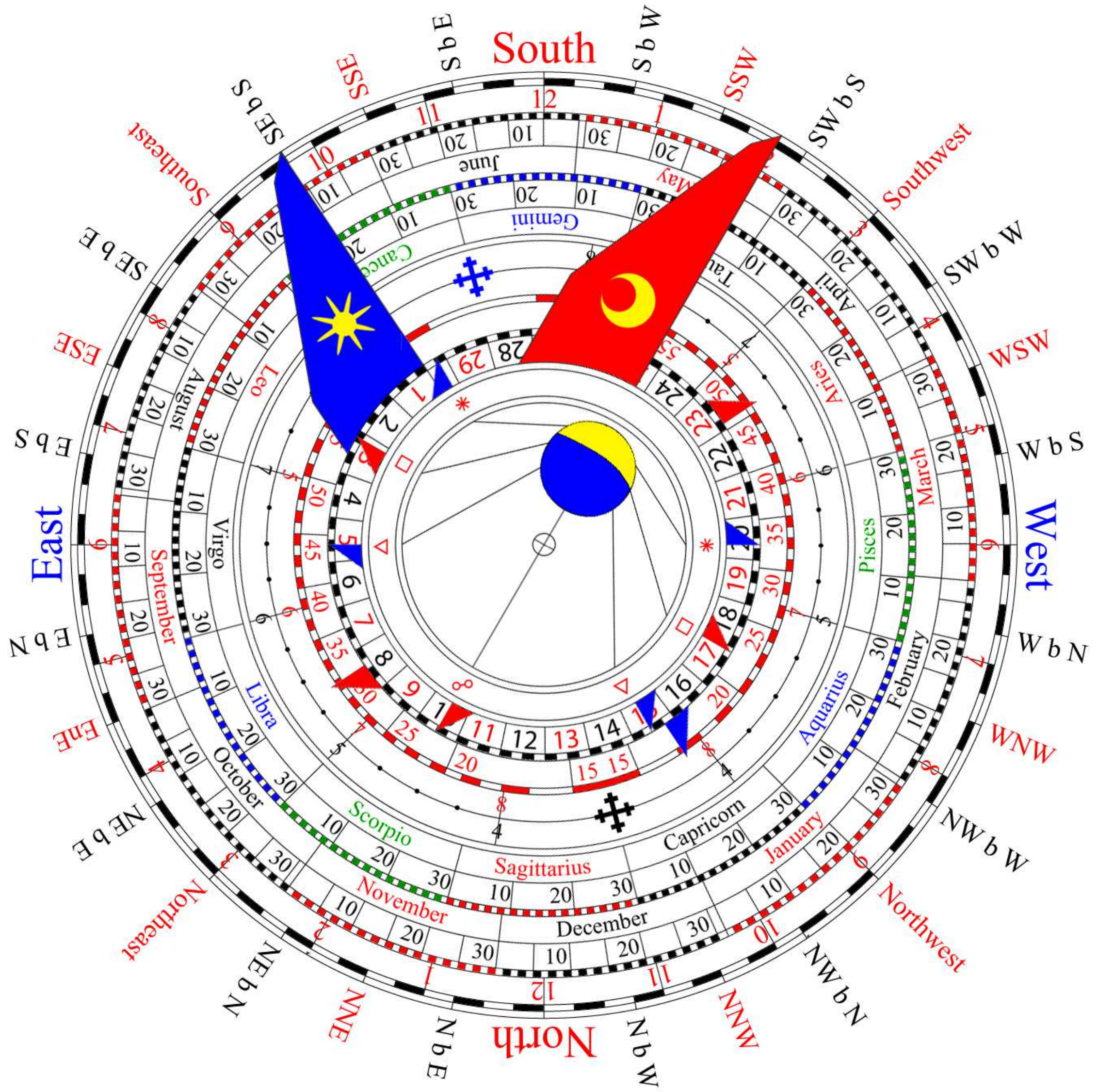
Binding the Heavens: Deconstructing the Lunar Volvelle



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Acknowledgements

Figure 1: A volvelle from a sixteenth century edition of Sacrobosco's *De Sphaera* in the Whipple Collection. https://commons.wikimedia.org/w/index.php?curid=1071278. Public Domain

Figure 2: Volvelle with three moving parts representing the zodiac, the sun, and the moon. http://www.bl.uk/catalogues/illuminatedmanuscripts/ILLUMIN.ASP?Size=mid&IllID=12771, British Library, Catalog reference: Egerton 848 f. 22. Public Domain

Figure 3: Lunar volvelle. http://bodley30.bodley.ox.ac.uk:8180/luna/servlet/view/all/who/Nicholas%20of%20Lynn/what/Manuscript?sort=Shelfmark. Bodleian Library, University of Oxford, Shelfmark: MS. Ashmole 370, Folio: fol. 025r. Used with permission.

Figure 4: Volvelle. http://www.bl.uk/catalogues/illuminatedmanuscripts/ILLUMIN.ASP?Size=mid&IllID=4136, British Library, Catalog reference: Sloane 4100. Public Domain

This is a handout for my class "Binding the Heavens: Deconstructing the Lunar Volvelle"
Copies of this handout and the supporting files are available on my website at
www.astrolabeproject.com

Version 2 – July 2018

Introduction

In the Middle Ages scholars developed a wide range of devices to aid in the study of the world around them. Sundials, quadrants, and astrolabes are all familiar subjects in the background of the art of the period, and their use was widespread. However, when writing books on subjects of a technical nature, authors could not assume that a reader would have access to a given specialized tool, and so was born the volvelle.

A volvelle is a device made up of rotating parts that are stacked on a central pivot; so that by physically manipulating the parts, the system depicted can be set and read for various conditions.

Modern descendants of the volvelle can be found in common use today: Mortgage and loan calculators, for example. But these modern tools have an ancient lineage. Possibly invented by the Greeks, and definitely used by Arab scholars (Kanas), the earliest surviving examples come to us from the 13th century Spanish scholar and artist Raymond Llull (Kwakkel), who, familiar with volvelles in Arab texts, introduced the concept into Europe via his book *Ars Magna* in 1305.

While volvelles in period were sometimes made of more durable materials, such as wood, for the most part they were drawn or printed on paper or vellum, bound into the books they illustrated, and were assembled with paper or string pivots. Decoration varied widely: Some examples are plain and functional, while others are decorated to a greater or lesser extent. There are even elaborately illuminated examples.

While there are always exceptions, most of the surviving pieces deal with astronomy, astrology and the relative positions of the sun, moon, and planets. In some cases the purpose of the volvelle included in a text was to illustrate a concept: For example, the geometry of lunar and solar eclipses as in John of Sacrobosco's astronomy treatise *On the Sphere* [Figure 1].

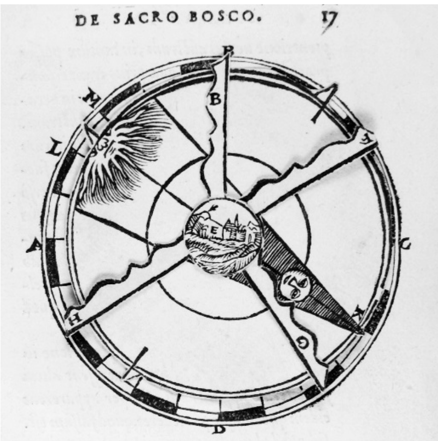

Figure 1: Volvelle illustrating lunar eclipse, "De sphaera" Johannes de Sacrobosco, 16th cen.

