

# Chapter 21

(Oechslin: 2.1)

## Klein's geographic clock in Dresden (1738)

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.

### 21.1 Introduction

The clock described here was constructed in 1738 by Jan Klein (1684-1762).<sup>1</sup>

This clock was an order of the elector of Saxony Frederick Augustus II (Augustus III of Poland) (1696-1763). The year 1738 is inscribed on the mock pendulum.<sup>2</sup>

The clock is a geographical clock inspired by Johann Baptist Homann (1663-1724)'s design of a geographical clock which was constructed in 1705 by Zacharias Landteck (1670-1740) [4, 14] (figure 21.1).

It is similar to Klein's geographical clock kept in the Clementinum in Prague (Oechslin 2.2) which may be the earlier one.<sup>3</sup> In any case, the Dresden clock has a simpler mechanism than that of Prague which uses three versions of the annual motion, instead of two here. The Dresden clock is topped by the Polish crown.

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<sup>1</sup>For biographical information on Klein, see the chapter on the geographic clock in Prague.

<sup>2</sup>For brief descriptions of this clock, see Grötzsch [8], Schardin [19, p. 21], Oechslin [13, p. 38, 49-50], Michal [11, 12], Šolc [21] and Pařízek [16] who dates it around 1760. This clock was also shown at the 1989 Hahn exhibition [25, p. 63-64].

<sup>3</sup>Pelcl also describes Klein's three clocks in Prague, and mentions that a copy of the geographical clock in Prague had to be made for the King August of Poland and is now in Dresden [17, p. 137-141]. Although the Prague geographical clock has been dated around 1753 by Böhm [1], I prefer to follow Engelmann [6] who believes that the Prague clock was made sometime between 1732 and 1737. Maurice, incidentally, claims that Klein must have made a third geographical clock, because Klein's portrait shows a geographical clock which is neither that of Dresden, nor that of Prague [10, v.1, p. 268].

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The globe of the clock was made by Pater Sichelbarth, but Schardin writes that he was born in 1690 and died in 1747.<sup>4</sup> I believe that there is a confusion with Pater Ignatius Sichelbarth (1708-1780), a Jesuit who was a painter and went to China around 1745 where he became a mandarin.



Figure 21.1: Johann Baptist Homann's geographical clock (1705).

<sup>4</sup>[19, p. 21]

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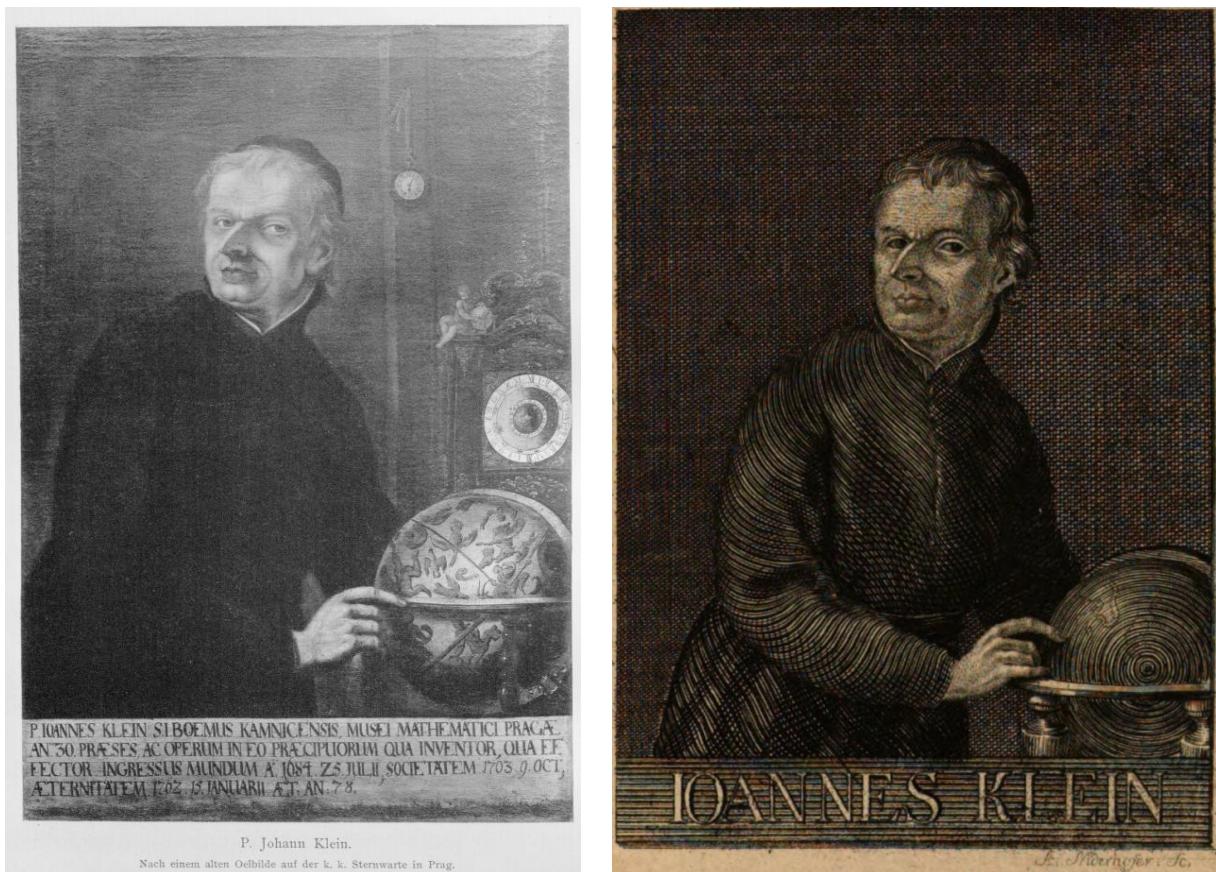


