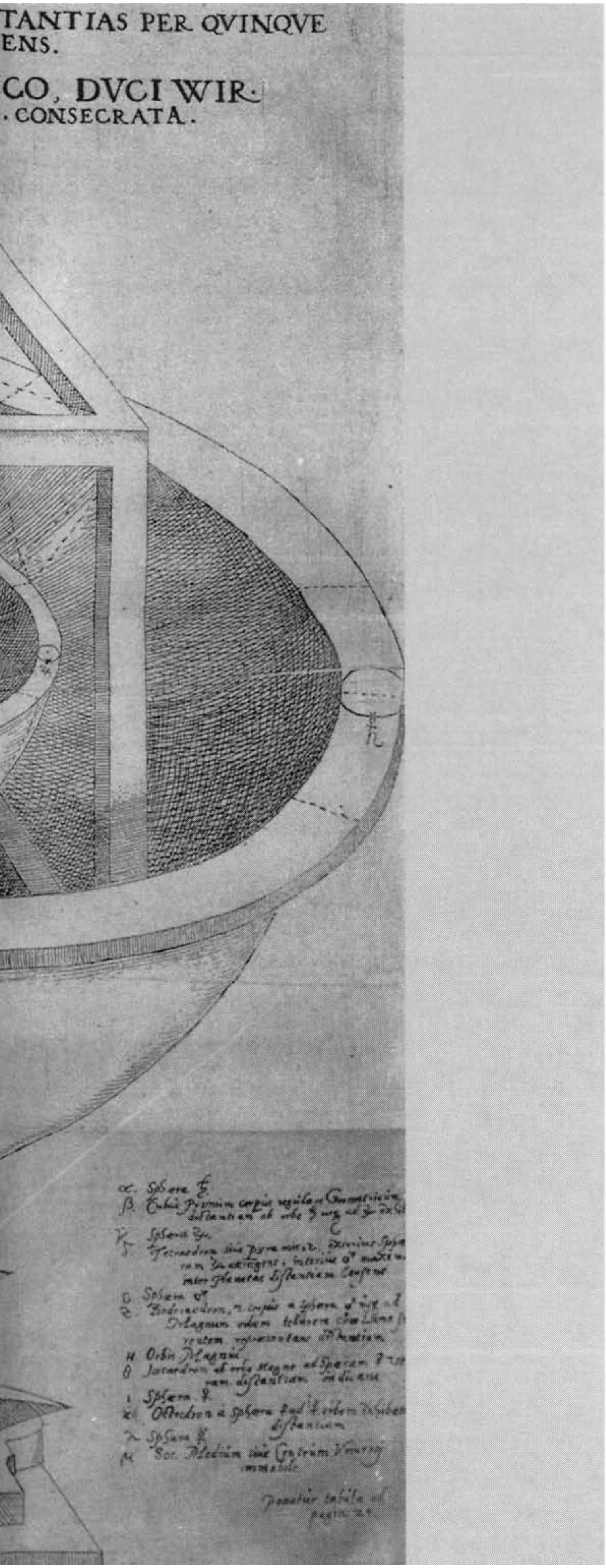

The History & Practice of Ancient Astronomy

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The outermost scale (the *altitude scale*) consists of four quadrants, each graduated from 0° to 90°. This scale is used with the alidade for observing the altitude of a star or of the Sun. The alidade can be furnished with two *vanes*, each of which is pierced by a sighting hole.

The *shadow box* (fig. 3.26) is used to solve problems involving shadows. The last feature of the back of the astrolabe is a family of circular arcs used for telling the *seasonal hour* by means of the altitude of the Sun.

Many features of your astrolabe were more or less standard during the whole history of the astrolabe. But some features (e.g., the scales on the rete for mean time and for right ascension) are modern conveniences.

