

Some further early clocks from Nuremberg

Dietrich Matthes* & Rocío Sánchez-Barrios**

This article should be considered as an addition to John Leopold's fundamental work on early Nuremberg clocks from 2002. We investigate several further Nuremberg clocks and archival evidence that emerged since. This allows us to corroborate several hypotheses about dissemination of horological knowledge in the sixteenth century and gain new insights on well-known clockmakers.

John H. Leopold's 2002 article on early clocks from Nuremberg is a classic by now.¹ The present work strives to be a footnote to that article in that it discusses some recent discoveries of further clocks and watches from Nuremberg. These new pieces are noteworthy insofar as they allow to further investigate several paths that Leopold [2002] started to tread. The focus shall be on the first three quarters of the sixteenth century in order to further the understanding of the development and dissemination of horological technologies through Germany and other countries.

Horology in Nuremberg starts to rest on firm ground with the creation of the famous automaton clock in the *Frauenkirche* (Church of our Lady) (Fig. 1). The theme of the clock is unusual in that it is not an exclusively astronomical program but rather a description of the constitution of the Holy Empire, which was codified in 1356 in the Golden Bull. Amongst many other regulations it decreed that the first Imperial assembly of each emperor had to take place in Nuremberg. The pride of this elevation above other cities of the empire provided ample motivation for the motif of the clock. Yet the clock as visible today—the seven electors [not seen in the photo] circling and bowing to the emperor at noon while musicians play (two trumpets, flute, drum and a bell) under the dial and



Fig. 1. Automaton clock 'Männleinlaufen' at the Church of our Lady in Nuremberg. Jörg Heuß (movements), Sebastian Lindenast (figures), Adam Krafft (stonemasonry), 1506-1509.

spherical moon—was made in 1509 by Jörg Heuß, as witnessed by an inscription in the

* Dr Dietrich Matthes (d.matthes@gmx.net) is the author of *Zeit Haben. Tragbare Uhren vor 1550* (Having Time. Portable timekeepers before 1550), published in 2018 and reviewed in the December 2018 journal. Two earlier articles from his hand have appeared in *Antiquarian Horology*: 'A watch by Peter Henlein in London?' (June 2015) and, co-authored by Rocío Sánchez-Barrios, 'Mechanical clocks and the advent of scientific astronomy' (September 2017).

** Rocío Sánchez-Barrios (rosanchezb@hotmail.com) is an engineer by training with a keen interest in early horology.

1. J.H.Leopold, 'Some early clocks from Nuremberg', *Antiquarian Horology*, March 2002, 505-526.

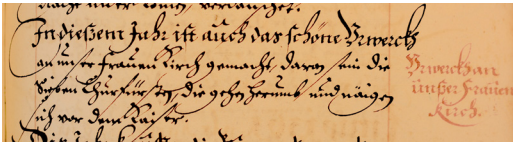


Fig. 2. Entry in a sixteenth-century manuscript chronicle of Nuremberg for the year 1361. Private collection.

clock and the associated and detailed invoices.² Today's device bears physical witness to the 1509 original clock in most of the figural programme visible on the outside, but hardly any in terms of the mechanisms.³ All figures bar the seven electors are still those made of copper by Sebastian Lindenast the elder⁴ in 1506–1509,⁵ although some have changed their instruments.⁶ It is unclear exactly what automaton clock there was in this location between 1358 (the year of completion of the church) and 1509.⁷ On this latter question we can now shed some additional light including a definitive date. We have found a sixteenth-century manuscript⁸ that makes reference to an automaton clock having been made for the church in the year 1361:

In this year [entry for the year 1361] the beautiful clock on the Church of our Lady was made, which shows the seven electors who walk around and bow before the emperor.⁹ (Fig. 2).



Fig. 3. Drum-shaped table clock with alarm surmount, marked by Gallus Schellhammer, around 1550, movement later. Kunstgewerbemuseum, Berlin.

2. An excellent and detailed analysis of both the physical and archival evidence was given in B. Huber & H. Mackenlein, 'Das Männleinlaufen an der Frauenkirche in Nürnberg', *DGC Jahrbuch* 44, 2005, pp. 127-141.

3. All the movements and much of the automaton gears and levers have been changed several times. The musical movement is no longer present or operational, rendering the program silent (see note 2)

4. 1460-1526

5. The statues of the seven electors were sold in the nineteenth century for the value of their (in total) 43 kg copper and replaced by wooden ones. The associated weight increase to around 25 kg per statue subsequently posed a significant challenge for the mechanism (see note 2).

6. The original setup had four trumpets. The drum and the flute visible today on the two small figures above the large trumpets are later changes (see note 2).

7. The invoice book for the Church of our Lady notes for 6 May 1506 that 'the old clock should be removed and a new one with the emperor and the electors walking around him should be made as it had also been at the old one' (see note 2), confirming that an automaton clock of the same theme had been there before.

8. From the library of the Barons of Reischach in the castle of Nußdorf, *Cronica der löblichen und weitbesuchten kay. Reichs Vesten und Stadt Nürnberg*, private collection

9. 'in dießem Jahr ist auch das schöne Urwerk an unser lieben Frauen Kirch gemacht, daran sein die sieben Churfürsten die gehen herumb und neigen sich vor dem Kaiser'.



Fig. 4a. Clock by Gallus Schellhammer, Nuremberg 1540–1550, engraved and etched case. Height 15 cm. Photo: Auktionen Dr. Crott.

This would suggest that today's clock from 1509 (and later) bears some witness to the idea and philosophy of the original mechanism of 1361.

Leaving aside the — mostly archival — knowledge on the famous early watchmaker Peter Henlein of Nuremberg (around 1480–1542), it is worth noting that the oldest spring-driven timepiece that can be certainly identified as being from Nuremberg is most likely by him.¹⁰ It is the drum-shaped small clock in a silver case that is discussed in Leopold [2002].

There are some further timepieces that

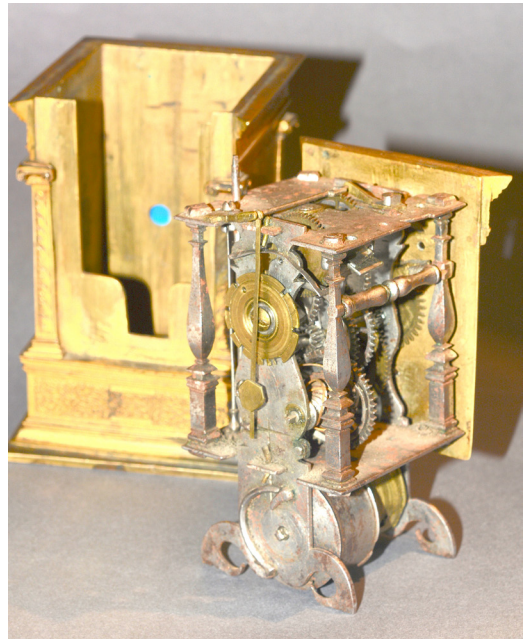


Fig. 4b. The Schellhammer clock, with the movement lifted out of the case in which it stands. Photo by the author.

