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Salomon Coster, the clockmaker of Christiaan Huygens. The production and development of the first pendulum clocks in the period 1657 – September 1658

Ben Hordijk* and Rob Memel**

*Ever since in 1888 the first volume of *Oeuvres Complètes* was published, much has been written about Christiaan Huygens's invention on Christmas Day 25 December 1656 of the application of a pendulum to a clock movement and the further developments of the early pendulum clock. By copying information, taking assumptions for granted as true evidence and through misinterpretation, the story of the pendulum clock threatens to get out of proportion. To put the history and the involvement of the protagonists back into perspective, renewed independent research was needed, based on original documents in the archives and libraries. This article covers the most important developments up to and including Huygens's publication of *Horologium* on 6 September 1658.*

In recent decades, several authors have published articles about the history of the introduction of the pendulum clock. The most important source of these publications is, almost inevitably, the extensive standard work *Oeuvres Complètes de Christiaan Huygens*,¹ for which the editors deserve our respect and gratitude. We recently found that not all documents kept in the archives have been noticed or recorded by the editors. This prompted us to re-study the first period of the pendulum clock on the basis of our own extensive archive research independent from *Oeuvres Complètes*, *Spring-Driven Dutch*

pendulum clocks 1657–1710,² *Catalogue of the Manuscripts of Christiaan Huygens*,³ and all other publications. Original documents were examined in the reading room of the University Library of Leiden,⁴ in combination with the *Codices Hugeniani* in the digital archive of publisher Koninklijke Brill N.V. in Leiden.⁵ New, not previously published, finds were made. Time to entrust our findings to this paper.

The notes of Christiaan Huygens

Shortly before his death in 1695, Huygens donated a significant part of his scientific

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1. *Oeuvres Complètes de Christiaan Huygens publiées par la Société Hollandaise des Sciences* (The Hague: Martinus Nijhoff, 22 vols, 1888–1950); hereafter: OC.

2. Dr R. Plomp, *Spring-Driven Dutch pendulum clocks 1657–1710* (Schiedam: Interbook International, 1979).

3. Joella G. Yoder, *Catalogue of the Manuscripts of Christiaan Huygens Including a Concordance With His Oeuvres Complètes*. History of Science and Medicine Library, Volume 35 (Leiden-Boston: Brill, 2013).

4. Leiden University Library, Special Collections, Personal Archive of Christiaan Huygens (*Codices Hugeniani*); hereafter: *Codices Hugeniani*.

5. *Codices Hugeniani Online*, Brill (2016; ISSN: 2468-0303).

treatises to the University Library in Leiden. After 1800 this legacy was further enriched with family-owned manuscripts and letters. The personal archive of Christiaan Huygens has been brought together in the Leiden University Library in the so-called *Codices Hugeniani* and is digitally available. These *Codices Hugeniani* are collected in fifty-two volumes and contain notes and folders with loose texts in the fields of astronomy, mechanics, mathematics and music, as well as annotated books and sent / received correspondence. At the top of the pages of the original letters of Huygens the editors of *Oeuvres Complètes* added in pencil their own method of numbering the letters, which matches the letter numbers in *Oeuvres Complètes* as contained therein. For clarification and traceability we added the OC numbering in the footnotes as well.

In order to gain a better understanding of the following, it is important to know that before Huygens sent a letter to one of his contacts, he first wrote a draft or working copy. The primary purpose of this working copy was to organize his thoughts and make improvements when necessary. Once this was to his liking, Huygens wrote the letter in a final version to send it out. He kept the working copy for himself so that he could reread it later. The working copies of Huygens's outgoing correspondence are thus located in Leiden, while the same letter in the final version may be kept elsewhere, for instance in Paris.

The original documents of the University Library in Leiden show that Huygens consistently and frequently used his working copies of letters as scrap paper for notes, sketches and points of interest. Especially the back, but also the margin of the copy was used (Fig. 1). These notes are not always included in *Oeuvres Complètes* and can provide new presumptive evidence to the history of the development of the pendulum clock.