Figure 21.2: Left: Portrait of Jan Klein with his geographic clock from 1753/1754. (source: [1]) Right: portrait in Pelcl's biographical notice [17].

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Figure 21.3: Klein's 1738 clock on a 1975 stamp from the DDR.

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Although Oechslin describes the gear trains of the clock, I believe that he did not have the opportunity to disassemble the clock. He may have used some unpublished source, or only examined the works from the outside, comparing it with the geographical clock located in Prague.

This clock is a table clock with two sides. The clock is spring-driven with a fusee and regulated by a short pendulum.<sup>5</sup> There are two striking works and six bells. The clock works 8 days. One side shows the time on a 12-hour dial with additional openings for the day of the month, the sunrise and sunset. There is also an aperture for a mock pendulum. The other side shows a fixed the Northern hemisphere, but with a rotating transparent shell representing the part of the Earth which is not lit by the Sun. The Sun rotates around the Earth and there is a ring for the ecliptic. For the study of this clock, it is best to first read the description of the geographical clock located in Prague, as it is supplemented by Böhm's drawings [1].

The common arbor to both sides is arbor 2 which makes one turn in one hour. Measured from the time side, we have

$$V_2^0 = -24 \quad (21.1)$$

$$P_2^0 = -\frac{1}{24} = -1 \text{ h} \quad (21.2)$$

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<sup>5</sup>[5, p. 113]

## 21.2 The time side of the clock

This side of the clock gets its input from arbor 2 which carries the minute hand. This motion is derived from the going work which is not described by Oechslin.

The motion of arbor 2 is transferred to tube 8 which makes a turn in 12 hours, but the teeth counts are not given by Oechslin. We thus have

$$V_8^0 = -12 \quad (21.3)$$

$$P_8^0 = -\frac{1}{2} = -12 \text{ h} \quad (21.4)$$

The motion of tube 8 is first transferred to arbor 9 which makes a turn in a day, but Oechslin doesn't give the details of the gears:

$$V_9^0 = 1 \quad (21.5)$$

This arbor carries a finger which moves a 31-teeth wheel by one position and this will serve to indicate the day of the month in the lower part of the 12-hour dial, just above the figure VI. The lengths of the months do not seem to be accounted for.

The motion of arbor 9 is used to obtain the motion of arbor 13:

$$V_{13}^0 = V_9^0 \times \left(-\frac{a}{a}\right) \times \left(-\frac{1}{5}\right) \times \left(-\frac{1}{73}\right) = V_9^0 \times \left(-\frac{1}{365}\right) = -\frac{1}{365} \quad (21.6)$$

$$P_{13}^0 = -365 \text{ days} \quad (21.7)$$

This arbor carries a cam and this cam is used to move the hours of sunrise and sunset back and forth. These hours are written on a horizontal slider, with the hour of sunrise on the left and the hours of sunset on the right. The figures on the left part are given in opposite order as the figures on the right, so that when the sunrise is one hour later, the sunset is also given one hour earlier.