nice complement his analyses. Leopold had used an outstandingly original line of geographical argument to identify the watchmaker symbol of Gallus Schellhammer (the initials 'G' and 'S' together with the portrait of a man wearing a pointed hat) who became master in 1537 and was murdered in 1558. His wife Anna Hyplerin and the journeyman Adam Lintzen were executed for poisoning him, as was the woman convicted of supplying the poison. To the list of his four horizontal table clocks and one drum clock¹¹ can now be added two more pieces: a second, almost identical, drum-shaped clock with his punchmark¹² (Fig. 3) and a tower-shaped small table clock that also shows his punchmark ('G' and 'S' to either side of a man's bust with a pointy hat) at the front.¹³ (Figs 4a & b). This latter fragment shows the same decorative features as his horizontal

10. D. Matthes, 'A watch by Peter Henlein in London?', *Antiquarian Horology*, 36/2 (June 2015), 183–194.

11. Number M17b in Dietrich Matthes, *Zeit Haben – tragbare Uhren vor 1550* (Nuremberg, 2018).

12. Number M17 in Matthes, *Zeit Haben*. Kunstgewerbemuseum, Berlin

13. Offered as a 'Renaissance clock fragment' in the Frankfurt/Mannheim auction house Dr. Crott. It is a miniature tower-shaped table clock of very small size (15 cm high). One fusee together with its wheel, one spring barrel, both springs, ratch and click, hammer, the dial, the alarm train and the entire escapement area have been removed or replaced but the rest of the movement remains

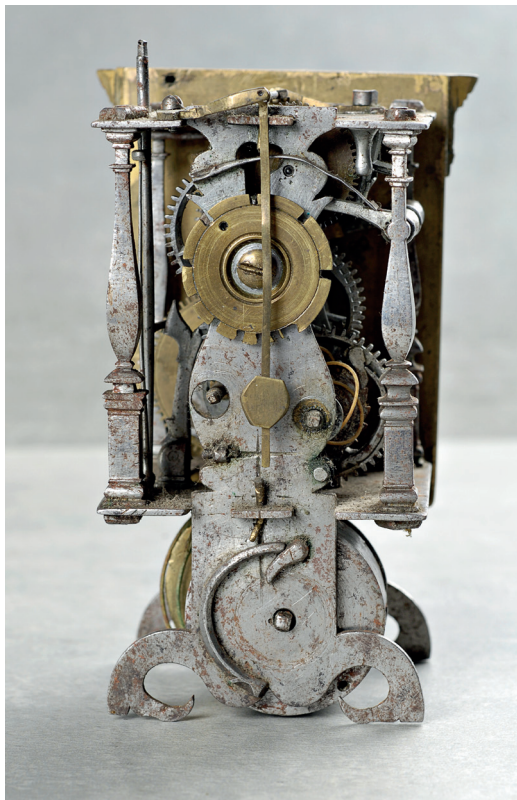


Fig. 4c. The movement of the Schellhammer clock. Auktionen Dr. Crott.

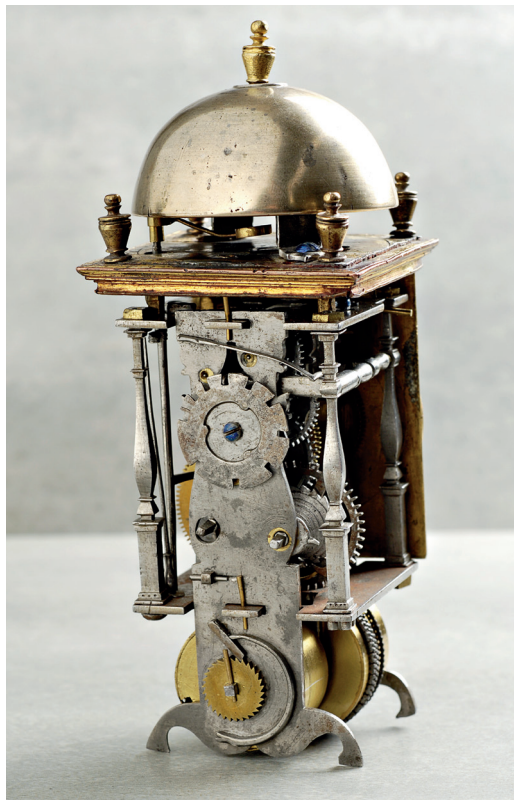


Fig. 5. Clock by Steffen Brenner, marked 'SB', dated 1563, 17 cm high. Auktionen Dr. Crott.

table clocks: a steel movement with elaborately pierced plates in a decoratively symmetrical or near-symmetrical pattern, but here obviously standing vertically. The elaborately engraved case shows *Arithmetica*, *Geometria* and *Musica* based on engravings by Sebald Beham (around 1531–1550) and also bears the maker's mark, which is unusual as it was more customary to place this on the movement.¹⁴ The additional noteworthy feature is the etched decoration on the lower part of the case and the dial. This rare style of

decoration shall be further discussed later. The clock can be dated to around 1550.¹⁵

What is intriguing about this newly discovered clock is the striking similarity, to the point of almost complete identity, of all decorative and constructive aspects of the movement with the clocks made by Steffen Brenner, the Danish court clockmaker in Copenhagen.¹⁶ (see Figs 4c and 5). Leopold [2002] had speculated that he learned his trade in Nuremberg, 'probably with Schellhammer'; the former had also been

14. See Leopold, 'Some early clocks from Nuremberg'.

15. The clock does not have the other characteristic features that Leopold [2002] describes for Schellhammer's pieces: it has unwarned striking rather than warned striking with concentric detents, no moon indication and no equinoctial sundial. Yet the maker's mark identifies it as by Schellhammer and it has to be considered as representative of the simple production of that highly unconventional master.

16. Steffen Brenner received an annual salary since 1550 at the court of Christian III in Copenhagen. In 1554 he was nominated court clockmaker. K. Maurice & O. Mayr, *Die Welt als Uhr/Clockwork Universe* (Munich/New York, 1980), cat. no. 49.

17. It has been observed that he used pre-made parts from Nuremberg for some of his clock cases, Maurice & Mayr, *Die Welt als Uhr*.