December 1656 – June 1657

Huygens's correspondence and notes

On Christmas Day 1656, Huygens invented the simple and ingenious way of applying a pendulum to the escapement of a clock movement. This date can be determined accurately because Huygens wrote in a letter to the astronomer Boulliau on 26 December 1657:

It was yesterday exactly a year ago that I made the first model of this kind of clockwork. (*Il y eust hier un an justement que je fis le premier modèle de cette sorte d'horloges.*)⁶

Almost one year earlier, on 12 January 1657, Huygens first mentioned in the last paragraph of his letter to his mentor Frans van Schooten that he had recently invented a new construction of a clock driven by weight, which runs so regularly that he has high hopes it will make the determination of longitude at sea possible.⁷

In a letter to Claude Mylon, dated 1 February 1657, Huygens writes:

I really like the news you tell me about Mr Bulliaut's⁸ arrival in these countries, because in addition to what I had to show him in the field of optics, I have a great desire to discuss some specific opinions I find in his work about the astronomy, namely, the comparison of days; I will also share with him a new invention which should be of great use in astronomy and which I hope to use successfully in the search for longitudes. You might hear about it soon.⁹

In a letter to Huygens, dated 12 April 1657, Mylon writes that everyone he spoke with about Huygens's invention of the pendulum clock found it very beautiful. Also that it will be even more so if he makes it invariable with

6. Gallica.bnf.fr/Bibliothèque nationale de France, *Correspondance et papiers politiques et astronomiques d'Ismaël Boulliau*, letter 189 Huygens to Ismaël Boulliau 26 December 1657 (OC II, p. 109, no. 443).

7. *Codices Hugeniani*, Hug 45 letter Huygens to Frans van Schooten 12 January 1657 (OC II, p. 5, no. 368).

8. Bulliaut read Ismaël Boulliau.

9. *Codices Hugeniani*, Hug 45 letter Huygens to Mylon 1 February 1657 (OC II, p. 7, no. 370).

