Chapter 12 **(Oechslin: 8.9)**

Hahn's globe clock in Villingen (1770-1783)

This chapter is a work in progress and is not yet finalized. See the details in the introduction. It can be read independently from the other chapters, but for the notations, the general introduction should be read first. Newer versions will be put online from time to time.

12.1 Introduction

The clock described here was constructed sometime in 1770-1783 by Philipp Matthäus Hahn (1739-1790)[1]. It was located in Villingen-Schwenningen[2] but is now located in Furtwangen.

This clock is made of three separate parts. The central part shows the hours and minutes on an ordinary dial, and the hours alone on a smaller 24-hour dial below the main dial.

The right part shows the month, the sign of the zodiac and the planetary regents (in the order Mars, Sun, Venus, Mercury, Moon, Saturn and Jupiter). This part is surmounted by a geographical globe. The left part shows the day of the week and the day of the month, and is surmounted by a celestial globe.

The way the two globes are driven is very similar to that used in the double-globe clock of Karlsruhe (Oechslin 8.8) constructed in 1785.

12.2 The geographical globe

The component of the geographical globe gets its input from the clock at the center through arbor 19 which makes one turn in 24 hours. Seen from the

[1]For biographical details on Hahn, I refer the reader to the chapter on the Ludwigsburg *Weltmaschine* (Oechslin 8.1).

[2]See especially the 1989 exhibition catalogue [4, p. 414-415]. Besides in Oechslin's 1996 book, the clock was also illustrated by Abeler [1, pl. 15a]. In 1974, the clock was located in the Kienzle-Uhrenmuseum.

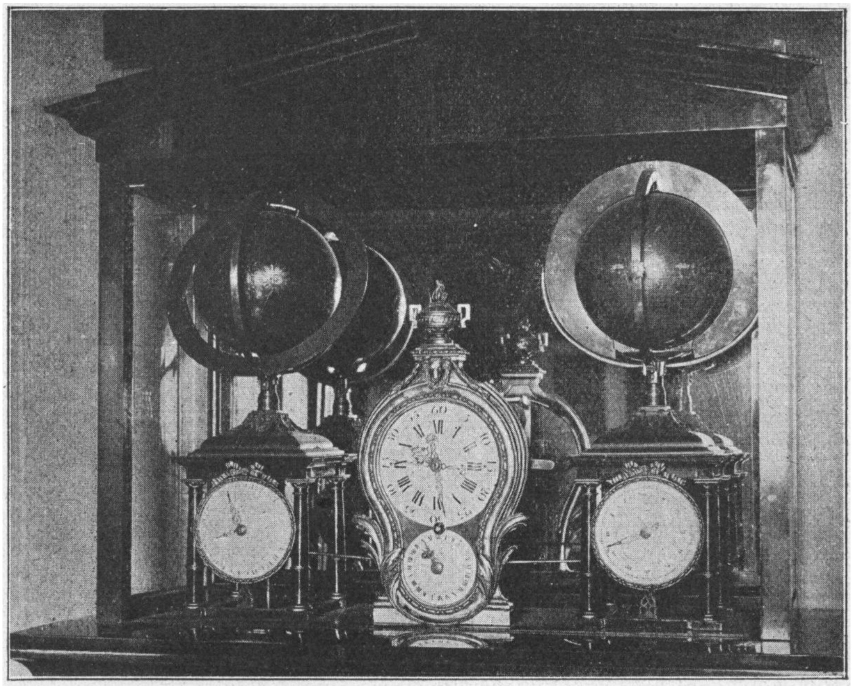

Figure 12.1: Hahn's clock in Villingen. (source: [2])

right, we have

$$V_{19}^{0} = 1 \tag{12.1}$$

This motion is used to derive the motion of the central vertical arbor 20:

$$V_{20}^{0} = V_{19}^{0} \times \frac{57}{57} = V_{19}^{0} = 1 \tag{12.2}$$

This arbor makes one turn counterclockwise in one day. This corresponds to arbor 28 in the Karlsruhe clock.

Likewise, the motion of arbor 20 is used to produce the motion of the vertical tube 22:

$$V_{22}^{0} = V_{20}^{0} \times \left(-\frac{7}{118}\right) \times \left(-\frac{3}{65}\right) = V_{20}^{0} \times \frac{21}{7670} = \frac{21}{7670} \tag{12.3}$$

$$P_{22}^{0} = \frac{7670}{21} = 365.2380\ldots \text{ days} \tag{12.4}$$

This is an approximation of the tropical year and the same value is also given by Oechslin. Tube 22 does therefore make one turn counterclockwise (as seen from above) in one year. This tube seems to move the day/night boundary.

The same ratio $\frac{7670}{21}$ was used in the astronomical clock in Basel (Oechslin 8.10) constructed in 1775 and in the double-globe clock of Karlsruhe (Oechslin 8.8).

As for Karlsruhe, this, however, is not entirely correct. If the limit day/night moves in one year, then the Earth should actually make one turn in one sidereal day, and not 24 jours as it does now (or seems to be doing). This suggests a construction error, and that the sidereal day motion produced for the left globe was initially also meant to be used in the geographical globe.

