Locating people in high latitudes: addendum to NAE Laboratory Technical Report LTR-FR-32

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LOCATING PEOPLE IN HIGH LATITUDES

(Addendum to NAE Laboratory Technical Report LTR-FR-32)

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LOCATING PEOPLE IN HIGH LATITUDES

(Addendum to NAE Laboratory Technical Report LTR-FR-32)

Location by Ranging From a Synchronous Polar Satellite

1.0 INTRODUCTION

Section 15 and Figures 11 to 22 of LTR-FR-32 are concerned with the nature of coverage obtained from a satellite in polar orbit but at an altitude of about 22,650 nautical miles such that it synchronizes with the earth's rotation in a somewhat queer manner. Instead of remaining fixed over a point on the equator as the "fixed" equatorial orbiting ones do, the polar synchronous satellites going round the earth once a day in their polar inertial orbit, cast a "ground zero" track on the surface of the earth that is a figure 8 passing over both the north and south poles and crossing the equator at the same place each day as shown in Figures 11 to 19 of the main report.

At the time of writing it was assumed that a method of determining the location of a suitable emergency or other transmitter on the earth's surface could be found, but how to resolve the ambiguity as to which side of track the transmitter is located, was not described. It is now realized that the almost continuous curvature of the figure 8 track of the polar synchronous satellite on the earth's surface provides the key to resolving this ambiguity.

around the "ground zero" point on the track at the instant the range was obtained. The transmitter location could be anywhere on this locus. The second range obtained a few minutes later (Fig. 2) will similarly yield a range circle about the new "ground zero point" on the track. This second circle should cross the first at two points. One of these should be the location of the transmitter on the earth's surface. In another few minutes a third range should be obtained and a third range circle plotted about the third ground zero point on the figure 8 track. This new circle must cross each of the others at two points. If the satellite track were straight (Fig. 3) the two points would always coincide with the ones obtained from circles 1 and 2 and the ambiguity would not be resolved. When a polar orbit at synchronous altitude is used the curvature of the figure 8 track comes into play, and it is found that there is only one point, B, at which all three circles cross (Fig. 4), and two points, A and C, where only two circles cross each other.

3.0 RESOLVING AMBIGUITY

The solution, of course, is to ignore all points where less than three circles cross each other and dispatch rescue aircraft or teams to the now located area. A high degree of range accuracy is called for, but modern techniques make this a very real possibility. Since a new range should be available every few minutes, for a dwell of up to 6 hours a day, in polar regions, and up to 12 hours a day with only one satellite in temperate an unknown amount. Once a tentative location is found a refinement is possible by looking up the general elevation of the terrain near this location and recalculating a new location until the main objective seems to be met. This is, of course, to direct rescue aircraft close enough to receive a signal direct from the lost transmitter and home in on it.

Calculations should of course take account of the non-spherical shape of the earth and the real position of the satellite. Since these calculations may be made at a convenient temperate zone ground station with plenty of time available, this should not be a problem with a modern computer.

5.0 CONTINUOUS COVERAGE

It will require four satellites of course to give continuous coverage in mountainous areas but fortunately these can be added one at a time as economics permit, without basic effect on the system.