Fig. 6. Pendant watch, Nuremberg, 1537–1550, 54 mm diameter, 19 mm high. Patek Philippe Museum, Geneva.

suggested by K. Maurice.¹⁷ This assertion can now be confirmed given the present fragment. Not only did Steffen Brenner learn the craft in Nuremberg from Schellhammer at some point before 1550/1553, the date of his first signed and dated clock which was already made in

Copenhagen,¹⁸ but he also took his master's designs to the north. He did so to such an extent that he continued to build almost identical movements in all structural and decorative elements, including sub-stage barrels below the movement, at a time when most other makers had moved on fully to integrate the spring-barrels into the movements. All the way to 1576 he built movements in that design, which had already been employed in the 'Burgundy clock of Philip the Good',¹⁹ as well as in a clock presumed to have been made in Nuremberg around 1480–1520.²⁰ Furthermore, he continued to use the elaborately pierced plates, the extravagantly shaped pillars (see Fig. 4) and also the architectural cases that are typical for Gallus Schellhammer but also for other Nuremberg makers such as Hans Gruber.²¹

Despite losses and later changes to the case of this little table clock, it allows for one further observation: the decoration in the unusual etching technique at the lower part of the front is virtually identical to one further timepiece: an unsigned and undated watch that is well known as one of the earliest preserved pendant watches.²² (Fig. 6) This watch is noteworthy for its etched, rather than engraved, decoration—a feature almost as rare on watches as the watch itself. The etched ornament on its band is identical to the etched ornaments on the Gallus Schellhammer *Türmchenuhr* both in style and in technique (Figs 7a & b). Given that watchmakers in the early sixteenth century

18. Nationalmuseum, Stockholm. See Leopold [2002] for pictures and details of this clock.

19. Germanisches Nationalmuseum, Nuremberg, HG 9771, around 1430.

20. Germanisches Nationalmuseum, Nuremberg, WI 163, around 1480–1520. This clock shows the 'Nuremberg hours' and also has some further early features (besides the sub-stage barrels): it shows inverse winding holes for a key of quadratic cross section as well as late gothic decorative elements both on its all-iron case and in the movement. See also T. Eser, *Die älteste Taschenuhr der Welt* (Nuremberg, 2014).

21. Examples can be seen in K. Maurice, *Die deutsche Räderuhr* (Munich, 1976), numbers 104–113. Gruber's cases share a striking number of similarities in their architectonic construction with Brenner's clocks and this Schellhammer *Türmchenuhr*. This also pertains to some pierced plates and the shaped pillars (although Gruber's shaped pillars are characteristic yet decidedly different from Schellhammer's and Brenner's). The similarities are close enough to consider the hypothesis whether Gruber too had collaborated with, or worked in, Schellhammer's workshop.

22. Patek Philippe Museum, Geneva.

23. E. Groiss, 'Das Augsbürger Uhrmacherhandwerk', in Maurice & Mayr, *Die Welt als Uhr*, p. 74 and footnote 85. In 1578, there were already six goldsmiths working exclusively as clockcase-makers in Augsburg, together with a further seven coppersmiths creating brass clock-cases only.



Figs 7 a & b. Left: etched decoration on the pendant watch from 1537-1550, Patek Philippe Museum, Geneva. Right: etched decoration on Gallus Schellhammer's small table clock, 1540s, Auktionen Dr. Crott.

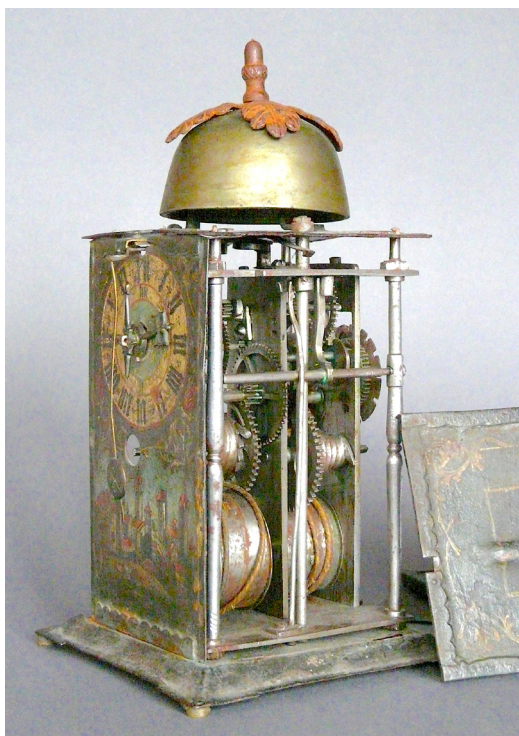


Fig. 8a. All iron table clock, Nuremberg, first third of the sixteenth century. Private collection.



Fig. 8b. Painted depiction of Nuremberg castle, showing between the two towers on the right the 'wheat house', constructed in 1495.



Fig. 8c. Depiction of the castle in the *Nuremberg Chronicle* in 1493 before the construction of the 'wheat house'.

usually (but not always)²³ also made the cases for their movements, the watch was likely made by Schellhammer but certainly by a master in Nuremberg who at least frequented the same case maker. Its dating, second quarter of the sixteenth century, hence can now be narrowed down to 1537-1550.

Gallus Schellhammer's (and certainly

Steffen Brenner's) construction of sub-stage barrels was already in the process of being developed further (and overcome) during the first half of the sixteenth century. Testimony to this is a fourth newly-identified Nuremberg clock (Figs 8a-c): a table clock of tower shape that is larger than the aforementioned example by Schellhammer. The clock is

24. Interestingly, a second one of those four pieces can most likely be ascribed to Nuremberg (see note 20). The two other timepieces are in the Kunsthistorisches Museum, Vienna (Inv. Kunstammer, 856), dated 1545, and in the Kellenberger collection in Winterthur (around 1630).

entirely made of iron, including the case, and is one of only four Renaissance timepieces known to the authors to which this feature applies.²⁴ It has a striking and a going train which shows the hours on a dial at the front. The case is entirely painted with ornamental plants on the sides. The localisation to Nuremberg is in this case based on two facts. The first is that the clock shows the castle of Nuremberg painted on its front below the dial; this view of the castle closely follows the woodcut from the *Schedelsche Weltchronik/ Nuremberg Chronicle*²⁵ except for the noteworthy detail that the building between the towers on the right was built the year after the *Nuremberg Chronicle* was published and hence is missing there, while it is present on the clock's view of the castle, which points to local knowledge of the painter and hence a Nuremberg manufacture. The second is that the leaf ornaments beside the view of the castle closely follow several Nuremberg examples from the first quarter of the sixteenth century,²⁶ confirming the dating of the clock to the years 1500–1530.²⁷ The clock has until recently been in the possession of the counts of Castell in Castell (close to Nuremberg),²⁸ presumably since its early days. This clock and the other piece from around 1500 presumably from Nuremberg (see note 25) share another early feature: both do not yet have a striking-train control-dial.