In other cases, the purpose was to allow the user to perform calculations and to determine the timing of events such as phases of the moon, and the relative positions of the heavenly bodies. The volvelles the class example is based on are in such devices.

Note: The example volvelle is designed for use in Oxford, England, approximately 52 degrees north.

Examples from period

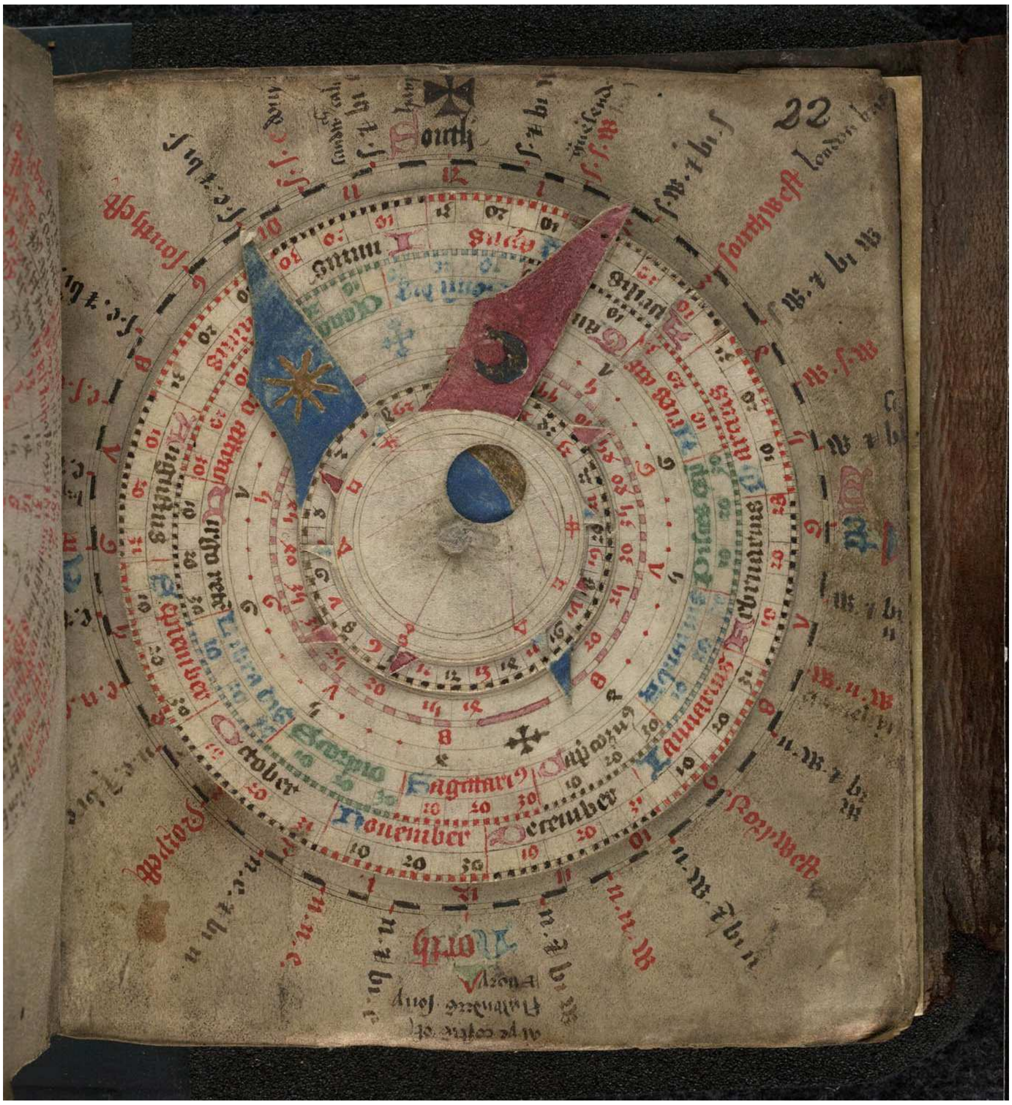

Figure 2: Lunar volvelle, English, 1490/1.
In the book "Medical miscellany, including an astronomical calendar"
British Library, Catalog reference: Egerton 848 f. 22

Figure 3: Lunar volvelle, English, ~1424.
In the book "The Kalendarium of Nicholas of Lynn"
Bodleian Library, Oxford, Catalog reference: MS. Ashmole 370