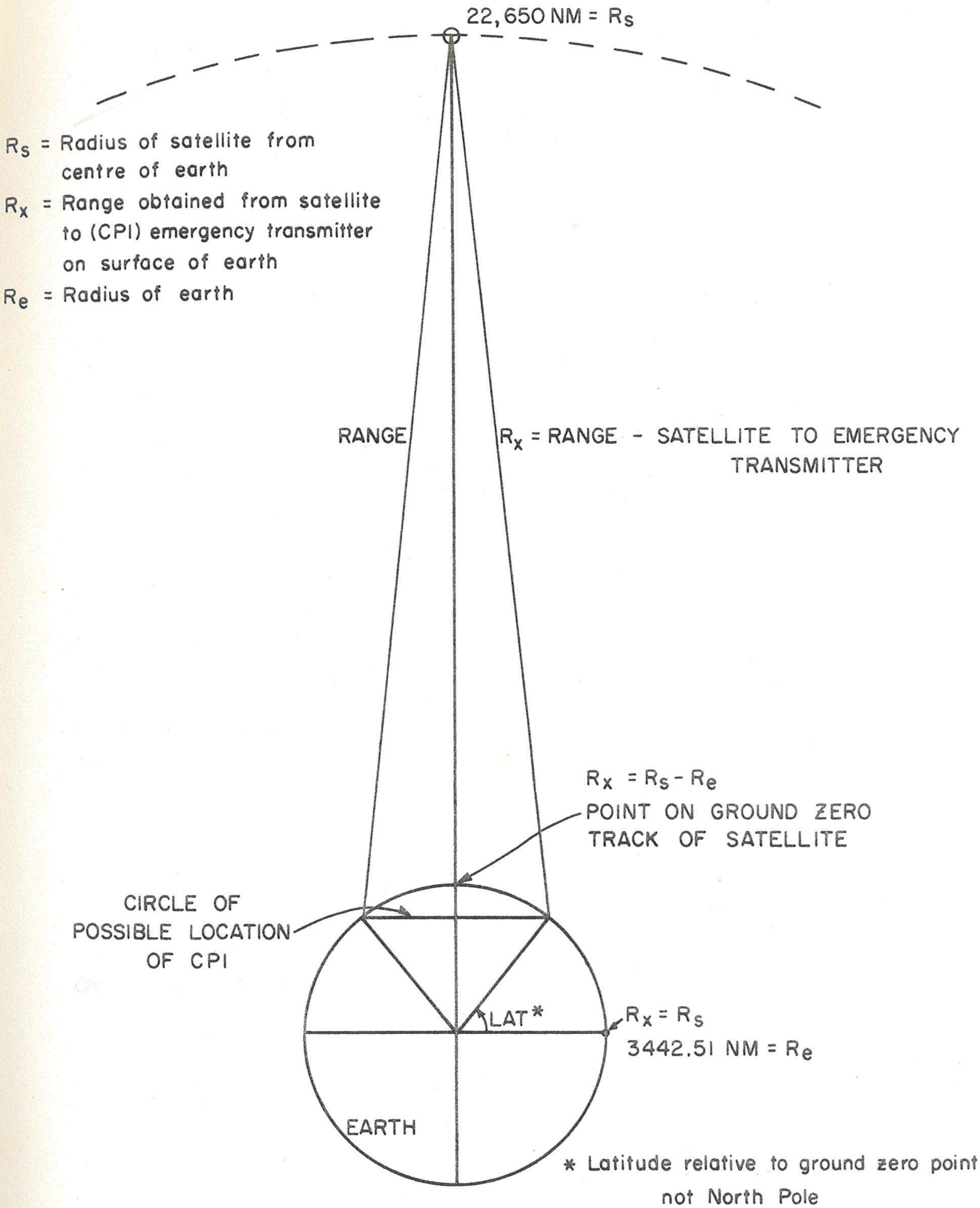

FIG 1 POLAR SYNCHRONOUS SATELLITE

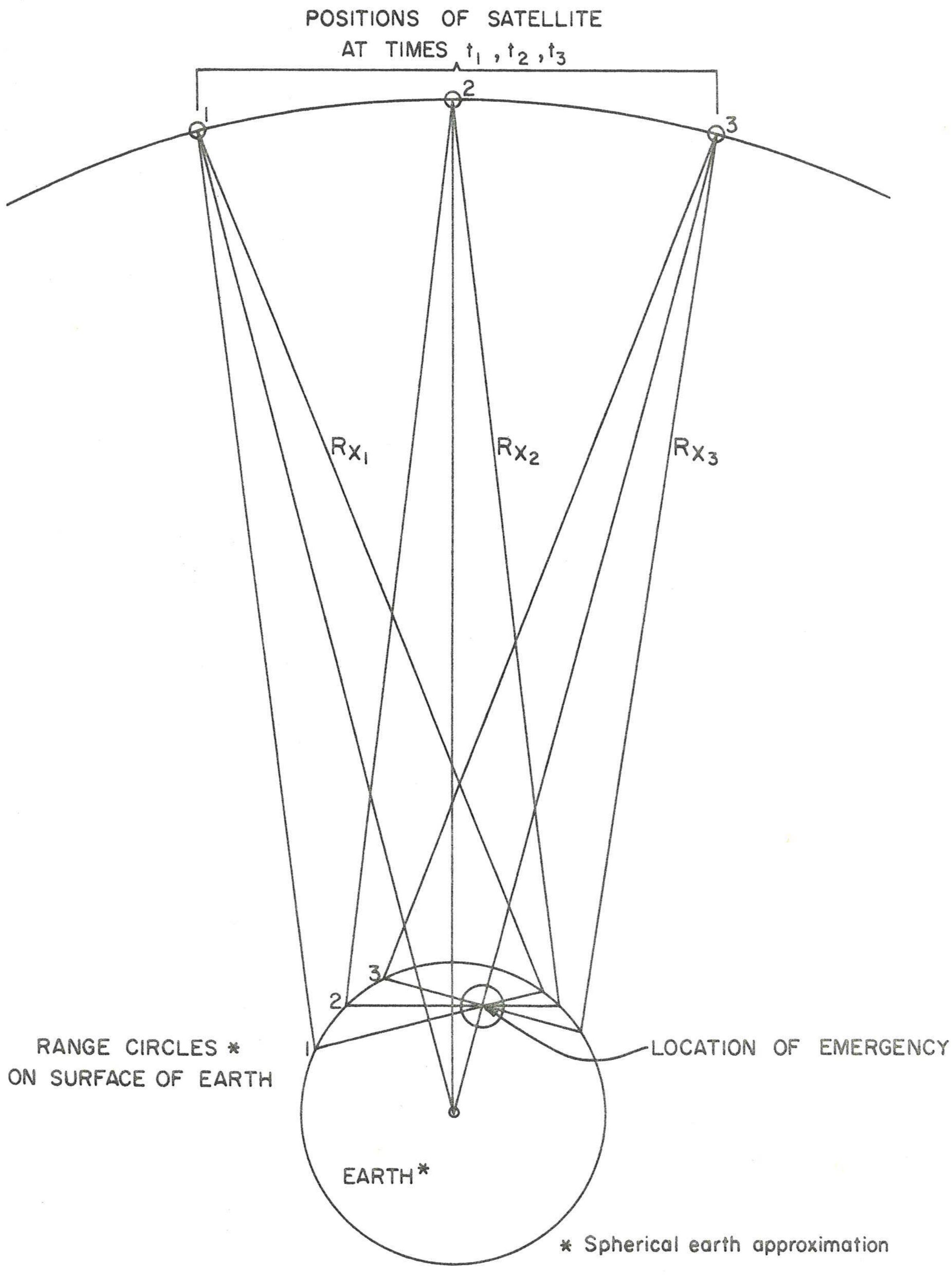

FIG 2 RANGE & RANGE CIRCLES