Sights need not be solved in the order taken. During evening twilight the brightest bodies should be observed first, as soon as they can be "brought down" successfully to the horizon. During morning twilight the reverse is true, the dimmer stars being observed while they are still visible. However, with advance planning, one can include in the list of bodies to be observed those which should provide the best fix.

If all observations were precisely correct, in every detail, the resulting lines of position would meet at a point. However, this is rarely the case. Three observations generally result in lines of position forming a triangle. If this triangle is not more than two or three miles on a side under good conditions, and five to ten miles under unfavorable conditions, there is normally no reason to suppose that a mistake has been made. Even a point fix, however, is not *necessarily* accurate. An uncorrected error in time, for instance, would move the entire fix eastward if early and westward if late, at the rate of 1′ of longitude for each 4^s of error in time.

With two or four observations, the ideal is to have them crossing at angles of 90°. With three observations, the ideal is angles of 60°. With three observations it is good practice to observe bodies differing in azimuth by 120°, as nearly as possible. This provides lines of position crossing at angles of 60°, and, in addition, any constant error in altitude is eliminated, serving only to increase or decrease the size of the triangle, but not affecting the position of its center. If the azimuths differ by 60° (or the azimuth spread is less than 180°), a large constant error in altitude would result in a fix *outside* the triangle, as shown in figure 1707c. With lines of position crossing at 60°, the assumed constant error for a fix outside the triangle is three times that for a fix inside the triangle. With four bodies, azimuths differing by 90° produce a box fix, with constant error eliminated by using the mid point as the fix. With more than four observations, the selection of the fix becomes more complex, and general rules are probably undesirable. The evaluation of each observation and the exercise of judgment become of greater importance. Whatever the number of observations, common practice, backed by logic, is to take the center of the figure formed unless there is reason for deviating from this procedure. By "center" is meant the point representing the least total error

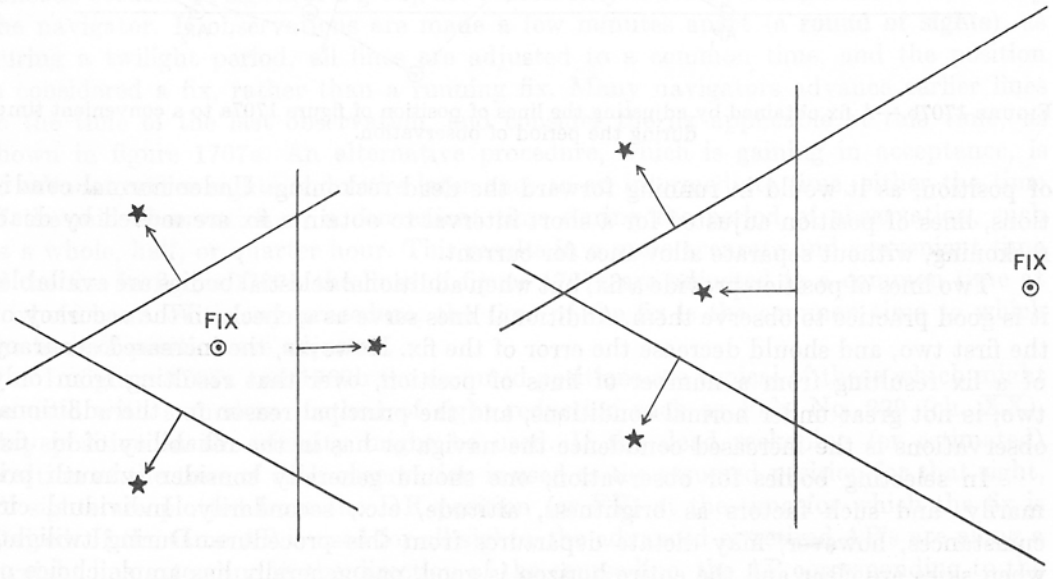

FIGURE 1707c.—A fix from three lines of position, assuming a constant error in altitude. If all lines are moved away (in this case) from the bodies observed, they would meet in a point which might be either inside (left) or outside (right) the triangle.

of all lines considered reliable. With three lines of position, the center is considered that point, within the triangle, which is equidistant from the three sides. It may be found by bisecting the angles, but more commonly it is located by eye. If a fix outside the triangle is to be used, and eye interpolation is not considered sufficiently reliable, the point can be found by bisecting two external angles and the internal angle at the third intersection. If a constant error is assumed, the most probable position of the fix can always be found, whether within or outside the triangle, by bisecting the angle formed by azimuth lines originating at each intersection.

The matter of navigational errors as applied to this problem is further discussed in chapter III of volume II.

1708. A running fix (R FIX), in celestial navigation, is a position obtained by observations separated by a considerable time interval, usually several hours. The usual occasion for a running fix is the availability of a single celestial body for observation, generally the sun. The delay between observations is usually to permit the azimuth to change sufficiently to provide a good angle of cut between lines of position. Thus, the sun may be observed about 0900, and again about noon.

Generally, a longer wait results in a more nearly perpendicular intersection of the two lines of position, but it may also increase the error of the advanced line. The earlier line is advanced for the course and distance made good. The ability with which these can be predicted determines the accuracy of the running fix, assuming accurate observation, sight reduction, and plotting. For this reason it is impractical to set a specific time limit upon the advancement of a line of position. This should be determined by the conditions of each situation, in the best judgment of the navigator. Experience is valuable in acquiring such judgment.

When an observation of a single body is made, with the intent of later advancing it to obtain a running fix with a second observation, the line of position should be plotted for the time of observation, regardless of the method used for advancing it, for the single line usually provides some useful information, as indicated in article 1704.

Allowance for current, when advancing a line of position, can be made by solving a vector diagram, as indicated in article 807, to determine the course and speed made good. An alternative method is to advance the AP or line without allowance for current, and then to advance it a second time in the direction of set of the current, for a distance equal to the drift multiplied by the number of hours between the time of observation and the time to which the line is advanced. This method is illustrated in figure 1708a. The distance AB is equal to the distance between the 0800 and 1152 DR positions. The direction BC is the estimated set of the current, and the length BC is the distance through which the current is assumed to act.

A third method provides accurate results even when a reliable estimate of the current is not available, provided (1) a good fix was obtained several hours before the time of observation, and (2) the average current between the time of the previous fix and the time of observation can be assumed to continue until the time to which the line is to be advanced. This method is illustrated in figure 1708b. The 0510 fix is shown at the left, and the DR positions at 0830 and 1215, the ship being on course 074°, speed 12 knots. The sun is observed at 0830 and again at 1215, and it is desired to advance the earlier line to obtain a running fix at 1215. The lines of position at 0830 and 1215 are plotted. To advance the 0830 line of position, the distance AB is assumed to increase uniformly with time interval from 0510. The interval to 0830 is 3^h20^m, and that to 1215 is 7^h05^m. Therefore, $A'B'=AB\times\frac{7^h05^m}{3^h20^m}=AB\times 2.1$. The advanced line of position is drawn through B', parallel to the original line through B. The running fix is at the intersection of the 1215 line and the advanced 0830 line.