Turning back to early watches from Nuremberg, there are a number of further examples besides that given above. One of them, although unmarked, can be attributed to Nuremberg because of an engraved decoration on the reverse of its case (Fig. 9). It is a drum-



Fig. 9. Pendant watch, Nuremberg, around 1550, formerly belonging to the Pfinzing family, 67 mm diameter, 39 mm high. Private collection, Qatar; Photo: Auktionen Dr. Crott.

shaped pendant clock-watch made in the 1550s with mostly iron movement and brass case.²⁹ The coat of arms on the reverse of the case refers to an alliance between the Pfinzing family³⁰ and the Welser family,³¹ and was probably added later in 1573 to commemorate

25. H. Schedel, *Register des Buchs der Croniken ...* (Nuremberg, 1493).

26. Such as the leaf ornaments on a chandelier created for the Nuremberg family Behaim in 1507 in the Germanisches Nationalmuseum and similar leaf ornaments on several paintings from the circle of Jacob Elsner (GNM, Inv. Gm 2438 and HG 11161 and in particular the Brevier for Abbot Johannes Stanttenat of Salem monastery from 1493, Heidelberg, University library, Cod. Sal. IXc, fol. 107r.

27. The lack of comparative examples makes it hard to further narrow down this range.

28. The 'Faber-Castell' branch of this family nowadays is famous for its writing tools as well as a bank in Frankonia, Germany.

29. See for example Eser, *Die älteste Taschenuhr der Welt?*, p. 182 no. 48 and p. 87.

30. A wealthy Nuremberg patrician family of traders and metal producers who were members of the 'inner council' of the city.

31. Another wealthy Nuremberg patrician family of traders in metal and spices as well as banking.

32. Further to the alliance coat of arms there is a motto *Gott begnadet Hoffnung* ('God graces hope') which is known to have been used by Hans Pfinzing.

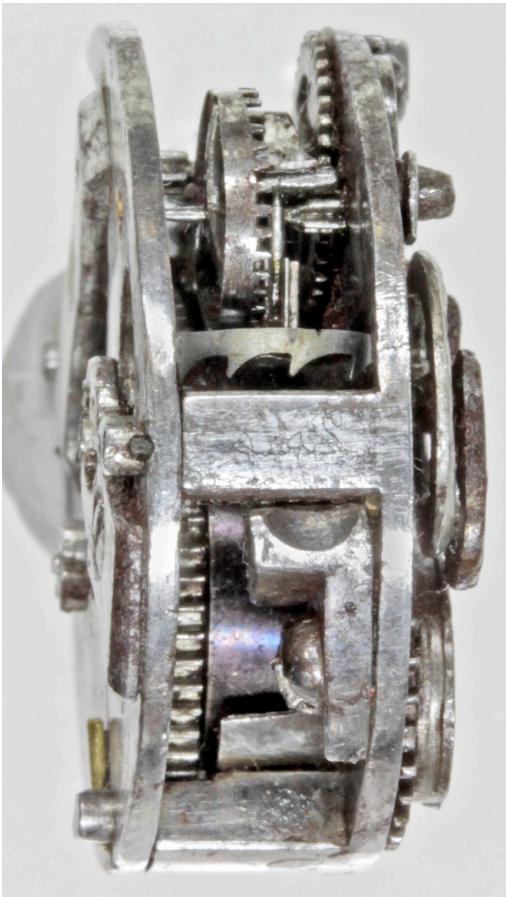


Fig. 10. Miniature pendant watch, Nuremberg, 1550s, marked by Hans Gruber, 23 mm diameter, 14 mm high. Nuremberg, Germanisches Nationalmuseum, LG 3656, Photo: Roland Schewe, Germanisches Nationalmuseum.

a wedding of Hans Pfnzing and Sabine Welser.³² This allows to ascribe its production firmly to Nuremberg since many of the horological centres were forbidding import of non-locally-made clocks.³³ It is worth noting that the very flat iron movement has (the original) brass bushings. The two open springs without barrels are held apart by a butterfly-shaped piece between them as discussed in Tait & Coole,³⁴ the outer support for them is given by the pillars. The bridge holding the crown-wheel is v-shaped and in one piece, which constitutes a transitional construction between the earliest c-shaped bridges and the v-shaped bridges of

33. E.Groiss (as in note 23), p. 77 and footnote 110.

34. H. Tait, P. G. Coole, D. Thompson, *Catalogue of watches in the British Museum I The Stackfreed*, (London: British Museum Publications, 1987).



Fig. 11 a-d: Clockmaker's punchmarks, clockwise from top left:

a. arrow mark ascribed to Sebastian Lehr, Nuremberg

b. mark ascribed to Hanns I. Grimm, Nuremberg, showing a half cog-wheel as also present on his epitaph (Fig. 16)

c. mark of Hans Zel(t)ner, Augsburg 1526-1531, afterwards Vienna (this example on a clock dated 1533 in the National Museum in Copenhagen)

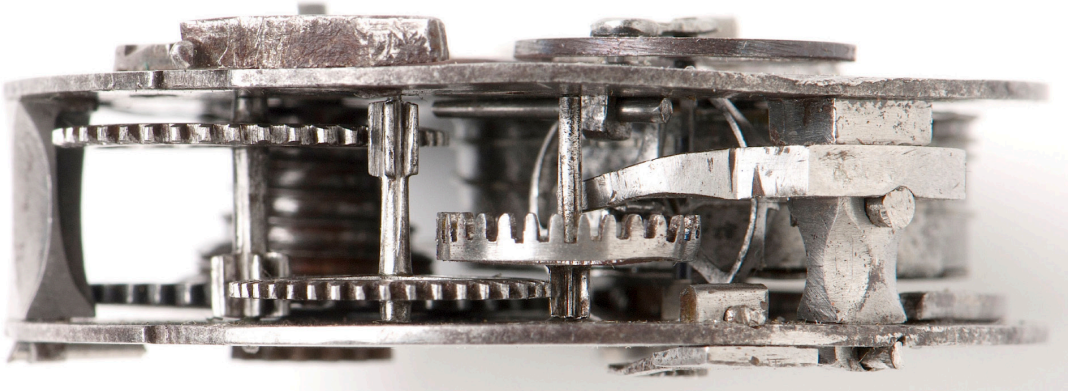
d. mark of Hans Gruber, Nuremberg (see text for location of the other examples; Hans Gruber used five variations of his mark throughout his life, yet they are all based on the crossed shovels also shown on his epitaph. See literature in note 21 for examples of his work and punchmarks).



Fig. 12. Epitaph of 'Hans Gruber Uhrmacher' (clockmaker) showing his clockmaker sign of the crossed shovels, erected by his descendants in 1617, Nuremberg, Johannisfriedhof, Grave 198, H/6 (shared with his wife, parents-in-law and descendants).

two individual pieces as was customary from the mid-sixteenth century onwards.³⁵

A third watch completes the picture of



Figs 13a and b. Pendant watch with arrow mark, Nuremberg, Sebastian Lehr (?), 1540s, Stuttgart, Württembergisches Landesmuseum. Photos Museum.

Nuremberg watchmaking before 1560 (Fig. 10). It is a miniature pendant watch marked by the famous Nuremberg maker Hans Gruber³⁶ from the 1550s. He became master in 1552 but his earliest marked clock is dated to 1550.³⁷ The watch has a going train in a mostly iron stackfreed movement. The bands are slightly domed, as are the lids. The maker's mark (HG in a shield with two crossed shovels;

see Figs. 11d and 12) can be found on the movement rather than on the case, as is more usual for Nuremberg makers, including Hans Gruber.³⁸ The open mainspring is held between the pillars as in the case of the Pfinzing watch and additionally several pegs set in the plate, since there is no striking train and hence no second spring to enable a butterfly-piece as in the Pfinzing watch.