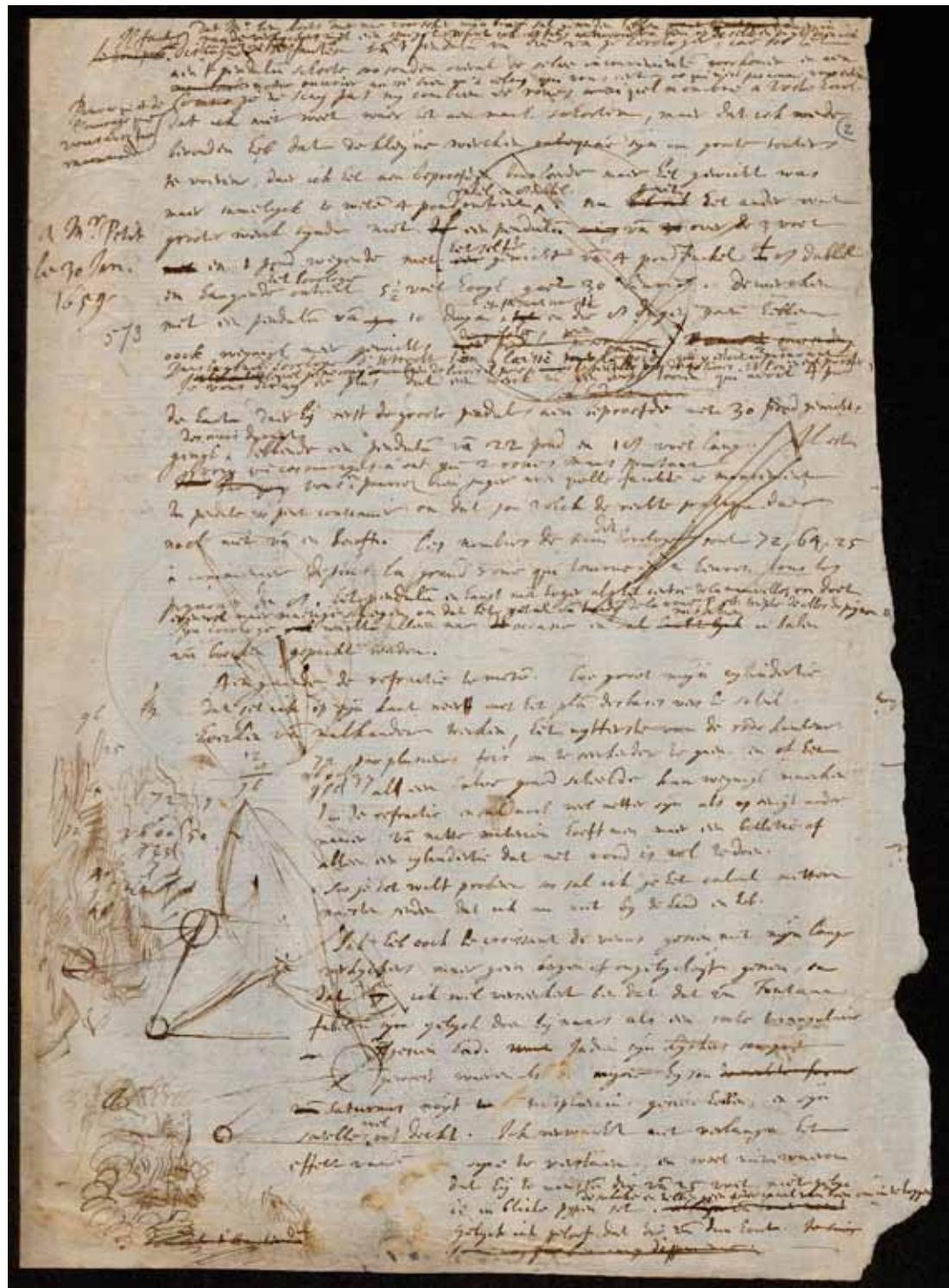


Fig. 1. Example of notes and sketches in a work-copy of a Huygens letter. Leiden University Library, *Codices Hugeniani*. Hug 45 letter from Huygens to Petit 30 January 1659 (OC II, pp. 326–29, letter 573).

weights as much as with a spring.¹⁰

Another, undated,¹¹ letter from Huygens to the manager of the Leiden Observatory Samuel Karl Kechel, also known as Kechelius, is very interesting. Huygens informs Kechel of the following:¹²

The occasion for the invention was provided by the pendulums you have been using for several years. Seeing that, because of the amazing equality of their oscillations, these were ideally suited for measuring time, I started to ask myself whether I could somehow keep their movement continuous and at the same time could take away the inconvenience of counting. I finally came up with the simplest of several ways in which this could be done. I connected the pendulum to the part that regulates the motion through its oscillating movement, called ‘onrust’¹³ in our language. However, I did not place this part horizontally, but upright, and let the pendulum hang from a rigid iron bar. When I had done this and then put the weight on the clock, it turned out, just as I expected, that the force of the clockwork aided the individual oscillations of the pendulum, so that instead of gradually weakening into smaller oscillations and finally turning off, they kept going on in a certain deflection. Due to the fact that the oscillations remain equal, the motion of the movement remains equal as well.¹⁴

It is now established that Huygens’s very first design of his invention is a weight-driven pendulum clock with a vertical balance, contrary to previous assumptions of a spring-driven balance clock.¹⁵

The question is when Huygens owned a working pendulum clock. The answer can be found in a letter from the French mathematician Claude Mylon to Huygens dated 18 May 1657.¹⁶

I am glad that you are perfecting your new clock more and more, and I do not despair that you will make it as good at sea as in your own room, and that the changes of humidity will not alter it more than the change of weights. (*Je suis bien aise que vous perfectionniez de plus en plus vostre nouvelle horloge et ne desespere que vous ne la rendiez aussi bonne sur la mer que dans vostre chambre, et que les changements du sec a l'humide, ne l'alteront pas plus que le changement des poids*).

