while the rhumbline distance is:

$$D_R = 4359{\cdot}4 \text{ n.m.}$$

with the course:

$$C = 81{\cdot}0°.$$

The method with meridional parts proposed by Tijardović gives the results:

$$D = 1644{\cdot}0 + 2572{\cdot}9 = 4216{\cdot}9 \text{ n.m.}$$

$$\theta = 65° \ 34' = 65{\cdot}6°.$$

The formulae (1) and (2) give the results:

$$D = 1675{\cdot}9 + 2535{\cdot}6 = 4211{\cdot}5 \text{ n.m.}$$

$$\theta = 66° \ 03{\cdot}7' = 66{\cdot}1°.$$

As can be seen the distance by these formulae is 5·4 n.m. shorter than that by meridional parts. The difference is insignificant.

The method presented by Tijardović is worth remembering when planning trans-oceanic navigation.

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KEY WORDS

1. Marine Navigation. 2. Voyage Planning.

Measuring True Distance on a Mercator Chart

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A Mercator chart has the great advantage that rhumblines are straight lines and, since the projection is conformal, the course between any two points may be precisely measured. However, the expanding latitude scale means that distances may only be measured approximately. It is now suggested that, by the addition of a constant scale of latitude, distances may also be measured precisely through the simple use of a pair of dividers.

Figure 1 shows two triangles superimposed on one another. The larger triangle, $P_1 P_2 G$ is that corresponding to the rhumbline joining typical positions P_1 and P_2 as plotted on a Mercator chart and such that G is the intersection of the meridian through P_1 and the parallel through P_2. We have the relationship:

$$\operatorname{Tan}\theta = P_2 G / P_1 G, \tag{1}$$

where θ is the rhumbline course.

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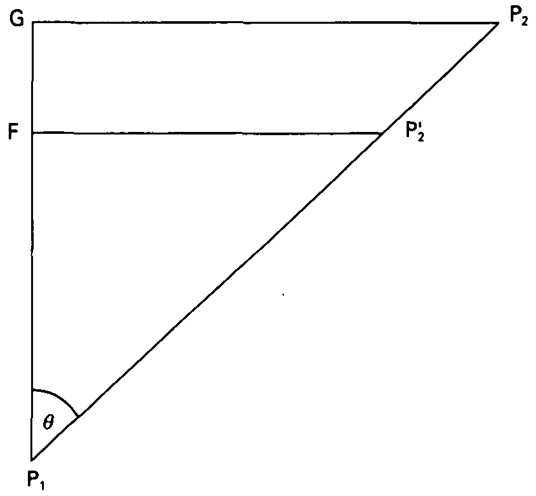

Fig. 1. Mercator and plane sailing triangles

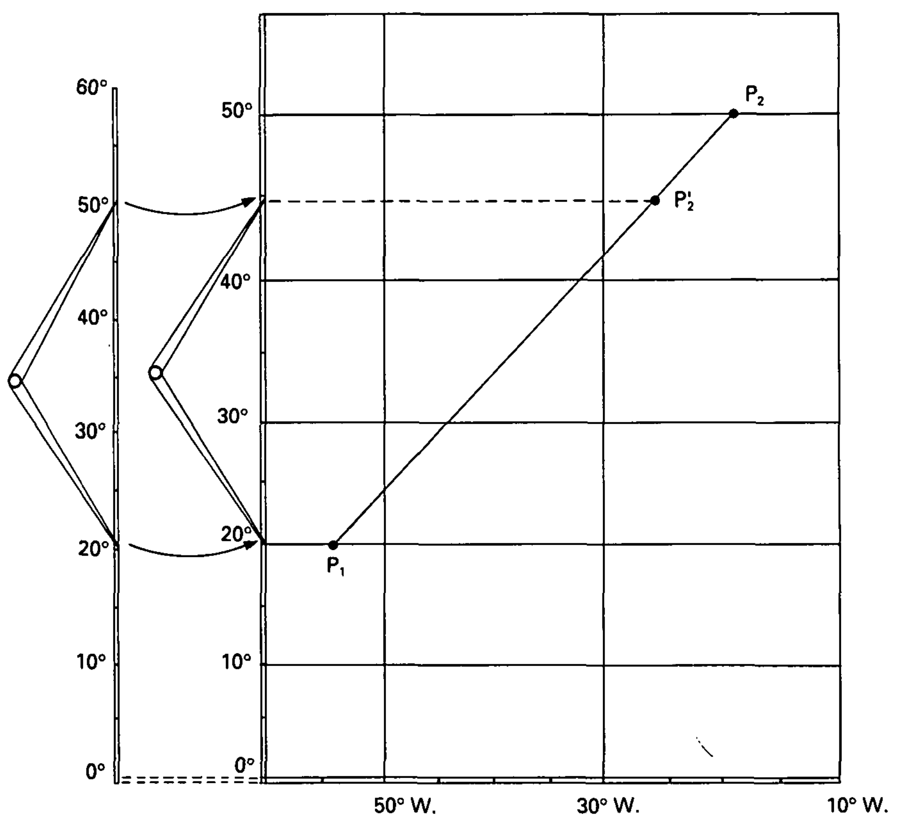

Fig. 2. Plotting course and distance from P_1 in latitude 20° N. to P_2 in 50° N. on a Mercator chart with added fixed latitude scale

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We next construct a fixed scale of latitude, starting from the bottom of the chart with the same latitude as the Mercator graticule, and such that each minute of latitude has a constant length corresponding to the Mercator latitude scale at the equator. The smaller right-angled triangle $P_1 P_2^1 F$ in Figure 1 is then constructed by making the distance $P_1 F$ equal to the difference in latitude between P_1 and P_2 on the fixed latitude scale. The distance $P_1 P_2^1$ in nautical miles is measured by dividers on the same scale. This procedure is simply the geometrical equivalent of the plane sailing formula:-

$$P_1 P_2^1 = P_1 F \sec \theta. \tag{2}$$

In order to demonstrate the practical application of the method, we refer to Figure 2, which represents a section of a Mercator chart. In the general case, to find the distance between P_1 and P_2, we start, as usual, by joining the positions with a straight line. Then, with the dividers, we step off the difference between the latitudes of P_1 and P_2 on the fixed scale. This distance we transfer to the Mercator scale, adding it to the latitude of P_1 to find the latitude of P_2^1. The position of P_2^1 may then be marked on the rhumbline. Finally, the distance $P_1 P_2^1$ may be stepped off by the dividers and measured in nautical miles from any part of the fixed latitude scale.

The technique described in this paper cannot be used when courses are east-west or nearly east-west, when the plane sailing formula (2) on which it is based also becomes impractical as the secant of the course takes very large values. For other rhumbline tracks, it is useful to be able to measure distances directly from the chart by a method which is sound in principle and which gives accurate results in practice.

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