35. See Tait a.o. (note 34), pp. 29-30 for a detailed discussion.

36. See Leopold, 'Some early clocks from Nuremberg', note 42 for an overview.

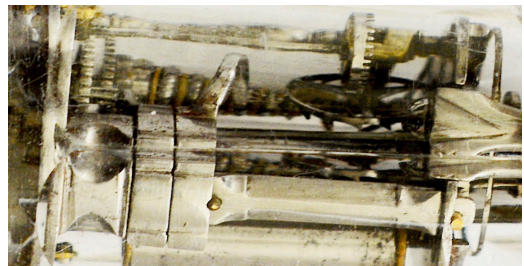
37. An astronomical table clock in Oslo university, Department of Astronomy, see e.g. Maurice, *Die deutsche Räderuhr*, number 151. See also Leopold, 'Some early clocks from Nuremberg', note 11 for a further discussion of this clock.

38. See Leopold, 'Some early clocks from Nuremberg'.



Fig. 14. Grave of Sebastian Lehr with emblems of a clockmaker, 1556, Nuremberg, Rochus Cemetery, Grave 364.

The Pfinzing watch and Gruber's miniature watch have the same ornamental decoration of the lids, which is also shared by a third watch fragment from Nuremberg: a watch lid found just outside the castle of Hohenstein, an administrative castle belonging to the city of Nuremberg.³⁹ This castle was conquered and destroyed in 1553,⁴⁰ which shows that the watch lid was made before 1553. These three identically-designed Nuremberg lids point to another yet unidentified maker, who made at least three pendant watches with an identical



Figs 15a and b. Pendant watch in a rock crystal case, Nuremberg, 1540s, Han(n)s I. Grimm, Louvre, Paris. Below: detail view: iron pillar of the movement with the bridge pushed over it (the bridge in brass) as is typical for German clocks. (Pillar seen through the cut rock crystal with associated refraction).

lid design.⁴¹ (Fig. 13) Several more clocks by this maker are known,⁴² and the fact that he marked all his clocks on the case, as was customary for Nuremberg, further corroborates the hypothesis that he was indeed located there. The date of the clocks indicates a time of activity of around 1530–1560. His mark—an empty circle from which

39. Published and illustrated in Matthes, *Zeit haben*, p. 178 fig 5.30.

40. By margrave Albrecht Alcibiades of Brandenburg-Kulmbach.

41. A complete watch is in the Württembergisches Landesmuseum, Stuttgart (Fig. 13) and two empty watch cases are in the British Museum, London (Ilbert Collection, 1958 (reg. No. CAI – 2202), see *Catalogue of watches in the British Museum I The Stackfreed* (note 34) for pictures) and the Museum of London (34.161/2).

42. Two drum clocks (M13 in Matthes, *Zeit haben*), and a table clock in the British Museum, 1958,1006.2112, also illustrated in Matthes, *Zeit haben*), one tower-shaped table clock (private collection) and a lavish hexagonal table clock (Louvre, Departement des Objets d'Art, OA 674) which are all marked on the case as was customary for Nuremberg.

arrows emanate—can speculatively be ascribed to Sebastian Lehr.⁴³ (see Fig. 11a and Fig. 14). The arrows were seen as symbolic for Saint Sebastian,⁴⁴ while the empty circle could refer to his last name: ‘empty’ (*leer* in German) is homophonic to ‘Lehr’, the last name of the maker. This reasoning for the choice of a maker’s mark would not have been unusual: Hans Gruber chose shovels (‘Gruber’ is close to *Grube* (pit) which derives from *graben* (digging) while Hans Zellner of Augsburg chose a tent (‘Zellner’ is similar to *Zelt* (tent) or *Zeltner* (tent-maker). This hypothetical ascription will need further investigation for confirmation.

A further early timepiece can be ascribed to Nuremberg. It is a watch in a rock-crystal drum case with brass lids on both sides and a (mostly) iron full-plate movement inside.⁴⁵ (Fig. 15). The rock-crystal case has a hinge on top for attaching it to a cord or chain to be worn as a pendant. The fusee movement of this watch has several interesting features that allow us to determine it to be of Southern German origin:

1. The movement is almost entirely made of iron, which was customary in France only before 1530. In Germany however, it took until the 1560s before clockmakers fully appreciated the technological advantages of using a combination of iron and brass for the movements.⁴⁶
2. The shape of the pillars is typical for German clocks, but not for French ones.⁴⁷



Fig. 16. Epitaph of Hans Grimm, erected by his descendants in 1595, showing a half cog-wheel similar to the punchmark ascribed to him here, Johannisfriedhof, Nuremberg, Grave 660, K/6.

3. The arbors are supported by bridges. In French clocks, they are always standing between the two plates, while German makers inserted bridges pushed over the pillars⁴⁸ or attached to the inner sides of the plates or pillars.⁴⁹
4. The ratchet is on the outside of the plate as is customary for early German timepieces.⁵⁰ In French ones, it is always on the inside.

43. Master 1525, city clockmaker of Nuremberg, died in 1556.

44. A fourth-century martyr who was condemned to death by being shot with arrows by Cesar Diocletian.

45. Louvre, Paris, Departement des Objets d’Art, OA 8290, Legs Mlle Marie-Julie Olivier, 1935. It is described in detail and illustrated in C. Cardinal, *Les montres et horloges de table du musée du Louvre*, vol. II (Paris, 2000), no. 43. Further pictures can be found in Matthes, *Zeit haben*. It has been noted that this is the oldest known watch in a rock crystal case.

46. With the exception sometimes of brass bushings, the nag’s head and the fly

47. Curiously, the movement has two different styles of pillars: a typically German one (see Fig. 15b) and a turned baluster shaped one. This latter shape occurs both in France and in Germany; a French example would be the timepieces MF5 & MF6 according to Matthes, *Zeit haben*, pp. 455-56, a German example would be Hans Gruber’s clock mentioned in note 37.

48. Movements of the C/M/Z groups according to the classification in Matthes, *Zeit haben*.

49. Movements of the HS groups in Matthes, *Zeit haben*.

50. The fifty-six small German drum timepieces from the sixteenth century in Matthes, *Zeit haben* all have the ratchet on the outside while the ten early French ones there all have it inside the plate (the ratchet is missing here but the click shows that it was outside).



Fig 17a. Mechanical globe clock, Christian Heiden, Nuremberg, dated 1570, Schatz des Deutschen Ordens, Vienna.