In addition to the correspondence to and from Huygens, there is also an early note by Huygens to be found in the *Codices Hugeniani*. This note states:

From 31 May till 6 June, this is in 6 days, found 2 min. too slow, which is daily $\frac{1}{3}$ min. Therefore $\frac{1}{6}$ of a turn added. (*Van den 31 Maj. tot den 6 Jun. Dat is in 6 daeghen, bevonden 2' te langhsaem, dat is daeghs $\frac{1}{3}$ min. Daerom $\frac{1}{6}$ van een draeij opgezet*).¹⁷

This means that a working pendulum clock had been constructed at least by 18 May 1657 and that Huygens was fine-tuning the pendulum. Secondly, it is remarkable that the period between the invention of Huygens on 25 December 1656 and a proven working pendulum clock on 18 May 1657 at the latest was very short. This does not surprise us,

10. *Codices Hugeniani*, Hug 45 letter Mylon to Huygens 12 April 1657 (OC II, p. 22, no. 382).

11. In the letter Huygens refers to the eclipse of the moon, that is why this letter can be dated June 1657, as there was an eclipse on 25 June 1657 and earlier and later eclipses don’t match the timeline.

12. *Codices Hugeniani*, Hug 45 letter Huygens to Kechelius June 1657 (OC II, p. 35, no. 392).

13. The balance – literally ‘unrest’.

14. The letter was written in Latin. Our quote follows the Dutch translation in R. Vermij, *Huygens, de mathematisering van de werkelijkheid* (Diemen: Veen Magazines, 2004), pp. 53 and 56.

15. Plomp, *Spring-driven Dutch Pendulum Clocks*, p. 13.

16. *Codices Hugeniani*, Hug 45 letter Mylon to Huygens 18 May 1657 (OC II, p. 29, no. 388)

17. *Codices Hugeniani*, Hug 05 folio 26^{rv} (OC XVII, p. 19).

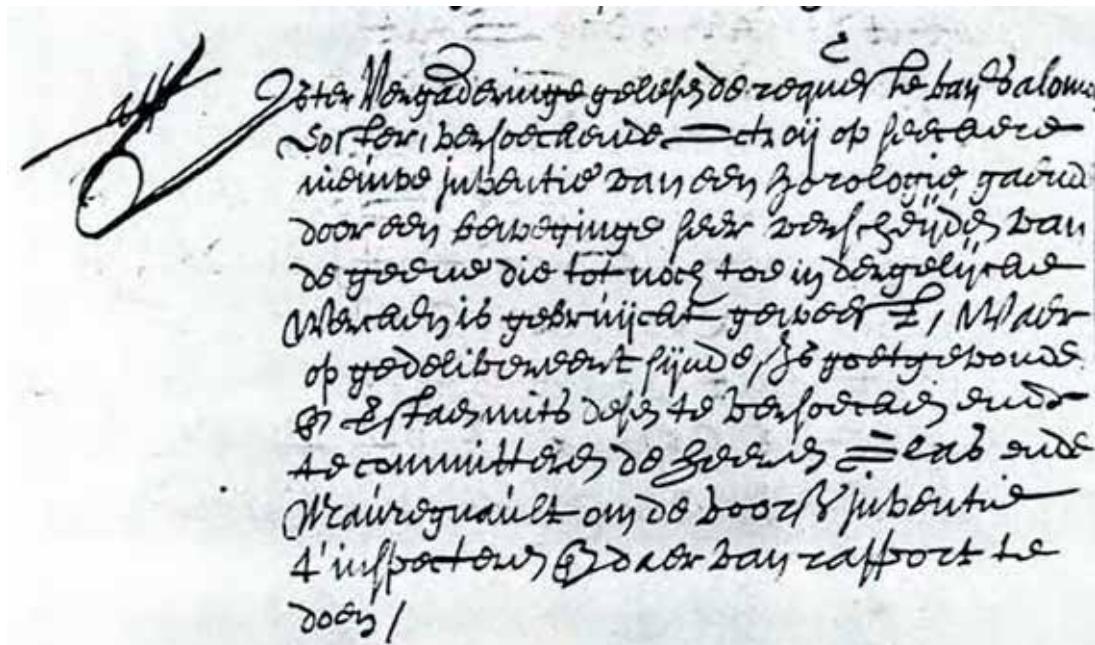


Fig. 2. Instruction to inspect the clock supplied by Salomon Coster for the patent procedure. National Archives The Hague, resolutien Staten Generaal 14 June 1657. [...] te versoecken ende te committeren de heeren Glas ende Mauregnault om de voors. inventie t'inspecteren ende daer van rapport te doen'.