## 21.3 The geographic side of the clock

The geographic side of the clock shows a fixed Northern hemisphere and a moving shell shows which part of the globe is lit, and which one is not, taking into account both the diurnal motion of the Sun, and the inclination of Earth's axis on the ecliptic. Just above the main dial, there is a small dial which can be used to regulate the clock.

The input motion of that side is also arbor 2 which makes one turn clockwise in one hour as seen from the other side:

$$V_2^0 = -24 \quad (21.8)$$

$$P_2^0 = -\frac{1}{24} = -1 \text{ h} \quad (21.9)$$

### 21.3.1 The rotating motion of the shell and the Sun

The arbor 2 carries a 3-pin pinion which meshes with a 72-teeth wheel on tube 3, which is on the central axis of the geographic side. The center of this side is therefore higher than the center of the opposite side which is at the level of arbor 2. Tube 3 has the velocity (measured from the geographic side)

$$V_3^0 = V_2^0 \times \frac{3}{72} = V_2^0 \times \frac{1}{24} = -1 \quad (21.10)$$

This tube makes a turn clockwise in one day and carries the transparent shell representing the shadow. This shell is not a hemisphere, but must extend at least  $90^\circ + 23.5^\circ$ . The clockwise motion is the expected motion, because the apparent motion of the Sun is clockwise.

The shell is also mobile around an horizontal axis (on the drawing, but in fact parallel to the dial), but this axis moves with frame 3. The Sun is at a fixed position on frame 3, at right angle with the horizontal axis of the shell, so that the Sun is always in the middle of the lit part of the Earth.

### 21.3.2 The motion of the ecliptic and the oscillation of the shell

The ecliptic is represented by a ring located around the Earth and this ring is part of frame 6. The ring is located outside of the Sun (part of frame 3), but inside of the 24-hour dial (frame 4).

The ecliptic ring, or the zodiac, makes a turn clockwise in a sidereal day. This motion is obtained as follows. A finger is located on the frame 4 of the 24-hour dial. When frame 3 rotates, a 5-pointed star on arbor 5 meets this finger and rotates the arbor. This motion is then transferred to the vertical

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arbor 6 which carries the ecliptic ring. We have

$$V_6^3 = V_4^3 \times \frac{1}{5} \times \left( -\frac{1}{73} \right) = V_4^3 \times \left( -\frac{1}{365} \right) = -V_3^4 \times \left( -\frac{1}{365} \right) \quad (21.11)$$

$$= V_3^0 \times \frac{1}{365} = -\frac{1}{365} \quad (21.12)$$

$$P_6^3 = -365 \text{ days} \quad (21.13)$$

The frame 6 makes a turn clockwise in 365 days.

There is a back and forth motion of the shell between the two solstices. In Winter, the shell covers the North pole, but in Summer the North pole is lit by the Sun. This is done by having a tilted rail on frame 6 and this rail guides the shell, having it oscillate with the period  $P_6^3$ .

In the Prague clock (Oechslin 2.2), there is another similar gear train which is used to produce the oscillation of the shell around an axis parallel to the dial, but it is a more complex solution.

## 21.4 References

- [1] Joseph Georg Böhm. *Die sogenannten Kunst-Uhren (Planeten-Uhrwerke) auf der kais. kön. Sternwarte zu Prag.* Prag: Gottlieb Haase, 1863.
- [2] Joseph Georg Böhm. *Die Kunst-Uhren auf der k. k. Sternwarte zu Prag.* Prag: k.k. Sternwarte, 1908.
- [3] Pavel Chadima and Martin Šolc. Astronomy and *Musaeum Mathematicum* at Clementinum College in Prague. *Acta Universitatis Carolinae - Mathematica et Physica*, 46 (supplementum):173–183, 2005.
- [4] Wolfram Dolz. Die „geographische Universal-Zeig und Schlag-Uhr“ von Johann Baptist Homann und die kleinen Globen von Sichelbarth und Doppelmayr als wichtige Bestandteile astronomischer Uhren des 18. Jahrhunderts. *Der Globusfreund*, 51/52:33–45, 2005.
- [5] Wolfram Dolz, Joachim Schardin, Klaus Schillinger, and Helmut Schramm. *Uhren — Globen — wissenschaftliche Instrumente, Mathematisch-Physikalischer Salon, Dresden-Zwinger.* Dresden: Karl M. Lipp, 1993.
- [6] Max Engelmann. Die geographischen Uhren des Prager Paters Klein. *Allgemeines Journal der Uhrmacherkunst*, 35(2):22–26, 1910.
- [7] Sibylle Gluch. Obtaining quality in marginal places: The clocks and quadrants of the Clementinum observatory in Prague in the 18th century. *Revue d'histoire des sciences*, 74(1):85–118, 2021.
- [8] Helmut Grötzsch. Die Dresdner Geographische Kunstuhr von Johannes Klein. *Schriften der „Freunde alter Uhren“*, 4:37–40, 1964.
- [9] Radko Kynčl. *Hodiny a hodinky.* Prag: Aventinum, 2001.
- [10] Klaus Maurice. *Die deutsche Räderuhr — Zur Kunst und Technik des mechanischen Zeitmessers im deutschen Sprachraum.* München: C. H. Beck, 1976. [2 volumes].
- [11] Stanislav Michal. Astronomische Kunstuhr von Johannes Klein. *Klassik Uhren*, 19(2):42–49, 1996.
- [12] Stanislav Michal. *Hodinářství a hodináři v českých zemích.* Praha: Libri, 2002. [not seen, see p. 147-162 for Klein].
- [13] Ludwig Oechslin. *Astronomische Uhren und Welt-Modelle der Priestermechaniker im 18. Jahrhundert.* Neuchâtel: Antoine Simonin, 1996. [2 volumes and portfolio of plates].