FOR THREE SATELLITE POSITIONS

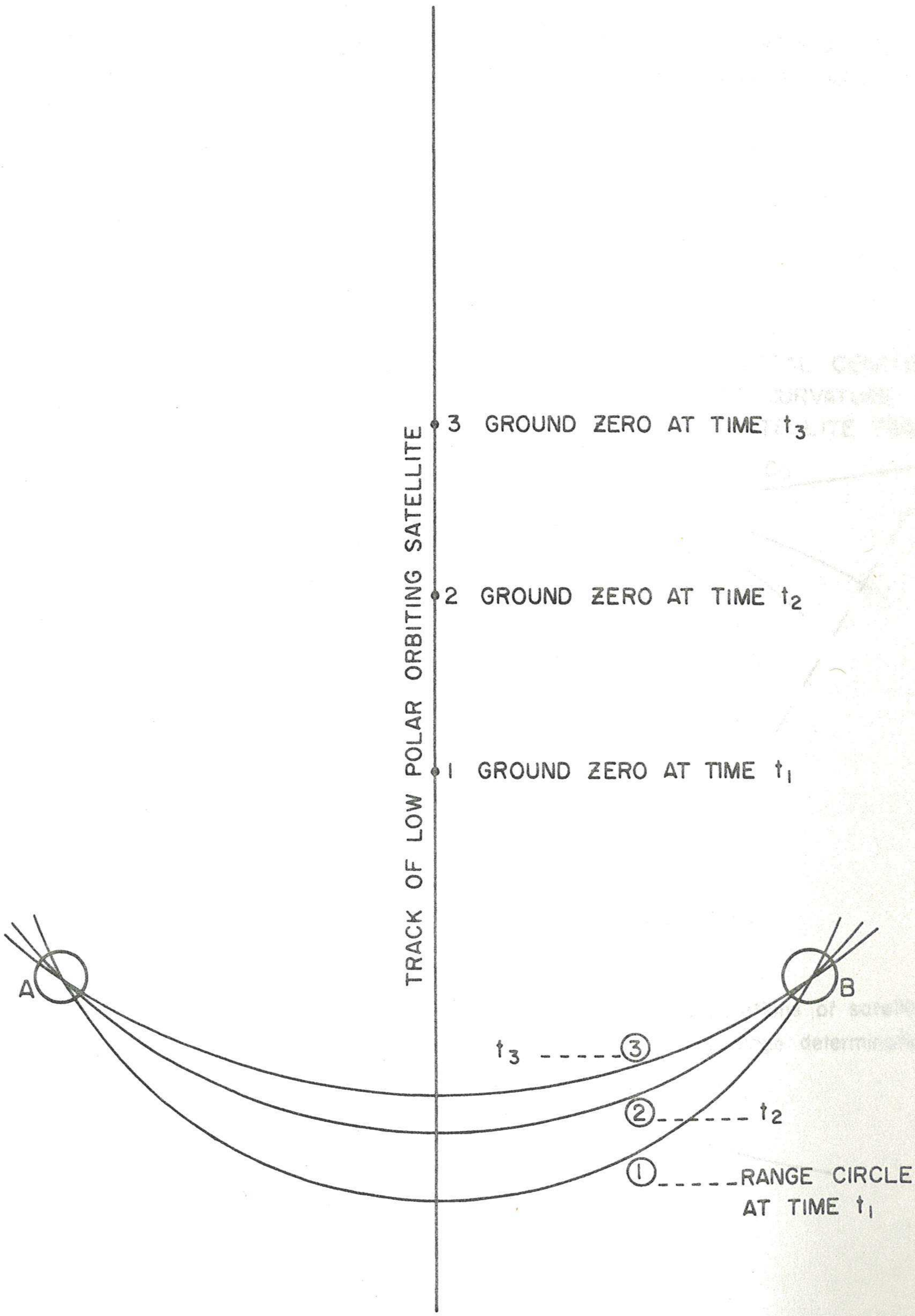

FIG 3 RANGING FROM THREE POSITIONS ALONG STRAIGHT TRACK - NOTE AMBIGUITIES A & B

