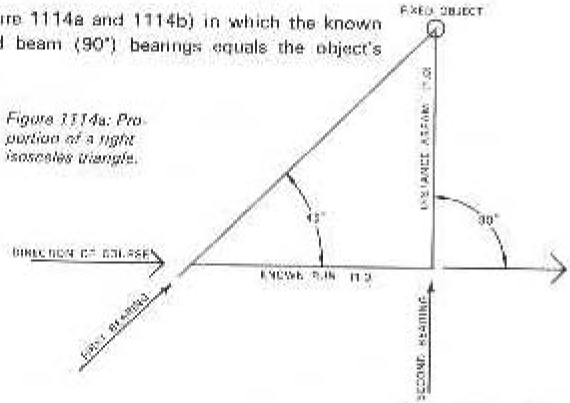

Figure 1114b: The bow and beam bearing.

Doubling the angle on the bow (Figure 1114c). This is developed as follows:

$$b = 180° - 2a$$
$$a + b + c = 180°$$
$$a + 180° - 2a + c = 180°$$
$$a - 2a + c = 0°$$
$$\text{and } a = c$$

$\therefore$ ABC is an isosceles triangle, and $AB = BC$

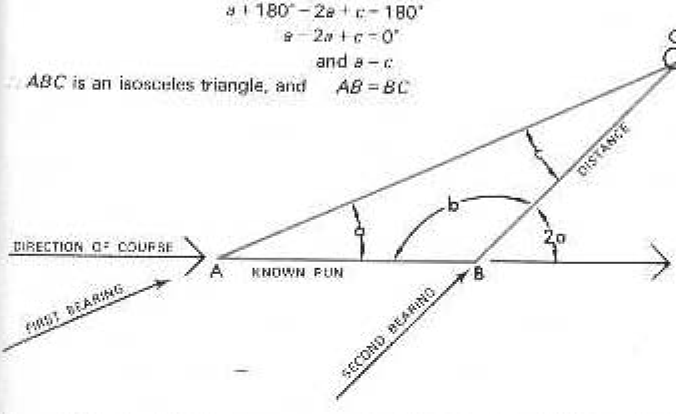

Figure 1114c: Doubling the angle on the bow

Hence, when the angular distance of the object on the bow is doubled, the run between bearings equals the object's distance at the second bearing.

The *22½°–45° case,* or $\frac{7}{10}$ *rule.* This is a case of doubling the angle on the bow, explained in the preceding case, the distance run being equal to the object's distance at second bearing. Also, in this particular case, $\frac{7}{10}$ of the distance run equals the distance the object will be passed abeam.

The *30°–60° case*, or *⅞ rule*, in which the relative bearings are 30° and 60° on the bow. This being another case of doubling the angle on the bow, the distance run between bearings equals the object's distance at second bearing. Also, ⅞ of the distance run equals the distance the object will be passed abeam.

The *26½°–45° case*. If the first bearing is 26½° on the bow and the second is 45°, the object's distance when abeam equals the run between bearings. This is true in other combinations of angles whose natural cotangents differ by unity. Some of these combinations are listed below in tabular form. The asterisked pairs are the most convenient to use, since they involve whole degrees only. In each case, the distance run between bearings equals the distance of passing the object abeam.

Figure 1115. Relative bearings.

1st Bearing	*2d Bearing*	*1st Bearing*	*2d Bearing*	*1st Bearing*	*2d Bearing*
°	°	°	°	°	°
20	29¾	28	48½	37	71¾
21	31¾	*29	51	38	74¾
*22	34	30	53¾	39	76¾
23	36¼	31	56¼	*40	79
24	38¾	*32	59	41	81½
*25	41	33	61¾	42	83½
26	43½	34	64½	43	85¾
26½	45	35	66¾	*44	88
*27	46	36	69¾	*45	90

Keeping in safe water without a fix.

1115. It is sometimes possible to insure the safety of a ship without obtaining a fix, and under some conditions such a method might be even more certain and yet easier to use than those discussed previously.

Along a straight coast where the various depth curves roughly parallel the shore the echo sounder or lead can be kept going and any tendency of the ship to be set in toward the beach will soon be apparent. Such a method, of course must be used intelligently. If a given fathom curve is blindly followed, it may lead into trouble. It is necessary to look ahead and anticipate the results. If the given fathom curve makes a sharp turn, for instance, a ship following a steady course might find itself in rapidly shoaling water before it could make the turn. The given fathom line, while affording plenty of water under the keel might pass close to isolated dangers, such as wrecks, shoals, or rocks.

In following a narrow channel, particularly one that is not well marked, a constant bearing on a distant object ahead or a range can be of inestimable value. A very slight deviation from the desired track is immediately apparent when navigating by means of a range dead ahead. Beacons are often installed in such a position as to form ranges to guide ships along channels, but when such an aid has not been made available, natural ranges can sometimes be found. The navigator should be alert to recognize such a situation, for the value of ranges, either artificial or natural, as guides in navigation cannot be overemphasized. In using a range, it is important to know how far the range can be followed; that is, when to turn. Turns in a channel are usually marked by turn buoys. Excellent fixes to check the progress of a ship can be obtained