For those reasons, the watch can be ascribed to before the mid-sixteenth century from Southern Germany. The decoration on the brass lids again shows the rare technique of etching rather than engraving,⁵¹ as in the case of the Nuremberg clocks by Gallus Schellhammer from the 1550s and the similarly decorated pendant watch discussed earlier. A punchmark on the movement reads 'HG' in a shield with half a cog-wheel underneath. The maker⁵² with those initials in the respective years in Southern Germany is Hanns I. Grimm (master 1537, died 1560),

city clockmaker of Nuremberg. The half-cog-wheel symbol (Fig. 11b) can also be found on his bronze epitaph (see Fig. 16). Indeed, clocks in rock crystal cases are known to have been made in Nuremberg in the 1540s, the city of Nuremberg paid the high sum of 100 florins in 1541 for 'a small artful orologium in a crystal sphere'.⁵³

To end the chronological sequence of timepieces, one further interesting note can be made in addition to Leopold [2002]'s description of the enigmatic Heiden⁵⁴ globes (Figs 17 a & b). Leopold observes that Heiden's 1570 globe⁵⁵ 'is of astounding

51. The technique of etching – often together with engraving on the same case – most often appears on clocks from Nuremberg, notably those by Gallus Schellhammer and Hans Gruber.

52. Heinrich I. Grienstetter (Augsburg, master 1549, died approx 1577) could also be a candidate if the watch is some years later than argued here. The same holds true for Hans Gasteiger (known 1545–1578 in Munich and in Vienna).

53. A. Gümbel, *Peter Henlein, der Erfinder der Taschenuhr* (Halle, 1924), p. 12 after a note in the city archive of Nuremberg.

54. Christian Heiden was born in Nuremberg in 1526, professor of mathematics (and rector of the gymnasium) from 1556, as well as maker of scientific instruments. He died in 1576 as he was about to join the Imperial Court.

55. Museum der Schatz des Deutschen Ordens, Vienna.

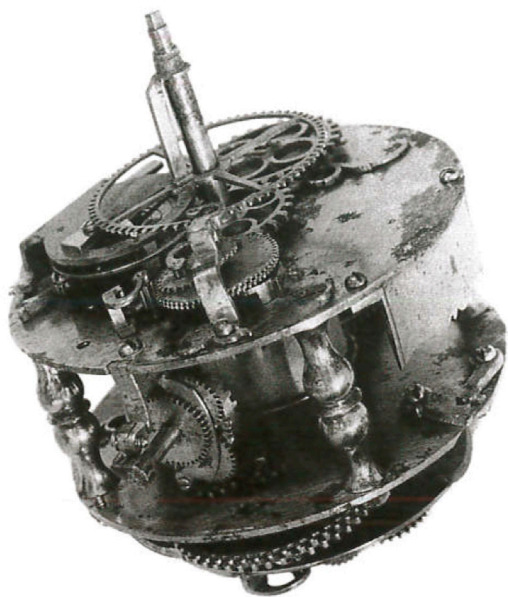


Fig 17b. The movement of the mechanical globe clock, Christian Heiden, Nuremberg, dated 1570, Schatz des Deutschen Ordens, Vienna.

complexity and probably the most sophisticated clock to survive from the middle of the sixteenth century.’ Since Heiden himself was a mathematician and engineer rather than a trained clockmaker, the question comes up: who actually made this remarkable movement? Leopold [2002] asserts that Heiden certainly designed and calculated the

trains, and then speculates that the actual making of the movements according to Heiden’s calculations was done in cooperation with a trained local clockmaker (Leopold [2002] speculates about Hans Gruber). He further notes that Jost Bürgi⁵⁶

was the only clockmaker after Christian Heiden to use epicyclic gearing within an ordinary wheel train and it seems likely therefore that he had, at least, access to the workshop that made the latter’s globes.⁵⁷

Indeed there is archival evidence to corroborate this hypothesis. An inventory of the Imperial *Kunstammer* notes for inventory number 2163/397:⁵⁸

A globe clock, the outside is the earth and inside the celestial sky, it shows the movement of the sun and the moon, all of silver, [...] started by Christian Heiden, made/finished [?] ⁵⁹ by Jobst Bürgi, including the key.

This indicates a globe clock very similar to that from 1570 in Vienna in the treasure of the Teutonic order. It shows that either Heiden ran a clockmaker workshop himself in which Jost Bürgi was employed, or Bürgi was a member of the workshop that cooperated with Heiden. Either way, the cooperation of

56. It is still unclear where this most outstanding Kassel clockmaker (1552–1632) learned his craft. A recently discovered manuscript by him (discovered by Jürgen Hamel in the Lippische Landesbibliothek in Detmold, Msr 86.4° - *Von Probirung und Schmelzung der Metalle* [*On the analysis and smelting of the metals*]) indicates that he had intricate knowledge on metals. To what extent this was standard for clockmakers is not entirely clear but it is known that locksmiths had very detailed knowledge on metallic alloys (M. Wayman (ed.), *The Ferrous Metallurgy of Early Clocks and Watches, Studies in post-medieval Steel*, British Museum Occasional Paper Number 136, London, The British Museum, 2000 – e.g. clock 2, pp. 35 ff). It would certainly not be surprising at all for a clockmaker who was trained in Nuremberg. The city was the centre for separation smelting works with a focus on analyzing silver coins for a higher silver fraction in their alloy content and then separating the alloys in them to reduce the silver content within legal limits but also for conversion of blister copper to rosette copper and then brass; see W. Freiherr von Stromer, ‘Nürnberg als Epizentrum von Erfindungen und Innovationen an der Wende vom Mittelalter zur Neuzeit’, in O. Schneider, *Nürnberg’s große Zeit* (Cadolzburg, 2000). In fact, Nuremberg, Florence and Venice (the ghetto) are the outstanding locations where such know-how was abundant in the fifteenth and sixteenth centuries.

57. Leopold, ‘Some early clocks from Nuremberg’, p. 526.

58. R. Bauer & H Haupt, ‘Die Kunstammer Kaiser Rudolfs II. in Prag. Ein Inventar aus den Jahren 1607–1611’, in *Jahrbuch der kunsthistorischen Sammlungen in Wien*, vol 72, (Neue Folge Band XXXVI), 1976, pp. 110–111.

59. the word *ausgemacht* could refer to Bürgi finishing a movement or to him actually making a movement that somebody else had designed and calculated. Today’s meaning (‘switched off’) is very different and cannot give guidance.