because it must have been relatively easy for a clockmaker to turn Huygens's invention into a working model. If a clockmaker was able to make watches or complicated horizontal table clocks with striking mechanism in the pendulum period, the Huygens pendulum clock with only three wheels (excluding the OP-construction and motion work) is very easy to build. Although Huygens ground his lenses himself, no indication has been found in his extensive oeuvre that he was also capable of making a clock himself. During the above-mentioned period, Huygens lived in The Hague and also stayed there. To construct his clock, it is likely that he collaborated with a local clockmaker with whom he communicated regularly to discuss the progress. In the period 25 December 1656 until the patent was filed, between 1 and 15 May 1657 (see below), there is no indication in Huygens's correspondence or in his workbooks which clockmaker it might be.

The patent

In the first half of 1657, master-clockmaker Salomon Coster applied for a patent at the States-General in which Coster stood proxy for the inventor Huygens.¹⁸ In the seventeenth century it often happened that a patent was granted to someone standing proxy for the inventor.¹⁹ For example, a patent was granted to Jan Andriesz Moerbeeck for printing textiles with figures, while the actual inventors were Aert Duyffkens and Herman Beex. Another patent was granted for a ribbon mill to Gabriel Hanedous, Pieter Bodje and Jan Veecken, while Willem Dircksz Sonneveldt was the inventor.²⁰

With the assistance of employees of the National Archives in The Hague, we have extensively researched the period between 1 January 1657 and 1 July 1657 in the letters and patent applications in the archives of the States-General and the States of Holland. Unfortunately, this search did not lead to any

18. Rob Memel and Victor Kersing, 'Salomon Coster' parts 1, 2 and 3, *Tijdschrift* 4/2014, 1/2015, 2/2018 and www.robmemel.nl.

19. G. Doorman, *Octrooien voor Uitvindingen in de Nederlanden uit de 16e–18e eeuw* (The Hague: Martinus Nijhoff, 1940), Chapter: Persoon van den Aanvrager, Overdracht, p. 21.

20. Doorman, *Octrooien*, Chapter: Serie der Staten-Generaal, pp. 116–118.

results. In consultation with the National Archives, it can be finally established that Coster's patent application is unfortunately no longer there. However, we have been able to determine that, in view of other patent applications from the same period, it took a period of four to six weeks from receipt of an application to processing and ultimately granting. Therefore we can conclude that Coster must have filed the patent application between 1 and 15 May 1657. In addition, it has been confirmed that it was common practice that appendices to a patent application (e.g. an illustration) would be returned to the applicant after processing. Appendices were attached to the official patent document of the patentee for legal reasons in case the patentee had to rely on his patent before a judge. In this way the content of the invention could be clarified.²¹

From the minutes of the meeting of the States-General of 14 June 1657 it appears that Coster's request was read in this meeting. It was decided to instruct the deputies Messrs. Glas and Mauregnault to 'inspect the invention and submit the report'.²² (Fig. 2)

Obviously, they had to inspect a working Salomon Coster pendulum clock, given the simple fact that Coster was the applicant for the patent and thus provided the working invention. As shown in the minutes of the meeting of the States-General of 16 June 1657 the report of Messrs. Glas and Mauregnault was heard, after which the application was approved. The patent (*privilege* or sole right) was granted to Coster and he received the privilege for 21 years.²³

To practice the patent in the Provinces, Coster had to apply for an attachment. On 16 July 1657 the States of Holland and West-Friesland granted this attachment for twenty years. From that moment Coster was the only

one allowed to make and sell pendulum clocks. Coster's patent was strictly demarcated and even pendulum clocks made outside Holland were not allowed to be sold or traded. The delivery of pendulum clocks therefore always had to take place under the auspices of Coster.²⁴