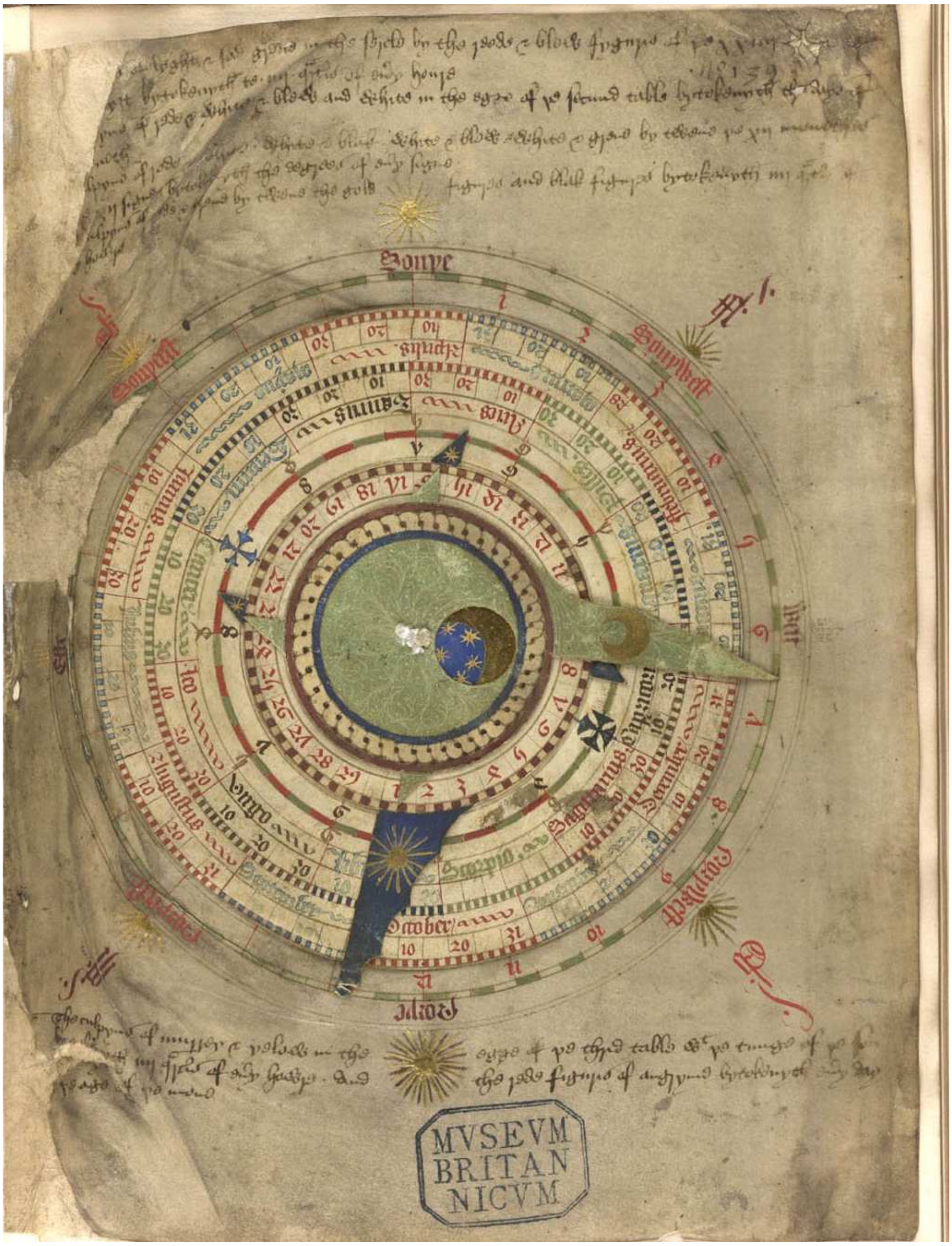

Figure 4: Lunar volvelle, English, 15th century
British Library, Catalog reference: Sloane 4100

Breaking down the parts

Volvelles come in varying levels of complexity, from the very simple, to the horribly complex. The example we are studying falls somewhere in the middle of the range. It consists of a base sheet, with three rotatable discs attached with a central pivot.

Let's take a detailed look at each part in turn:

The Base

This is the bottommost part of the volvelle. On the original this would have been a sheet bound into the book itself. As you can see [Figure 5], the page is marked with points of a compass or wind rose and is oriented so that south is at the top of the page. All the examples I have found orient this way. In the northern hemisphere where these devices originate, the sun, moon and planets move through the southern sky, so that, as with astrolabes, volvelles traditionally place south at the top.

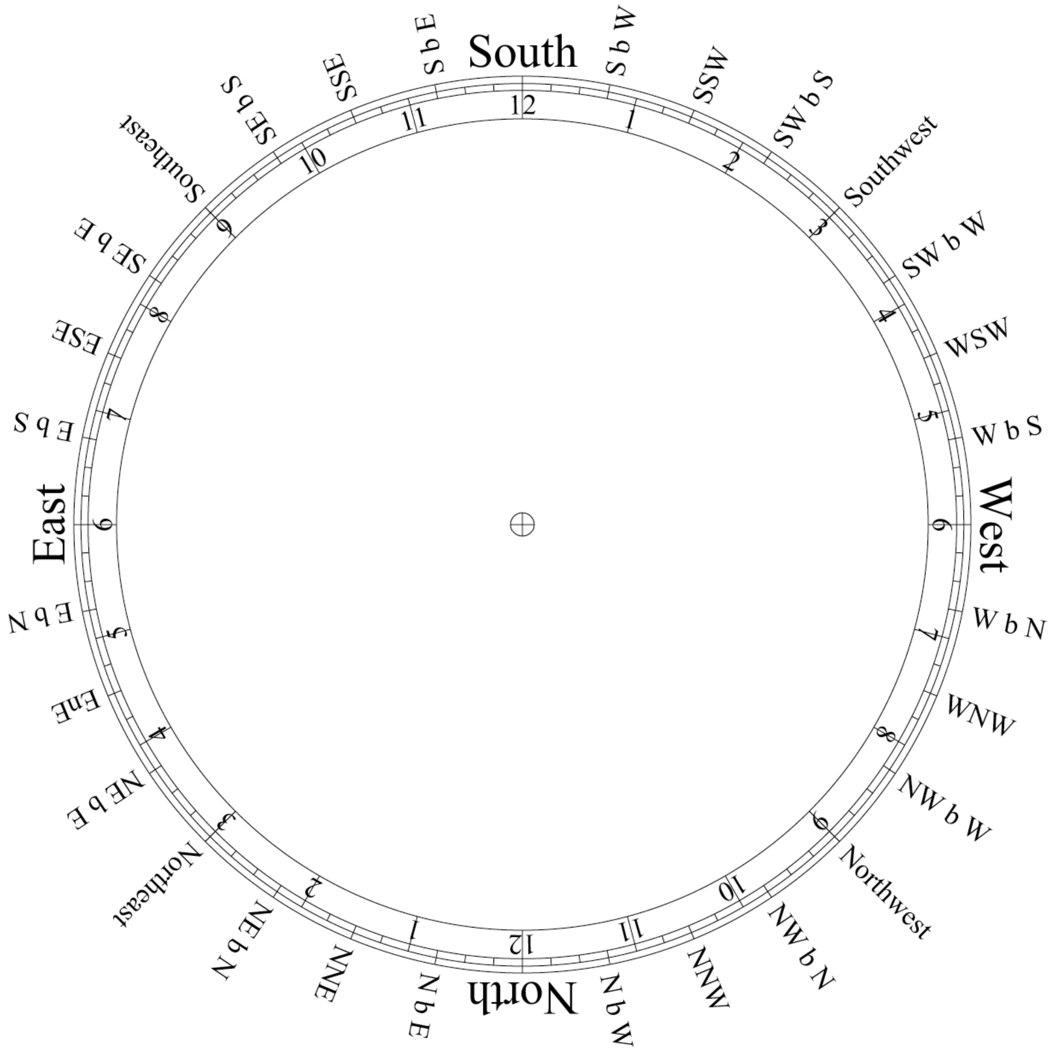

Figure 5: The base

The purpose of this wind rose is not currently known. Portable sundials of the same period were often marked similarly, and some included a small wind vane to determine the exact direction of the wind (Gouk 23). This was useful because in Europe, the type of weather to be expected can often depend on the current prevailing wind (Gouk 24):

- Southeast wind, known as the Sirocco: Cool, wet weather, rain
- Northwest wind, known as the Mistral or Maestro: Clear, sunny, dry
- South wind, known as the Ostro: Warm, humid, rain
- North wind, known as the Tramontane or Tramontana: Cold, dry

In addition, the wind direction was sometimes associated with zodiacal signs (Al-biruni 10).

But, even with this in mind, there are no supplementary markings on the wind rose. This device cannot tell you the current wind direction, but neither does it provide information if you already know the current wind. The reason for its inclusion is therefore unclear.

Inside the ring of compass points, the base sheet is marked with the hours of the day, with noon at the top and midnight at the bottom. This scale is most often divided into two 12 hour sections, but there are examples marked with the full 24 hours. The purpose of this scale is more straight-forward. It can be used to determine the approximate time of night using a sundial (see the section “To determine solar time using the moon’s sundial shadow”, page 18).

The Zodiac Calendar Disc

Sitting immediately on top of the base sheet is the zodiac calendar disc. This disc consists of four concentric scales.