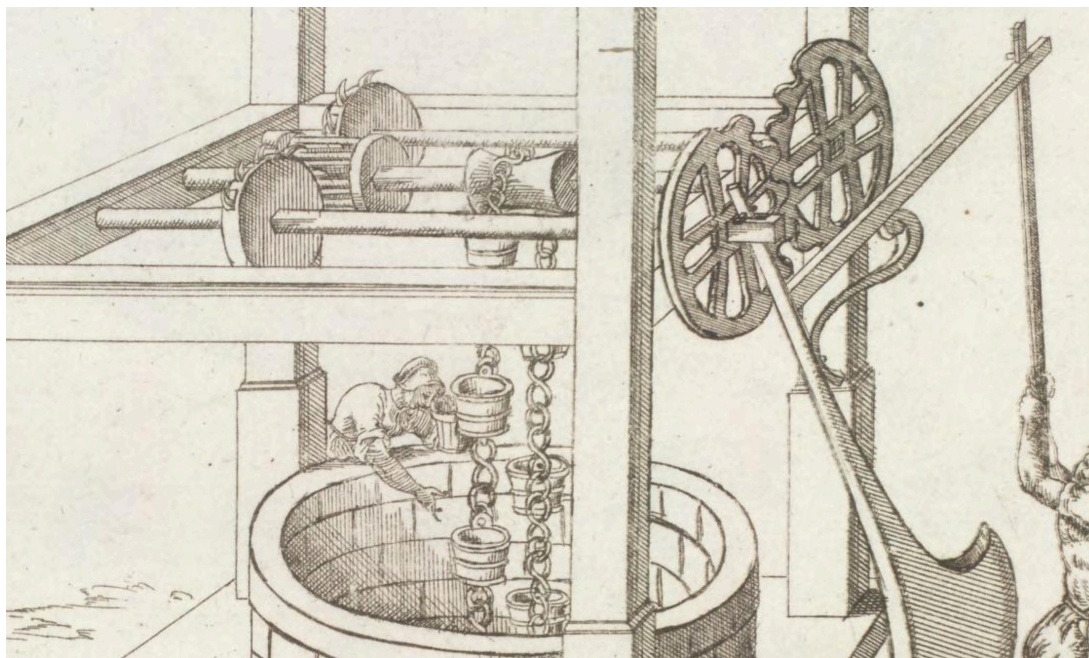


Fig. 18. Detail from Jacob Besson, *Theatrum Instrumentorum*, Lyon, first edition 1569 (this image from 1578 edition) pl. 44, showing the cross-beat drive for a pump above a well.

an outstanding mathematician like Heiden with an outstanding clockmaker like Bürgi could explain the remarkable quality of the 1570 globe clock,⁶⁰ – in particular if compared with the much simpler 1560 example.⁶¹ In addition, it would be an indication as to where Bürgi obtained his astronomical knowledge: cooperations between astronomers and trained clockmakers had proven to be successful (and potentially a pre-requisite) to make complex astronomical and planetary

clocks.⁶² A further observation is relevant in this context. It is well-known (albeit very often overlooked) that Jost Bürgi did *not* ‘invent’ the cross-beat escapement.⁶³ Rather, he introduced an existing technology into clockmaking. The cross-beat technology had already been published in a book in 1569 (first edition)/1578 (cited edition). Jacob Besson’s *Theatrum Instrumentorum* (Lyon, 1569/1578) contains on pl. 44 a detailed drawing where the cross-beat technology is

60. Bürgi would have been only 18 years old at the time that Heiden’s preserved Vienna globe clock was created. It is not clear whether he was involved in its creation as well. Clockmaker apprentices had to be at least 12 years old (E. Groiss, ‘Das Augsburger Uhrmacherhandwerk’, p. 65. This holds true for Augsburg – but the city of Nuremberg drew heavily on Augsburg’s regulations in October 1554 when they first drafted their own. So Bürgi could have been learning for six years already in 1570. Locals had a minimum requirement of three apprentice years and then three journeyman years before they could apply to start working on their masterpiece. Non-locals such as Bürgi had a minimum of three apprentice years and then four journeyman years (of which some time needed to be spent locally) before applying to start their masterpiece. (see e.g. K. Maurice, *Die deutsche Räderuhr*, p. 143). So Bürgi would have been a journeyman when working on the 1570 Heiden globe clock in the workshop of another master in Nuremberg. Probably, the emperor’s example that the inventory refers to was therefore made some years after 1570; Heiden died in 1576.

61. Formerly in the Mathematisch-Physikalischer Salon in Dresden, unaccounted for since 1945, see Leopold, ‘Some early clocks from Nuremberg’, for the comparison of the two.

62. Other examples of such collaboration were the creation of a large planetary clock by Johannes Werner and Peter Henlein in Nuremberg as well as Eberhard Baldewein and Hans Buch in Kassel.

63. K. Maurice, ‘Jost Bürgi oder über die Innovation’ [Jost Bürgi or on innovation], in: K. Maurice & O. Mayr, *Die Welt als Uhr*, pp. 94-95.

used to drive a pump, i.e. it is driven ‘the other way round’ to use a swinging pendulum to drive a circular motion of a pump (Fig. 18). This work, and/or this technology, would be of crucial importance to any mining operation. Mining and generally metal supply suffered from the low level of pumping technology for centuries: most metallic ores below ground are located at a depth below groundwater. Hence once the surface supplies were exhausted, further ore was only accessible with sufficiently sophisticated pumping technology.⁶⁴ Cities and regions that depended on mining, such as the southern German region between Nuremberg and Prague, were pro-actively promoting research into such new technologies. This included ‘private equity funds’ for funding of technology research on a time horizon of up to fifteen years.⁶⁵ Hence technology as contained in the treaty of Besson would be readily accessible in such cities as for example Nuremberg as the centre of such mining technology in the Holy Empire. Both Bürgi’s metallurgic knowledge as witnessed in the newly discovered manuscript (see note 56) as well as his encountering the cross-beat technology

could have happened anywhere. But given his proven studies (and probably either apprenticeship and/or journeyman time) in Nuremberg (note 60), it neatly explains his exposure to such technologies.

Overall, these additional finds of Nuremberg timepieces and archival information confirm the previous image of Nuremberg as one of the influential centers of early mechanical clockmaking. Tracing clocks and clockmakers from that city to their destinations in the few cases where that is possible in the first three quarters of the sixteenth century can corroborate the origin of the city’s fame as a horological centre.^{66, 67} And it is here that the reported finds allowed for two further arrows to be added firmly since Leopold [2002]: to Copenhagen and to Kassel/Vienna (Fig. 19). It is from Nuremberg that the early clockmaking tradition in several areas received crucial input. This focus on an exporting industry might have contributed to the city’s fame since several other early (indeed earlier) clockmaking centres such as Blois and northern Italian cities seem to have had a stronger focus on domestic supply. Furthermore, Nuremberg provided the perfect

64. It is the lack of pumping technology that led to a lack of metals – most importantly of silver, see W. Freiherr von Stromer, ‘Nürnberg als Epizentrum von Erfindungen’ and references therein. Since coinage was fully silver-value based, this lack of metal led to a gap in money supply M3. The today well-understood consequence of this is a permanent deflation – which is exactly what happened throughout the Middle Ages, similar to the gold standard in monetary policy that contributed to the depression in 1929–31. It is not by chance that the ‘explosion’ in technology and innovation happened after 1400 when better pumping technology (and a checkbook money system) appeared – nowadays known as ‘the Renaissance’.

