FORUM

Errors in Radar Appreciations

from Captain F. J. Wylie, R.N.

Captain H. Topley in his article on radar plotting errors (11, 167) has endeavoured to simplify the arithmetic and introduce an approximate formula which will be of practical use to the navigator. He admits that his approximation has limitations and it appears to me that some danger may arise from the difficulty which the non-mathematical navigator may have recognized when he has passed the point at which the formula will be safe to use. Further, Topley tends to concentrate on the errors in the estimated course and speed of the other vessel and to give rather less attention to the problem of errors in the closest position of approach (C.P.A.). The latter may be by far the most significant factor.

As far as errors in the estimated course and speed of the other vessel are concerned, the critical factor is the distance run by that vessel in the plotting interval (a term used in preference to the cumbersome 'computing interval') compared with the maximum error at the mean range. When the ratio of these quantities is near or less than unity the course errors become very large and unpredictable. Similar developments arise in connection with the error in the C.P.A. which depends upon the ratio between the relative distance run and the maximum error.

Topley takes the quasi-maximum error in range or bearing for a set of observations to be 0·03 R, where R is the mean range. The curves in Fig. 1 show the errors in the estimated course which correspond with various distances run using mean ranges of 10 miles and 5 miles respectively.

It can be seen from Fig. 2 that, when distance run equals maximum error (range and bearing) at the mean range, W is on the error circle and the course error is $\pm 90°$. Immediately the distance run is reduced further, the error becomes $\pm 180°$. Topley's approximations (and hence the curves in Fig. 1) do not follow this, but they do suggest that, if the distance run by the other ship in the plotting interval is more than $1\frac{1}{2}$ miles at mean ranges up to 10 miles or so, the errors in course should not usually be significant in crossing cases.

However, the maximum bearing error may well be greater than the amount that the bearing changes in the plotting interval. The rate of change may be so slow that a greater difference cannot be waited for. When this is so, ambiguity will exist as to the side on which the ship will pass and, of course, whether 'risk of collision' is technically present or not.

When these conditions exist, the amount by which the C.P.A. may vary will depend upon the distance run on the relative track in the plotting interval, which, since the bearing change is very small, will be virtually equal to the range change. In connection with Topley's conclusions, it is important to note that this ambiguity does not vary with the speed of the other ship; it may occur in any circumstances which include slow moving bearings.

Fig. 3 shows three different situations distinguished by small bearing changes; all are fine-bearing encounters, the first bearing being ahead, all are at the same mean range and hence have the same error circle, and in all cases the distance run by own ship is the same. Fig. 4 shows three encounters in similar circumstances except that the bearings are broad on the bow.