The Calendar and Zodiac Rings

The outermost scale is the yearly calendar, broken down in the usual months and days. Inside this is a zodiac scale, dividing the ecliptic (the sun’s annual path through the sky) into twelve 30-degree sections labeled with the signs of the zodiac. This is a method of locating objects in the sky still used widely today. The calendar and the zodiac are carefully oriented so that any given date is aligned under the zodiac position of the sun for that date. For example, looking at Figure 6, you can see that on December 20th the sun is located at Sagittarius 29. This allows the user to determine the position of the sun accurately on the zodiac. In addition, given the zodiac position of the moon or a planet, it is possible to determine their relative positions in the sky. There are other uses: Traditionally, the “First Point of Aries”, Aries 0, marks the spring equinox. So, by looking at the date for Aries 0 on the disc you can see the date of the equinox is March 20th. Additionally, the fall equinox, and the summer and winter solstices fall on Libra 0, Cancer 0, and Capricorn 0, respectively.

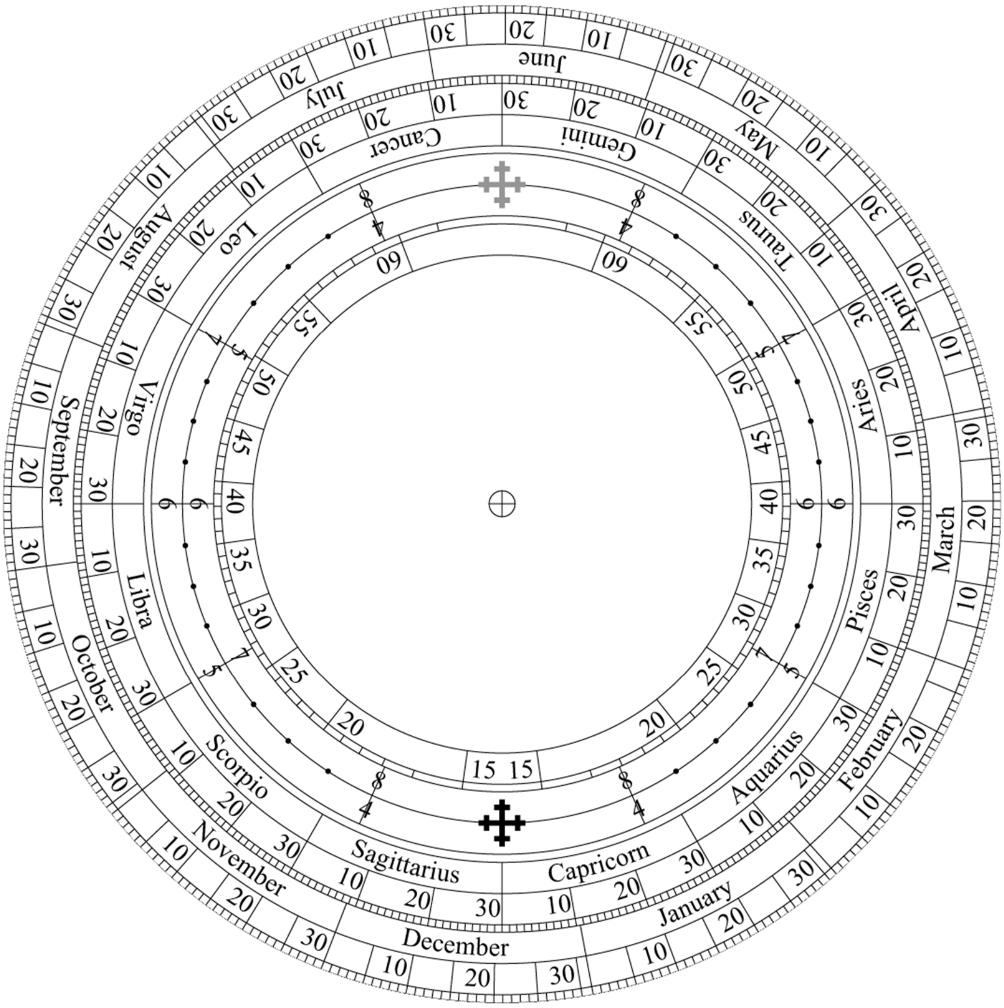

Figure 6: The zodiac calendar

The Day Length Scale

Inside the zodiac ring is a scale that can be used to determine the length of the day [Figure 6]. This scale is oriented to the zodiac so that the crosses mark the solstices and the remaining lines mark single-hour increments of the length of the day. Each hour line is marked on the inner part with the length of time from sunset to midnight, and on the outer with the number of hours from noon to sunset (Note: Which is the inner varies). Doubling this gives you the respective length of day and night. the three dots separating the hour lines correspond to 15, 30, and 45 minutes added to the estimate.

The Noon Altitude Scale

Inside this day length scale is a final scale. Like the day length scale, this one is oriented to the solstices and equinoxes, and in this case allows the user to determine the altitude of the sun at local noon for any given day.

The Sun Disc

The sun disc sits on top of the zodiac calendar. The large pointer reaches across the zodiac and calendar rings of the zodiac calendar to indicate the current position of the sun. There are three smaller pointers, one marking the point of opposition at 180 degrees from the sun and two marking the points of quadrature 90 degrees from the sun [Figure 7]. The sun disc is marked with a single lunar age scale that marks out the 29 1/2 days of the lunar cycle.

A note on the lunar cycle: the lunar orbital period is usually given as 28 days. This is an average of two figures: The sidereal month is the time interval (27.3 days) it takes for the moon to make one orbit of the earth relative to the background stars. Over the course of the month, however, the earth moves 1/12 of the way along its orbit, so we also have the synodic month, the time interval it takes the moon to complete one orbit relative to the sun (29.5 days). The period from full moon to full moon is the latter period, and what concerns us here.

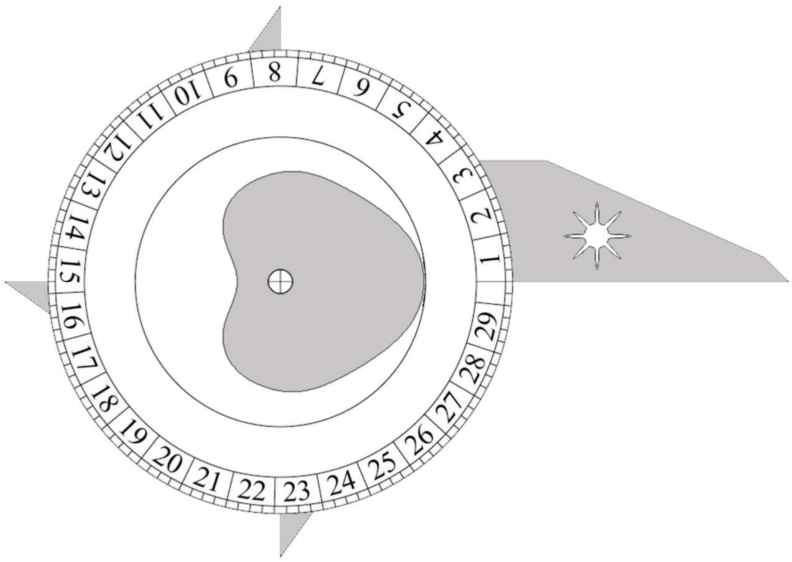

Figure 7: The sun disc

In the center of the sun disc is a heart-shaped figure, placed off center on a lighter colored circle. This was one of the methods used to simulate the phases of the moon, see Figure 8 for an example of another method.