- [14] Ludwig Oechslin. *Die geographische Weltzeituhr von Johann Baptist Homann und Zacharias Landteck und das Planetarium von François Ducommun*. La Chaux-de-Fonds: Éditions Institut l'homme et le temps, 2018.
- [15] Patrik Pařízek. Astronomické a geografické hodiny Johanna Kleina. *Rozpravy Národního technického muzea v Praze*, 225: Z dějin geodézie a kartografie 18:291–298, 2016. [Astronomical and geographical clocks of Johann Klein, not seen].
- [16] Patrik Pařízek. *České a Moravské historické hodiny 18. a 19. století — Czech and Moravian historical clocks of 18th and 19th century*. PhD thesis, Univerzita palackého v Olomouci, filozofická fakulta, katedra dějin umění, 2022.
- [17] František Martin Pelcl. *Abbildungen böhmischer und mährischer Gelehrten und Künstler, nebst kurzen Nachrichten von ihren Leben und Werken*, volume 4. Prag: Matthäus Adam Schmadl, 1782. [see p. 137-141 on Klein].
- [18] Peter Plaßmeyer, Wolfram Dolz, and Michael Korey. *Mathematisch-physikalischer Salon — Zwinger masterpieces, Staatliche Kunstsammlungen Dresden*. Berlin: Deutscher Kunstverlag, 2020.
- [19] Joachim Schardin. *Kunst- & Automatenuhren. Katalog der Großuhrensammlung*. Dresden: Staatlicher Mathematisch-Physikalischer Salon Dresden Zwinger, 1989. [see p. 21 for Klein's clock in Dresden].
- [20] Zdislav Šíma. *Astronomie a Clementinum = Astronomy and Clementinum*. Praha: Národní knihovna České republiky, 2006. [2nd edition, 1st edition in 2001].
- [21] Martin Šolc. Astronomické hodiny Jana Kleina. *Dějiny a současnost*, 26(3):28, 2004. [not seen, on Klein].
- [22] Joseph Stepling. *Exercitationes Geometrico-Analyticæ De Ungulis, Aliisque Frustis Cylindrorum, Quorum Bases sunt Sectiones Conicæ infinitorum generum. Adjungitur Descriptio Automati Planetarii*. Prague: Typis Universitatis Carolo-Ferdinandeæ, Societatis Jesu ad S. Clementem, 1751.
- [23] Anton Strnadt. *Beschreibung der berühmten Uhr- und Kunstwerke am Altstädter Rathhouse und auf der Königl. Sternwarte zu Prag*. Prag, Dresden: Walther, 1791.
- [24] Antonín Švejda. Přístroje a pomůcky z Klementina ve sbírce Národního Technického Muzea. *Acta Universitatis Carolinae — Historia Universitatis Carolinae Pragensis*, 57(2):107–141, 2017.

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- [25] 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.
- [26] Ladislaus Weinek. Ein alter bemerkenswerter Quadrant der Prager Sternwarte. In *Astronomische Beobachtungen an der k. k. Sternwarte zu Prag in den Jahren 1905-1909*, pages 78–82 (and plates). Prag: Sternwarte, 1912.