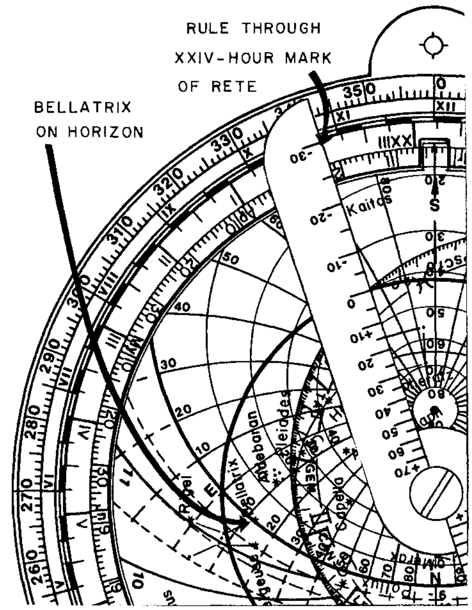

FIGURE 3.27.

Using the Astrolabe

Some of the most important applications of the astrolabe are described here in the form of worked examples. Unless otherwise noted, each example is worked for the latitude of Seattle (47 2/3° N). The secret of using the astrolabe is to *visualize* the meanings of the various circles. Once you have worked through a few problems, you should be able to solve new types of problems without instructions.

First Group: Problems Involving Stars

1. Rising position of a star:

   Example Problem: Where on the horizon does Bellatrix rise?

   Solution: Turn the plastic rete until Bellatrix appears on the eastern side of the horizon. (The horizon is the heavy circle on the plate marked with the letters E, N, and W; see fig. 3.27). Bellatrix crosses the horizon about 13° north of east.

2. Meridian altitude of a star:

   Problem: How high above the horizon is Rigel when it crosses the meridian?

   Solution: Turn the rete until Rigel comes to the meridian above the horizon. (The meridian is the straight line running through the middle of the plate; see fig. 3.28). Rigel is 33° above the horizon.

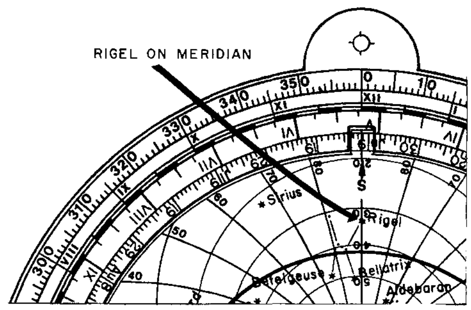

FIGURE 3.28.

3. The time a star spends above the horizon:

   Problem: How long does Bellatrix spend above the horizon each day?

   Solution: There are several ways to do this. The solution given here is the simplest. First, orient the rete so that Bellatrix is on the eastern horizon. Second, position the rule so that it passes through the XXIV-hour mark on the right ascension scale of the plastic rete (see fig. 3.27). (The XXIV-hour mark is the same thing as a zero-hour mark.) Be sure to use the hour marks *on the rete* and ignore the hour marks on the mater. Third, while holding the rule in place with your thumb, turn the rete until Bellatrix reaches the *western* horizon. You should find that the XIII-hour mark of the rete is about 1/4 hour past the rule. That is, the rete turned through 13 1/4 hours while Bellatrix went from the eastern to the western horizon. Thus, at Seattle, Bellatrix is above the horizon for 13 1/4 hours.

Second Group: Problems Involving the Sun

4. Position of the sun on the ecliptic:

   Problem: What is the Sun's position on the ecliptic on February 4?

   Solution: Turn to the back of the astrolabe. Orient the alidade so that it passes through the February 4 mark on the calendar scale, as in figure 3.26. Then read off the Sun's position on the zodiac scale. On February 4, the Sun is at the 15th degree of Aquarius.