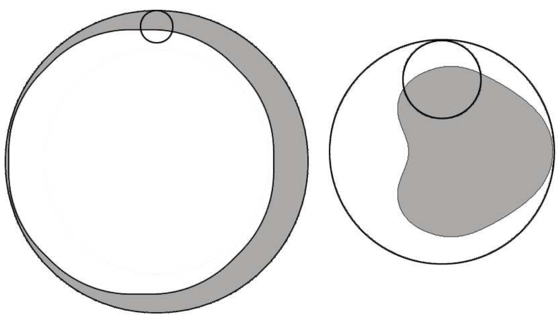

Figure 8: Methods for depicting the lunar phase

The Moon Disc

The final component of the volvelle is the moon disc. This final piece sits on top of the sun disc and rotates to show the position of the moon. Like the sun disc, there is a large pointer that crosses the lunar position scale on the sun disc, and continues across the zodiac calendar. There are also, in this example, seven other, smaller, pointers; one at opposition, two at quadrature, and four others, all marked with symbols:

- Asterisk – SEXTILE: An angle of 60 degrees (2 zodiac signs, 1/6 of the ecliptic, or 1/2 of a TRINE) from the moon.
- Square – SQUARE or QUADRATURE: An angle of 90 degrees (3 zodiac signs, 1/4 of the ecliptic, or 1/2 of an OPPOSITION) from the moon.
- Triangle – TRINE: An angle of 120 degrees (1/3 of the ecliptic) from the moon.
- Linked circles – OPPOSITION: An angle of 180 degrees (1/2 of the ecliptic) from the moon.

These mark significant astrological aspects concerning the relative positions of the sun and moon.

The lunar disc has a circular cutout that displays an approximation of the current lunar phase for a given position of the moon relative to the sun.

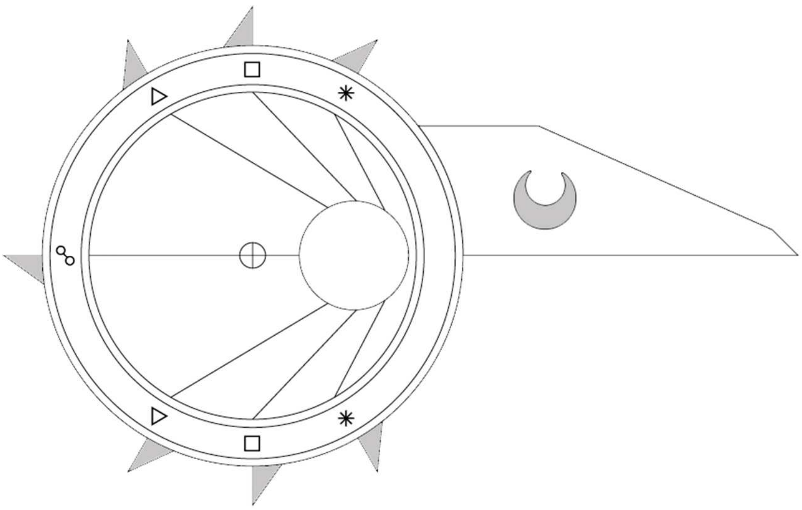

Figure 9: The moon disc

The Pivot

Tying all these layers together is a pivot. The pivot was usually paper, or cord, knotted to secure the discs and allow them to turn freely. In many cases the end of the cord was left untrimmed to allow it to be used as a pointer or index line.

Variations

Depending on the complexity of the volvelle, some of these parts may be simplified or omitted. For example, a simple version would consist of just a clock scale printed on the base sheet and the sun and moon discs, omitting the wind rose and the entire calendar/zodiac layer.

Uses

To determine the relative positions of the sun and moon for a given day

The simplest use for the volvelle, and one that more complicated uses build on, is determining the relationship of the sun and moon.

Over the course of the year, the sun moves against the fixed background stars of the zodiac. Likewise, each month the moon circles the earth. So as time passes, their relationship in the sky changes constantly. As we will see below, determining the location of the sun and moon on the zodiac for a given day, and their relative positions, can be useful.

The Sun

Finding the position of the sun is straight-forward. The calendar and zodiac rings are scaled and oriented to work together to allow the user to find the sun's location for any date. To find the sun's position, rotate the sun disc over the calendar scale until the pointer rests on the desired date. The sun's location on the zodiac can be read directly from the neighboring zodiac scale. Similarly, the zodiac locations for opposition and quadrature can be read from the smaller pointers on the sun disc. Reversing this procedure allows the user to find the date that the sun will be in a given zodiac position.

The Moon

Locating the position of the moon is less straight-forward. There are three approaches, each less accurate than the last:

1. If the user has access to an ephemeris or calendar with tables that list the moon's zodiac position, this figure can be used by simply rotating the moon disc to the correct zodiac setting.
2. Otherwise, the user can count the days since the last full moon and rotate the moon disc to the proper number on the 29.5 day lunar age scale on the sun disc.
3. Finally, the moon's position can be roughly estimated by observing the current lunar phase and rotating the lunar disc until the cutout for the lunar phase matches.

To determine the length of a given day (or night)

In the time before streetlights and other easy nighttime illumination, it was useful in planning journeys to know how much daylight would be available for travel. And for that matter how long the corresponding nights would last. Almanacs and calendars of the day would contain such information, but the volvelle included with it would be faster and more straight-forward to use.

For example, you are planning a journey of several days starting on the 15th of April. What can you expect in the way of daylight?

Turning to the volvelle in your calendar, you rotate the sun disc to line the up the pointer with 15 April. You can then read the half-day length from the outer part of the day length scale as 6 hours and 50 minutes, doubling this to get 13 Hours and 40 minutes. Getting the length of the night is worked similarly. Giving you an answer of 13 hours and 40 minutes of daylight, and 10 hours and 20 minutes of night. Not taking into account the twilight periods. See Figure 10.