On tube 22, a 76-teeth wheel meshes with another similar wheel at right angle and is used to display the month.

12.3 The celestial globe

The component of the celestial globe gets its input from the clock at the center through arbor 1 which makes one turn in $\frac{29}{57}$ hours. Seen from above, we have

$$\mathrm{V}_1^0 = \frac{57}{29} \tag{12.5}$$

This motion is used on the one hand to derive the day of the week and the day of the month, and on the other hand to derive the motion of the vertical arbor 10 which is the main input for the motion of the globe. We have

$$\mathrm{V}_{10}^0 = \mathrm{V}_1^0 \times \left(-\frac{35}{33}\right) \times \frac{38}{79} = \frac{57}{29} \times \left(-\frac{1330}{2607}\right) = -\frac{25270}{25201} \tag{12.6}$$

Arbor 10 thus makes one turn clockwise in one sidereal day. This is the usual value used by Hahn for the velocity of the sidereal day.

However, arbor 10 actually moves an entire frame containing gears which are themselves use to produce the motions of the Sun and the Moon. Arbor 10 moves the celestial sphere which rotates around the vertical axis representating the axis of the Earth. But the Sun and the Moon revolve (approximately) around the axis of the ecliptic, which is tilted by 23.5 degrees. The Sun is fixed on tube 18 and the Moon on tube 15. In order to compute the motions of these two tubes, we first compute the motions of tubes 14 (Moon) and 17 (Sun) with respect to the celestial globe (frame 10):

$$\mathrm{V}_{14}^{10} = \mathrm{V}_{11}^{10} \times \left(-\frac{53}{54}\right) \times \left(-\frac{54}{66}\right) \times \left(-\frac{3}{66}\right) = \mathrm{V}_{11}^{10} \times \left(-\frac{53}{1452}\right) \tag{12.7}$$

$$= -\mathrm{V}_{10}^{11} \times \left(-\frac{53}{1452}\right) = \mathrm{V}_{10}^0 \times \frac{53}{1452} \tag{12.8}$$

$$= -\frac{25270}{25201} \times \frac{53}{1452} = -\frac{669655}{18295926} \tag{12.9}$$

$$\mathrm{P}_{14}^{10} = -\frac{18295926}{669655} = -27.3214\ldots \text{ days} \tag{12.10}$$

$$\mathrm{V}_{17}^{10} = \mathrm{V}_{14}^{10} \times \left(-\frac{32}{53}\right) \times \left(-\frac{14}{113}\right) = \mathrm{V}_{14}^{10} \times \frac{448}{5989} \tag{12.11}$$

$$= -\frac{669655}{18295926} \times \frac{448}{5989} = -\frac{2830240}{1033719819} \tag{12.12}$$

$$\mathrm{P}_{17}^{10} = -\frac{1033719819}{2830240} = -365.2410\ldots \text{ days} \tag{12.13}$$

So, tube 14 makes one turn clockwise (from above) in one tropical month, and tube 17 makes one turn clockwise in one tropical year. The same values are given by Oechslin, also in sidereal days.

The same value for the tropical month was used in the double-globe clock located in Zurich (Oechslin 8.7) constructed that same year in 1785. And the value of the tropical year was used in the globe clock in Darmstadt (Oechslin 8.6), also in 1785. Both were also used in the double-globe clock in Karlsruhe (Oechslin 8.8) in 1785.

Finally

$$\mathrm{V}_{15}^{10} = \mathrm{V}_{14}^{10} \times \left(-\frac{48}{48}\right) = -\mathrm{V}_{14}^{10} = \frac{669655}{18295926} \tag{12.14}$$

$$\mathrm{V}_{18}^{10} = \mathrm{V}_{17}^{10} \times \left(-\frac{48}{48}\right) = -\mathrm{V}_{17}^{10} = \frac{2830240}{1033719819} \tag{12.15}$$

The Moon and the Sun rotate counterclockwise around the celestial sphere in one tropical month and one tropical year.

12.4 References

[1] Jürgen Abeler. Die Gebrüder Johann, Augustinerpatres und Uhrmacher. Bericht über eine Forschung des Wuppertaler Uhrenmuseums. *Mainzer Zeitschrift*, 69:197–205, 1974.

[2] Max Engelmann. *Leben und Wirken des württembergischen Pfarrers und Feintechnikers Philipp Matthäus Hahn.* Berlin: Richard Carl Schmidt & Co., 1923.

[3] Ludwig Oechslin. *Astronomische Uhren und Welt-Modelle der Priestermechaniker im 18. Jahrhundert.* Neuchâtel: Antoine Simonin, 1996. [2 volumes and portfolio of plates].

[4] Christian Väterlein, editor. *Philipp Matthäus Hahn 1739-1790 — Pfarrer, Astronom, Ingenieur, Unternehmer. Teil 1: Katalog*, volume 6 of *Quellen und Schriften zu Philipp Matthäus Hahn.* Stuttgart: Württembergisches Landesmuseum, 1989.