65. W. Freiherr von Stromer, ‘Nürnberg als Epizentrum von Erfindungen’.

66. The city has not only been *origin* of clockmaking knowledge and innovation but also *destination* – aspects of this can be seen in C. Zanetti, *The Microcosm, Innovation and Technological Transfer in the Habsburg Empire of the Sixteenth Century*, The Medici Archive Project, 2014 and C. Zanetti, *Janello Torriani and the Spanish Empire: A Vitruvian Artisan at the Dawn of the Scientific Revolution* (Nuncius 29; Leiden: Brill, 2017).

67. 1506: Letter from Galeazzo di Sanseverino from Milan to order a clock from Willibald Pirckheimer of Nuremberg (Nuremberg, Stadtbibliothek, PP 461,1); the 1510s: Andreas Osterberger exports clocks from Nuremberg to Königsberg and Masuria; 1523: two clocks are given by the city of Nuremberg to Mercurino Gattinara, chancellor of Charles V. in Valladolid (A. Gümbel, *Peter Henlein der Erfinder der Taschenuhr*); 1528: Peter Henlein (together with Johannes Werner) completes a planetary clock for Bishop Albrecht of Brandenburg; around 1540: Jakob Bulmann travels to Vienna to personally show a clock to King Ferdinand; around 1540: a clock is made for Ottheinrich of the Palatinate, most likely in Nuremberg (Leopold, ‘Some early clocks from Nuremberg’ and references there in footnote 22); before 1550: Steffen Brenner goes to Copenhagen after apprentice years in Nuremberg to become court clockmaker there. This does not inhibit Hans Gruber in 1583 to make a clock for King Fredrik II of Denmark (dotted line, see e.g. Leopold, ‘Some early clocks from Nuremberg’, p. 526); around 1575: Christian Heiden is invited to demonstrate his work in person to the emperor but dies before going; around 1575 and then in 1579: Jost Bürgi works on a Heiden globe clock for the Emperor and later becomes court clockmaker of the landgrave in Kassel – he joined the imperial court in Prague later in his life (dotted line).

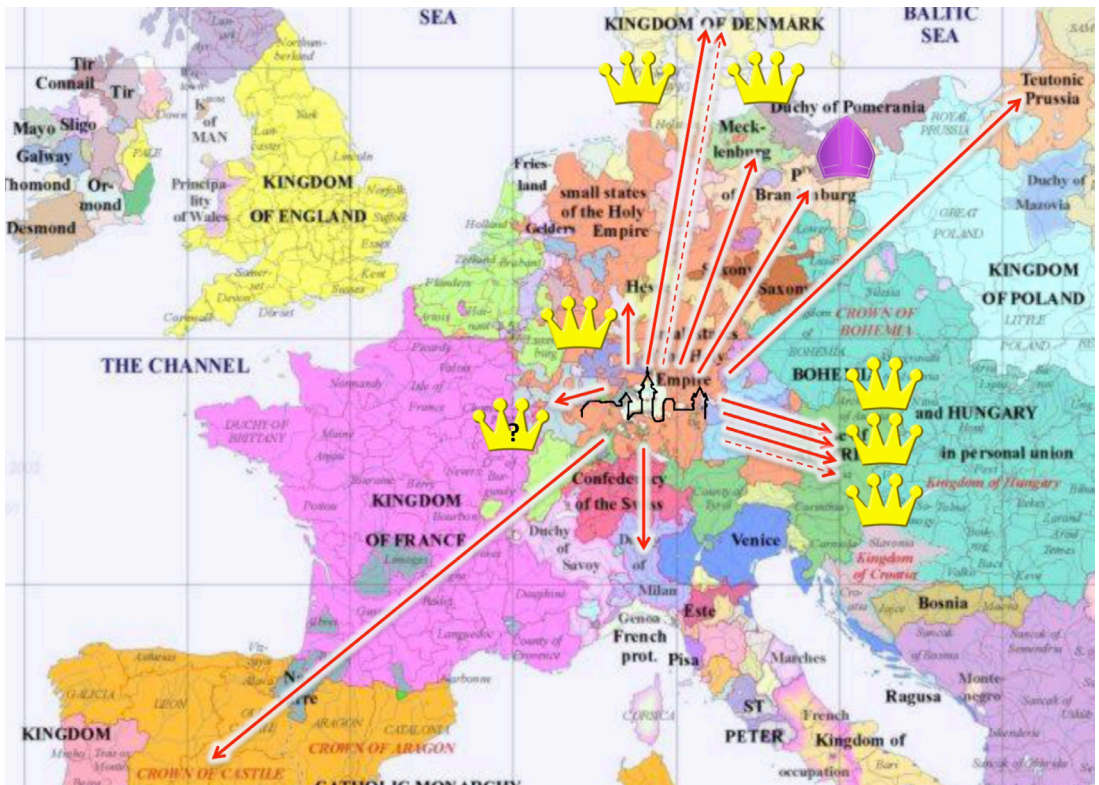


Fig. 19. Map showing export of clocks and clockmaker knowledge from Nuremberg in the first three quarters of the sixteenth century. Dotted lines give slightly later related occurrences. Crowns indicate aristocratic clients, mitres ecclesiastic clients. Prague and Vienna have both been centres of residence for emperors of the Holy Empire during those years – Vienna has been chosen as destination of the arrows here. Details for the arrows are given in footnote 67.

breeding grounds to create a clockmaking industry that focussed on fairly simple clocks aimed at a mass market,⁶⁸ rather than refined and complicated unique pieces for use by the court and high-ranking aristocracy. It was a centre of the mining industry with detailed know-how and abundant supply of all metals,⁶⁹ it furthermore developed into a centre of tool production.⁷⁰ Most importantly for clock- and watchmakers, it became the market-leader in

the making of files.⁷¹ And last but not least its location at the crossroads of the core trading routes provided a network of contacts and sales channels.

Acknowledgements

We would like to thank Bernhard Huber for information and valuable discussions on the Nuremberg ‘Männleinlaufen’ automaton clock.

68. D. Matthes, R. Sánchez-Barrios, ‘Dal’Oro all Ferro – Gli Orologi di Peter Henlein’, *La Voce di Hora*, June 2017, and a significantly enlarged version: D. Matthes, R. Sánchez-Barrios, ‘From Gold to Iron – Peter Henlein’s watchmaking’, *Watch & Clock Bulletin* Vol 61/3 No 439 (May/June 2019), 221–228.

69. See for example W. Freiherr von Stromer, ‘Nürnberg als Epizentrum von Erfindungen’.

70. This had for example already been the stated reason for Regiomontanus to move to Nuremberg in 1471; see E. Zinner, *Leben und Wirken des Joh. Müller von Königsberg genannt Regiomontanus*, 2nd ed., Osnabrück, 1968.

71. O. Dieck, *Die Feile und ihre Entstehungsgeschichte* (Berlin, 1925), pp. 23–31: ‘Nürnberg als Ahnenstadt der Feilenhauer’.