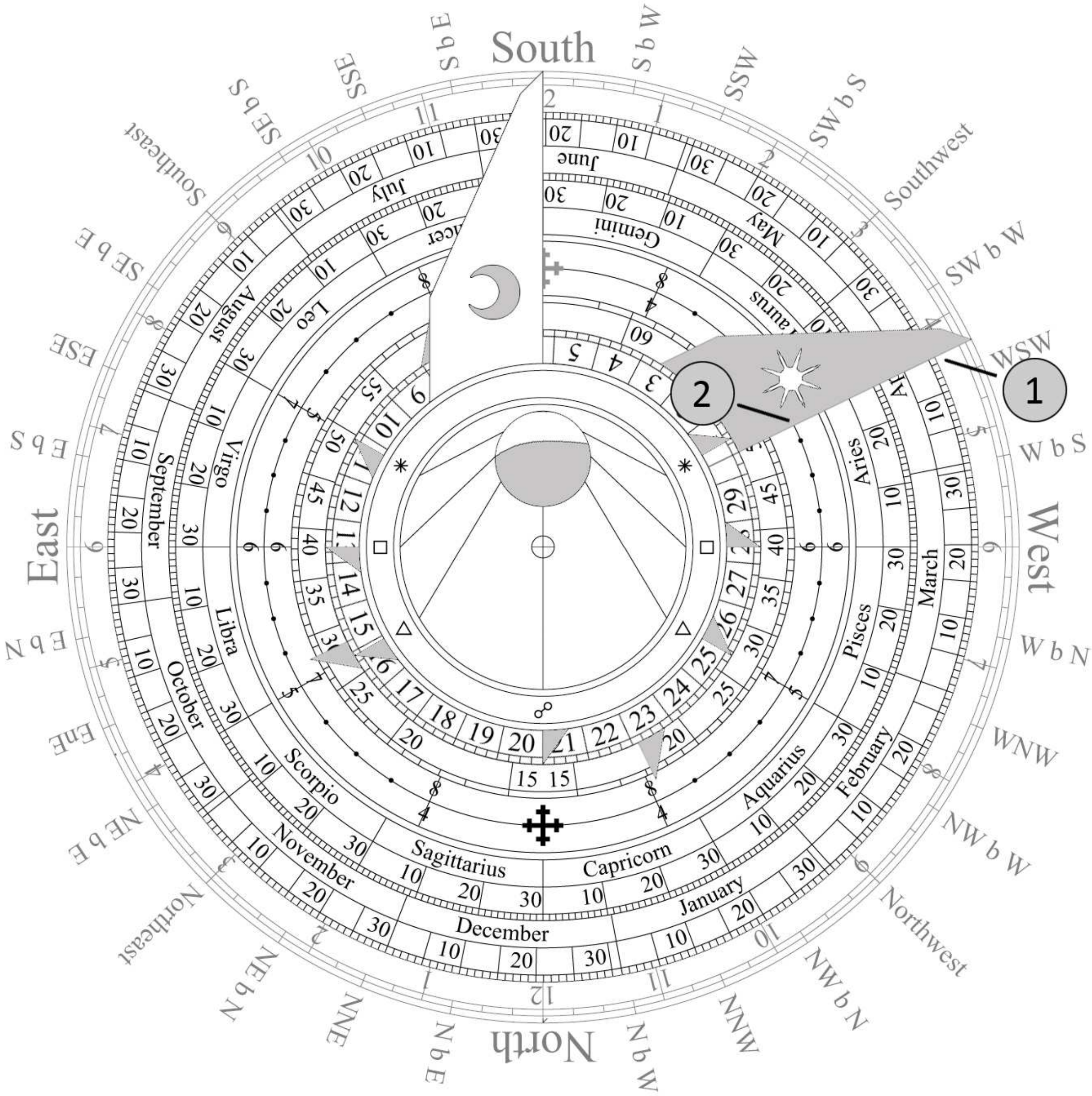

Figure 10: Determining day Length

Determining the length of day for a given date:

1. Set the sun pointer to the date desired (15 April).
2. Note where the pointer crosses the day length scale. Double the figure on the outside part of the scale for daytime (6:50), to get 13 hours and 40 minutes.

To determine the maximum angle of the sun above the horizon for a given day

Over the course of the year the sun's height above the horizon varies widely. In summer, it sits high and warm in the sky, but as the year progresses, each day it is a bit lower until at the winter solstice it sits at its lowest and the shadows are long and gloomy. Knowing the maximum altitude of the sun for a given day can be useful for planning things like window placement and gardens.

Doing this for any day of the year is simple with the proper use of this volvelle. The innermost scale of the zodiac calendar disc used in conjunction with the sun pointer arm make it easy. By placing the pointer on the date required, the arm will cross the altitude scale, giving the maximum altitude of the sun on that date.

For example:

The dead of winter is a time for planning. Your cook has asked for a kitchen garden to improve and expand the range of seasonings available for cooking. The problem is where to place it. The yard behind the kitchen faces south (good) but backs onto a neighbor's house, potentially blocking the sun most of the day (bad). You make measurements and determine that the sun must reach 45 degrees to give sufficient sunlight for a garden. Remembering the volvelle bound into the calendar volume you own, you consult that.

As there are two pointers available, you set the moon and sun pointers to the two "45" marks on the altitude scale then check the dates: April 6 and September 4. These are the first and last days of the year that the sun will reach an angle of 45 degrees above the horizon. Between these dates, the sun will be even higher at noon, reaching 61 degrees at the summer solstice. It therefore seems that the garden would get sufficient light [Figure 11]. You tell the cook to go ahead.

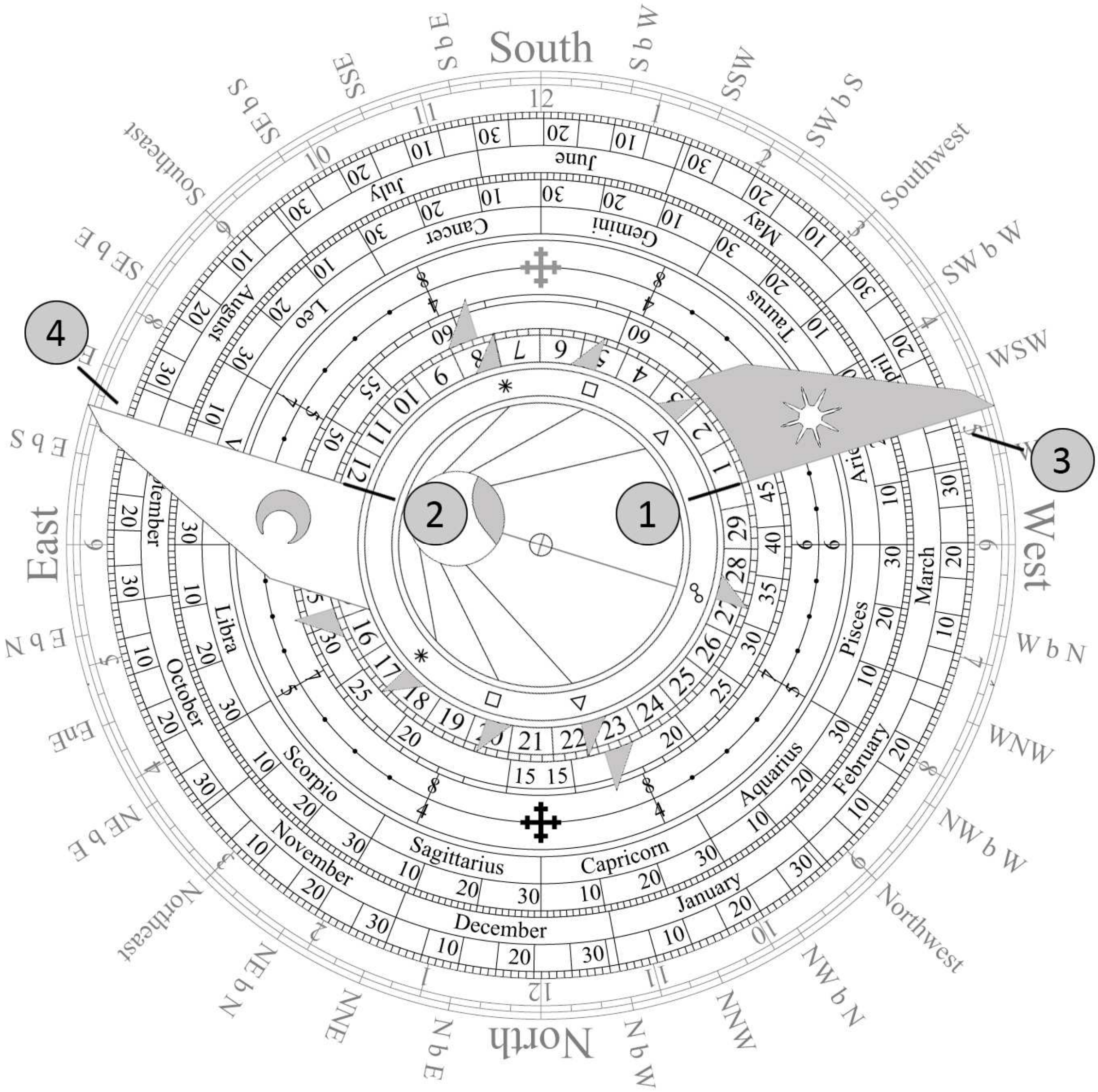

Figure 11: Determining solar altitude

Determining the altitude of the sun at noon for given dates:

3. Set the sun pointer on the 45-degree mark.
4. Set the moon pointer on the other 45-degree mark.
5. Locate the date crossed by the sun pointer: April 6.
6. Locate the date crossed by the moon pointer: September 4.