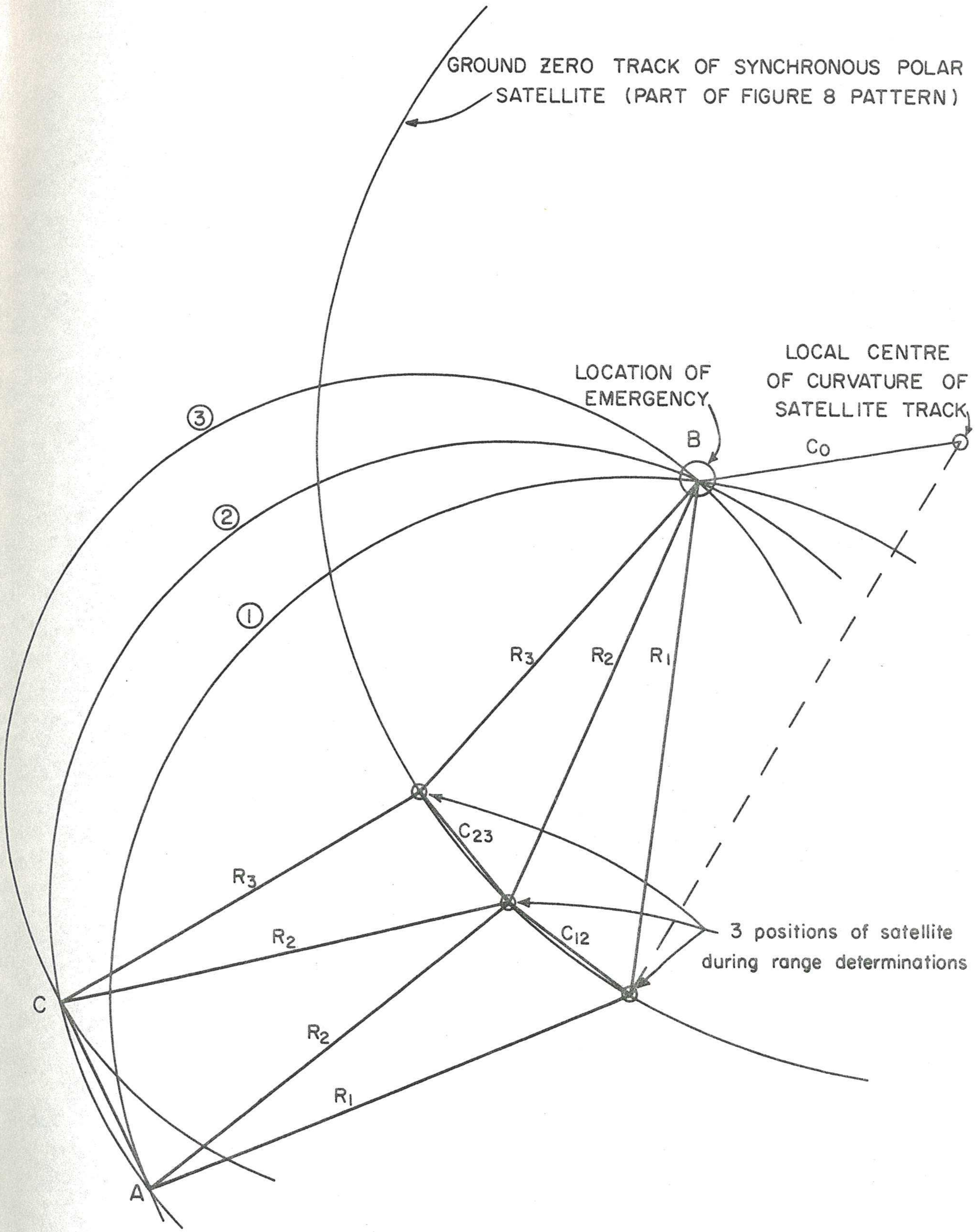

FIG 4 RESOLVING AMBIGUITY WITH ONE SATELLITE IN THREE POSITIONS ABOVE CURVING GROUND ZERO TRACK