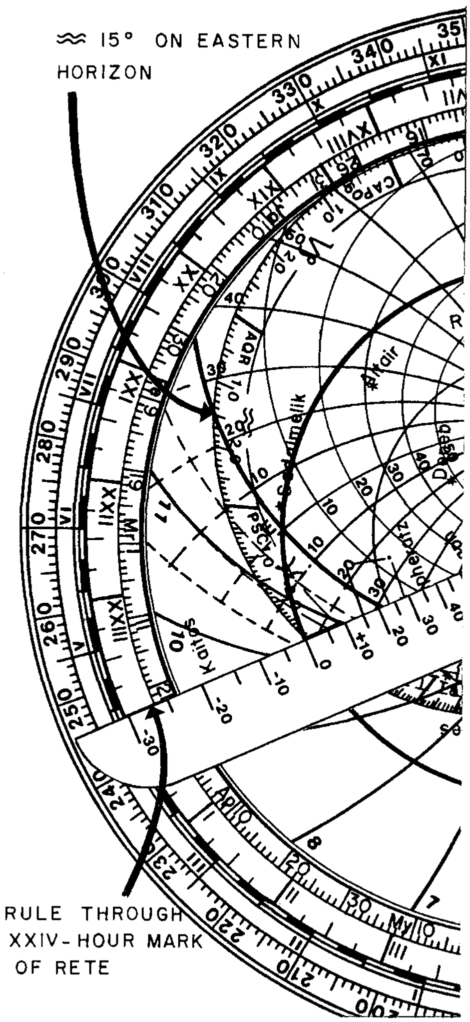

FIGURE 3.29.

5. Rising position of the sun:

Problem: For an observer in Seattle, where on the horizon does the Sun rise on February 4?

Solution: From problem 4, we know that on February 4 the Sun is at the 15th degree of Aquarius. Orient the rete so that AQR 15° is on the eastern horizon, thus simulating sunrise (see fig. 3.29). AQR 15° crosses the eastern horizon about 25° south of east. Note that this problem is essentially the same as problem 1.

6. Noon altitude of the sun:

Problem: What is the noon altitude of the Sun in Seattle on February 4?

Solution: As we know from problem 4, on February 4, the Sun is at the 15th degree of Aquarius. Turn the rete so that AQR 15° comes to the meridian, thus simulating local noon. You should find that is about 26° above the horizon. This is much like problem 2.

7. Length of the day:

Problem: How long is the Sun up at Seattle on February 4?

Solution: On February 4, the Sun is at Aquarius 15° (from problem 4). Orient the rete so that AQR 15° is on the eastern horizon; this represents sunrise. Then orient the rule so that it passes through the XXIV-hour mark on the right ascension scale of the rete (fig. 3.29). While holding the rule down with your thumb, turn the rete until AQR 15° comes to the western horizon (sunset). You should now find that the IX-hour mark on the rete is about 1/2 hour past the edge of the rule. Thus, at Seattle on February 4, the Sun is above the horizon for 9 1/2 hours. Note that this problem is essentially the same as problem 3.

8. Time of sunrise or sunset:

Problem: At what time does the Sun rise at Seattle on February 4?

Solution: There is more than one way to solve this problem. One way is to use the result of problem 7, that the Sun is above the horizon for 9 1/2 hours at Seattle on February 4. Half of this 9 1/2 hours is the length of the morning and half is the length of the afternoon. Thus, the Sun sets at 4:45 P.M. It rises 4 hours and 45 minutes before noon, at 7:15 A.M.

Alternative (and more elegant) solution: On February 4, the Sun is at the 15th degree of Aquarius. Orient the rete so that AQR 15° is on the eastern horizon, simulating sunrise. Now orient the rule so that it passes through the Sun (AQR 15°). The time of day is indicated by the rule's position on the scale of hours marked on the limb of the mater: sunrise occurs at 7:15 A.M.

The time of day obtained in this way is *Sun time* (what astronomers call *local apparent time*). There are several reasons why Sun time might differ from standard (or clock) time. Methods for obtaining clock time from the astrolabe are described in the fifth group of problems. But even with the simple procedures of Problem 8, the time obtained from the astrolabe will usually differ from clock time by less than half an hour. Only be sure not to neglect daylight saving time, when applicable.

9. Time of dawn:

Problem: In Seattle on February 4, at what time does dawn break?

Solution: Dawn breaks when the Sun is about 6° below the horizon. On February 4, the Sun is at the 15th degree of Aquarius. Place AQR 15° on the −6° almucantar on the eastern side of the astrolabe. Turn the rule so that it passes through the Sun (AQR 15°). The edge of the rule then indicates the time on the scale of hours of the mater. The time is about 6:40 A.M. Note that this solution is exactly like the alternative solution of problem 8, except that we use the −6° almucantar instead of the horizon.