To determine solar time using the moon's sundial shadow

Sundials are very useful for telling the time; during the day, that is; at night they are somewhat less useful. However, this limitation to the hours of daylight can be overcome with clever use of the lunar volvelle. Because the volvelle can represent the relative positions of the sun and moon for any time of the month, it can be used in conjunction with a sundial to tell the approximate time at night.

How this works is as follows: At the new moon the sun and moon are together in the sky. Therefore their shadows, if the moon's was visible, would show the same hour. Over the course of the next 29 1/2 days the moon makes a complete circle through the sky, relative to the sun. This means that each day the moon takes an additional 49 minutes to reach the same point in the sky (Lloyd 123). By counting the number of days since the new moon, and multiplying by 49 minutes, you can determine the difference in time between the time shown by the moon's shadow, and the actual solar time. The lunar volvelle can do this directly.

For example:

The hour is late as you work on your studies, you step from your library, out into the garden and check the sundial. The sun is by now long down, but the moon is up and casting a clear shadow across the hour of 1 PM.

Returning to your study, you open a reference to its lunar volvelle. You know that the current day is 12 days past the new moon, with the moon approaching full, so you set the moon dial to 12 (as you are approaching the end of the 12th day). Then rotate the sun and moon discs together until the moon pointer is resting on 1 PM. The sun pointer will point at an approximation of the current time (about 10:45 PM), see Figure 12.

The result from this method can only give an approximate time for the following reasons (Lloyd 126):

- The moon's phase can be difficult to judge accurately. First and last quarter are easy, but near the full moon, it is possible to be off by a day, causing an error of an hour or more.
- The moon moves through the sky over the course of the night, so exact positioning of the moon disc is difficult to estimate accurately.
- The eccentricity of the moon's orbit and its angle to the ecliptic can throw off the result by up to an hour.
- Finally, seeing the shadow of a gnomon requires a fairly bright light source. So near the new moon it is harder to see the time.

Still, with practice and experience it is possible to get at least an approximate time this way. Because of this the portable sundials of later period often were equipped with simplified lunar volvelles (Lloyd 123) (Gouk 22).

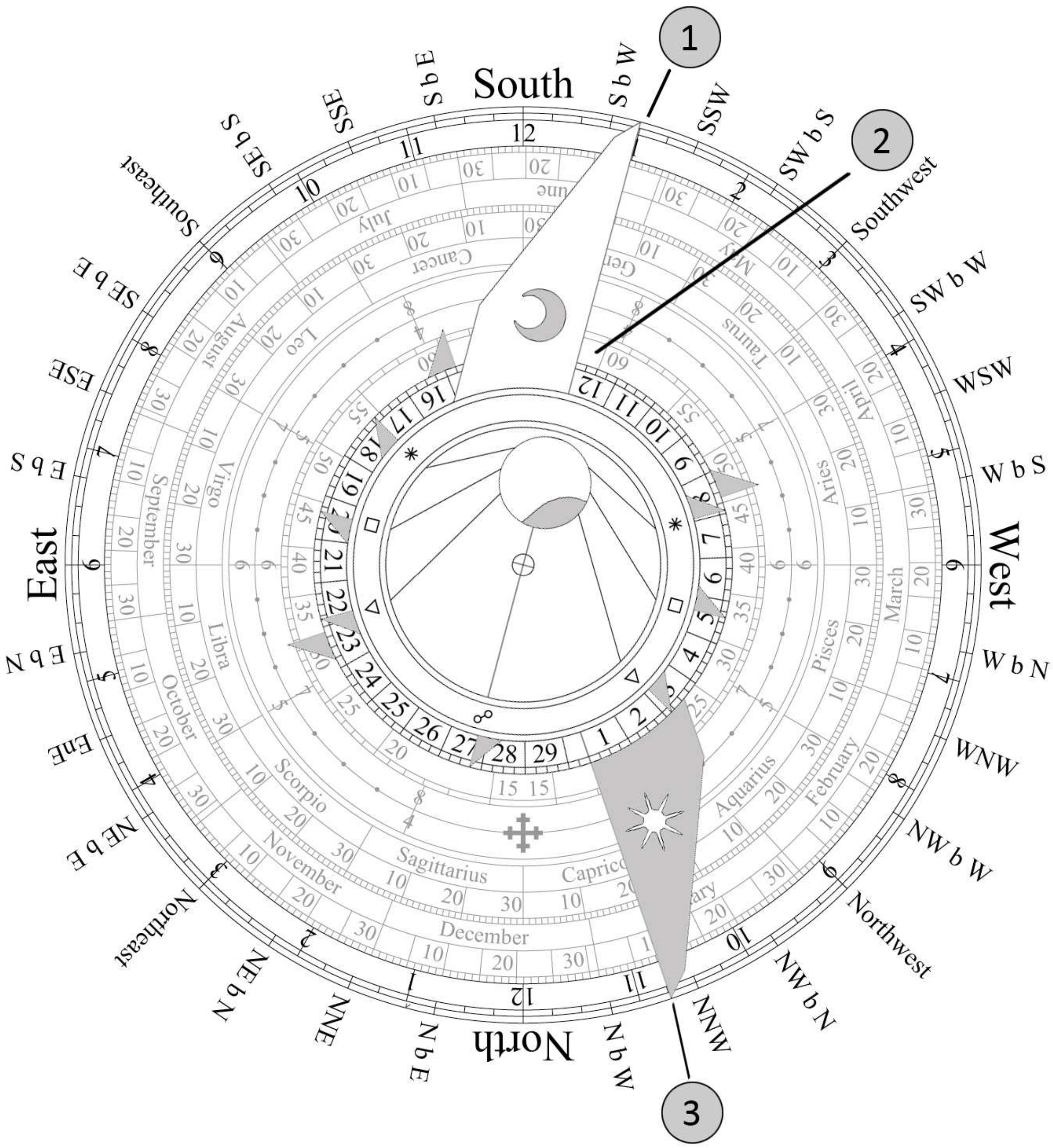

Figure 12: Converting lunar time

Converting lunar to solar time:

1. Set the moon disc to point at 1 pm.
2. Rotate the sun disc under it so that the position of the moon pointer rests over 12.
3. Read the approximate time from the position of the sun pointer (10:45 pm).