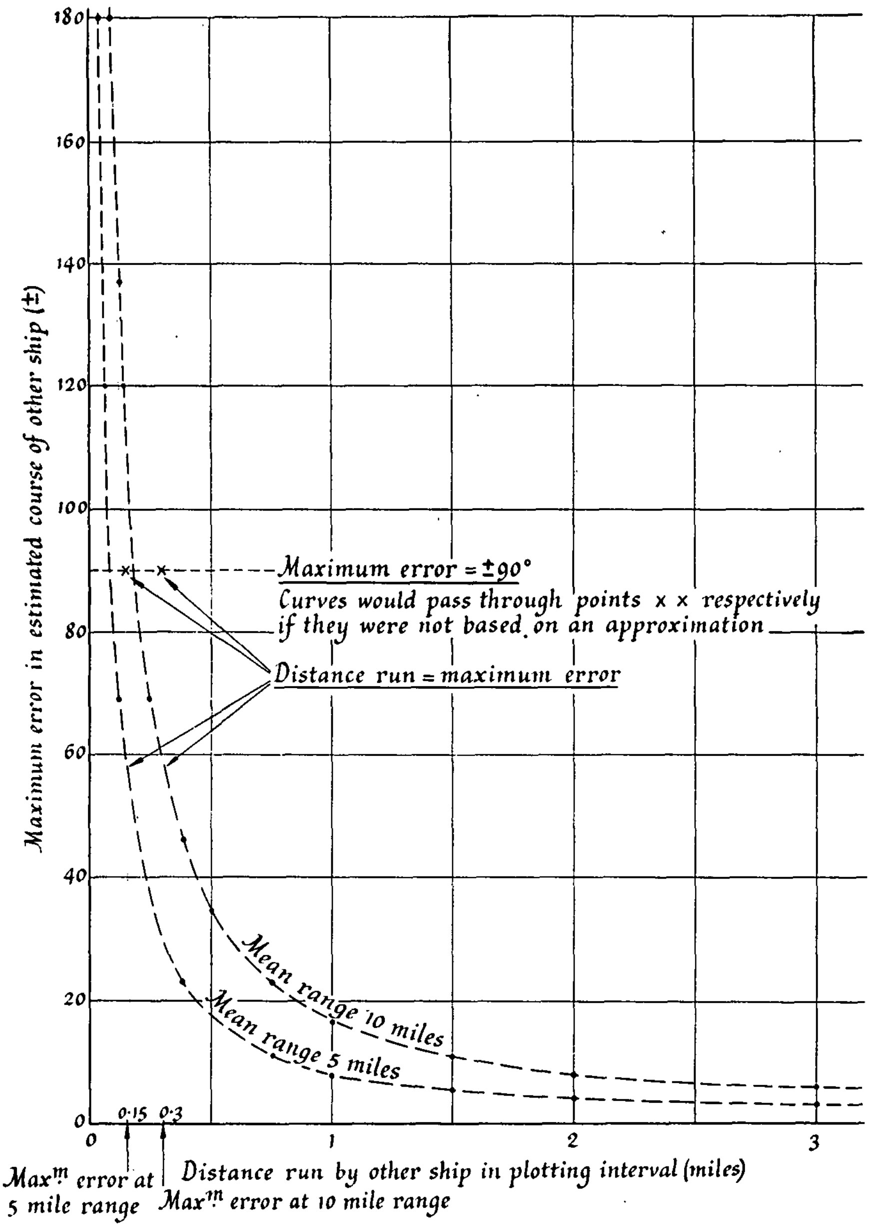

Fig. 1. Variation in error in estimated course of other ship with her distance-run in plotting interval. Curves based on the expression (Topley) Max^m. error in estimated course$=103R/(Kt)$. ($R=$ mean range; $K=$ estimated speed (knots); $t=$ plotting interval (min.).)

All these examples indicate that with slow-moving bearings, a small ratio of range change to bearing error introduces possibilities of large errors in the estimated C.P.A. As the bearing error is proportional to mean range it is obvious that C.P.A. errors $\propto$ (mean range/range change) and a simple calculation will show that with a range and bearing error of $0{\cdot}03R$ (Topley) and a range change

https://doi.org/10.1017/S0373463300018014 Published online by Cambridge University Press

of 1 mile at a mean range of 10 miles, the probable maximum error in the direction of OA (=relative track or apparent motion) will be as much as $\pm 16\frac{1}{2}°$ and, in C.P.A. distance, of 3 miles.

If the plotting interval is doubled so that range change is 2 miles at a mean range of 10 miles, the errors in C.P.A. would be halved. At a mean range of 5 miles, a range change of 1 mile would, of course, give the same result.

This suggests that in deciding what plotting interval to adopt when the bearing is slow moving, observers should have in mind a suitable ratio of range change to mean range.

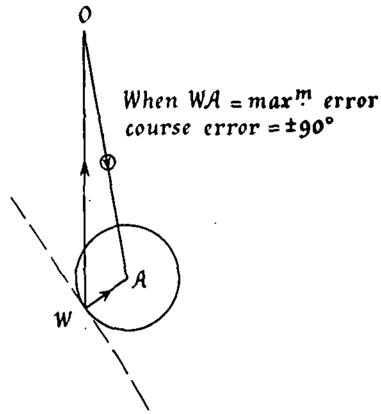

Fig. 2

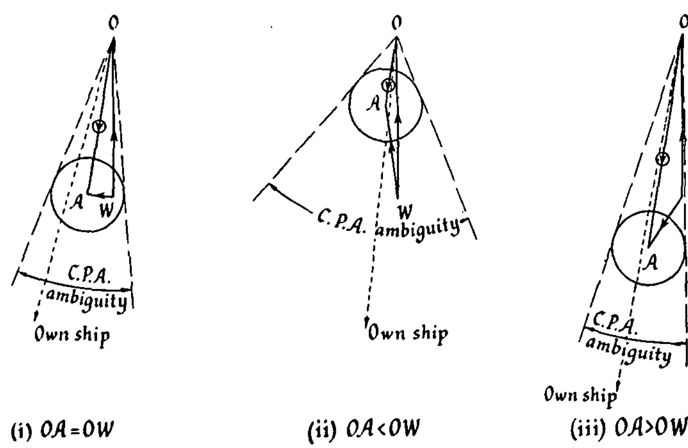

Fig. 3. Fine bearings, small change.

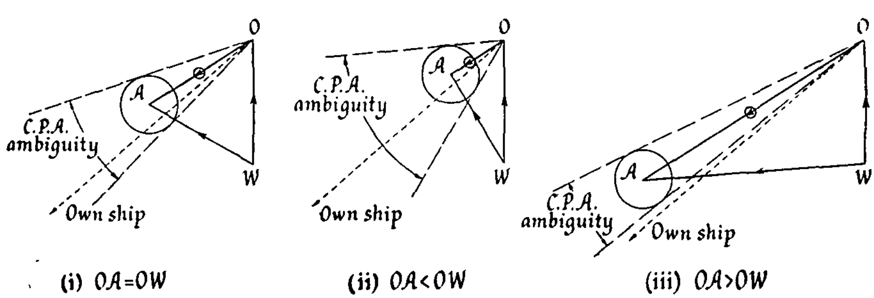

Fig. 4. Bow bearings, small change.