Astrological/medical uses

In the medieval period medical practice and astrology were often tightly entwined. What procedures were advised might depend as much or more on the current positions of the sun, moon, and planets as the patient's symptoms. The source of one of the volvelles above is a calendar/almanac written by Nicholas of Lynn in 1386. This book, along with many useful tables and charts for working with the motions of the planets, contains several sections concerning the proper timing of treatments based on the position of the moon.

"... the humours of the human body go out from the innermost parts to the exterior parts in the first and third phases of the moon, and are like rivers whose waters rise, in these phases; to have bloodletting done by phlebotomy or cupping, provided no other impediment exists, is very useful. In the second phase of the moon, and the fourth the humours are withdrawn from the exterior parts and flow to the interior ones, and they are like rivers whose waters recede. Because of this in these phases, if every other impediment is absent, it is praiseworthy to receive purges; but to let blood does not happen without harm to the body."
- Canon for discovering the apt time for letting blood, The Kalendarium of Nicholas of Lynn (Lynn 206).

"In order to know what time a laxative medicine should be given, or any other no matter what kind it might be, it is it is to be noted that in a man's body there are four natural powers, namely attraction, retention, digestion, and expulsion. Now the power of attraction flourishes with heat and dryness, and for that reason those things that strengthen it should be given when the moon is in a hot and dry sign without impediment. And similarly, those that strengthen retention should be given when the moon is in a cold and dry sign, because that power flourishes in coldness and dryness. Those things that strengthen digestion should be given when the moon is in a hot and wet sign. But those things that strengthen the power of expulsion should be given when the moon is in a cold and wet sign."
- Canon for giving and receiving medicine, The Kalendarium of Nicholas of Lynn (Lynn 208).

To illustrate this, let us look at an example for March 10th 2018. If you rotate the sun arm to March 10th on the calendar wheel you will see that the sun is in Pisces, just past Pisces 20. On that date, the moon was 23 days past new and waning from its last quarter. This places the moon as just moved out of Sagittarius and into Capricorn.

As you can see in Figure 13, the moon is in its fourth phase, so bleeding or leeching is not indicated, but a good purge is possible. However, Capricorn is a cold and dry sign (Al-biruni 7), which strengthens retention, so laxatives are also out.

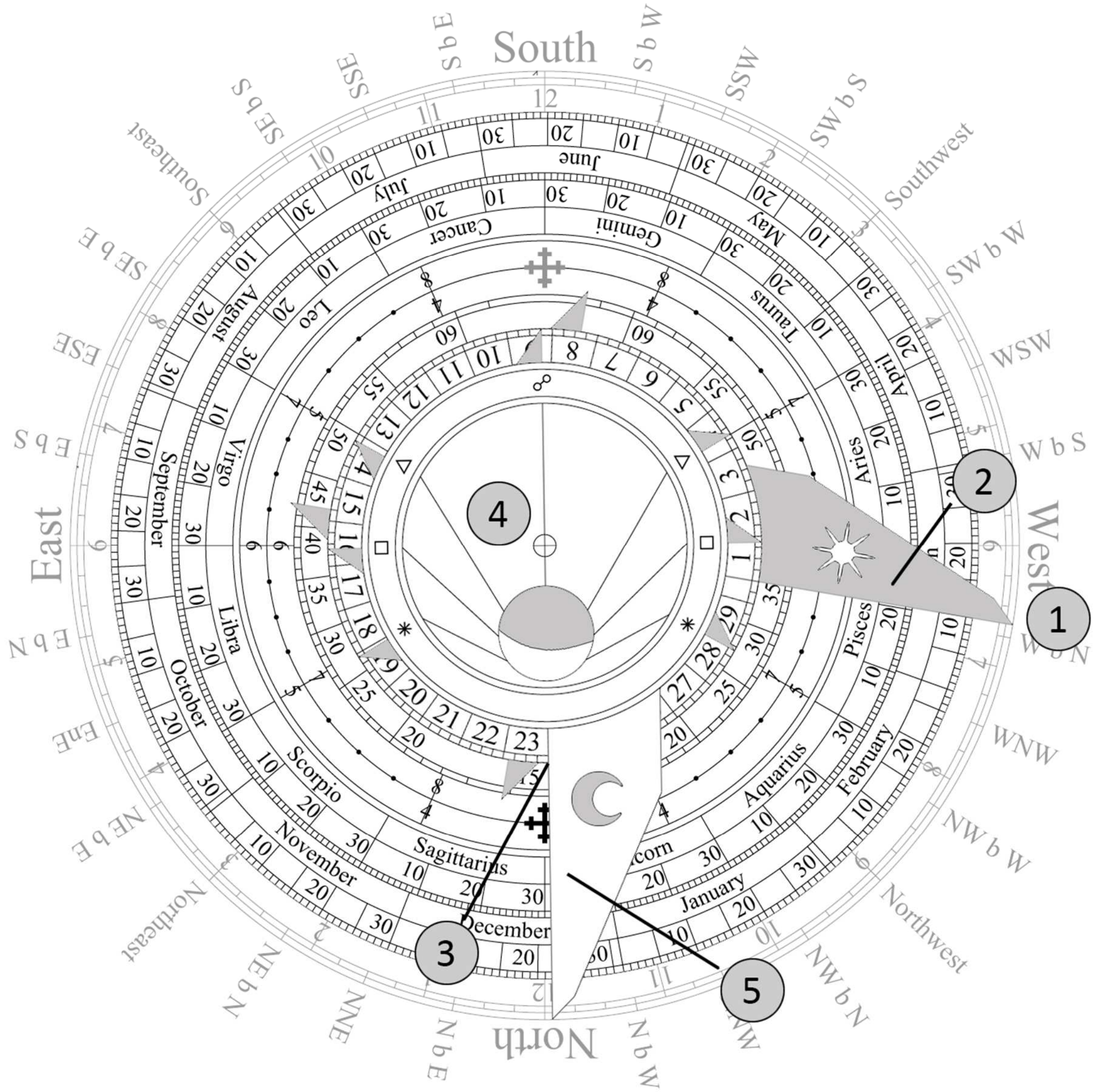

Figure 13: The situation on March 10th

Determining the relative positions of the sun and moon:

1. Using the calendar wheel, rotate the sun pointer until it rests on March 10th.
2. Note that the sun is in Pisces.
3. Rotate the moon pointer so that it rests on the mark for the 23rd day.
4. Note the phase as waning 4th quarter
5. Note the moon is in Capricorn.

Summary

The volvelle is a tool of interest to not just those researching period devices, but those interested in period medicine, bookbinding and illumination as well. For the researcher they provide a useful tool and an insight into the practices of the period. To the artist, they provide a chance to decorate and enhance a volume.

On-line Resources

There is a working volvelle simulation on my website:
http://www.astrolabeproject.com/sim/lunarvolvelle/sim.html

The three examples the class is based on can be found at:
http://www.bl.uk/catalogues/illuminatedmanuscripts/ILLUMIN.ASP?Size=mid&IllID=12771

http://bodley30.bodley.ox.ac.uk:8180/luna/servlet/view/all/who/Nicholas%20of%20Lynn/what/Manuscript?sort=Shelfmark

http://www.bl.uk/catalogues/illuminatedmanuscripts/ILLUMIN.ASP?Size=mid&IllID=4136

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