At the request of Christiaan Huygens another attachment to the States-General patent was granted by the Province Gelderland in their meeting of 19 October 1658 to Salomon Coster in collaboration with Jan van Call.²⁵ As a clockmaker, Coster needed a turret-clock maker to forge the necessary large parts for the conversion of turret clocks. Cooperation with turret-clock maker Van Call was obvious, since Huygens writes in his letter to his cousin W. Pieck in October 1658 that he thinks Jan van Call is an honest man and a renowned master.²⁶

[...] horologij mei edita anno 1657

In the *Codices Hugeniani* we found a drawing in ink of the profile of a pendulum clock with all elements labelled with a letter.²⁷ (Fig. 3) The drawing is severely darkened. This drawing has apparently escaped the attention of the editors of *Oeuvres Complètes* and consequently is not included in it. Joella Yoder has seen this drawing and noted that on the top right hand side Huygens had written '[illegible word] horologij mei edita anno 1657'.²⁸ She could not decipher the first word. Despite the fact that Yoder noticed this drawing, the document itself has never been published or used by anyone else. The right hand corner at the bottom has been torn off. An identical drawing, exactly positioned over the recto drawing, created in pencil, is found in verso (now the torn off corner is on the left). The elements on this drawing however are not labelled, unlike on the drawing on

21. Doorman, *Octrooien*, Chapter: Openbaring der Uitvinding; Beschrijving, Tekening, p. 21.

22. National Archives The Hague, archive inventory 1.01.02 SG inv.nr. 3219.

23. National Archives The Hague, archive inventory 1.01.02 SG inv. nr. 3219 (OC II, pp. 236–37 nr. 524).

24. See text patent Salomon Coster: *alsmede dat niemant dese soorte van Horologien, hetzij binnen ofte buyten dese landen gemaect, hier te lande soude moghen vercoopen ofte verhandelen*.

25. Gelders Archive, Arnhem, 0003 Staten van Kwartieren van Nijmegen en hun Gedeputeerden, inv. nr. 634, Landdagsscreessen 1657–1659 (OC XVII, p. 78).

26. *Codices Hugeniani*, Hug 45 letter Huygens to W. Pieck October 1658 (OC II, p. 248 no. 532).

27. *Codices Hugeniani*, Hug 32 folio 188^{rv}.

28. Yoder, *Catalogue of the Manuscripts of Christiaan Huygens*, Hug 32 page 145 folio 188.



Fig. 3. The recto side of *Codices Hugeniani*, Hug 32 folio 188, in Leiden University Library, showing a drawing in ink of the profile of a pendulum clock with all elements labelled with a letter, and top right the inscription [...] horologij mei edita anno 1657.

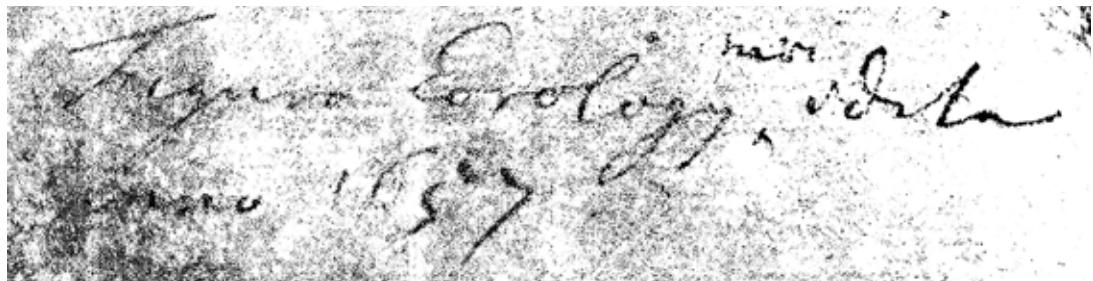


Fig. 4. Examination of a high-resolution image of the drawing with specialized professional software revealed the previously illegible word 'Figura'. The complete text is *Figura horologij mei edita anno 1657* ('Figure/drawing of my clock made known in 1657'). Edited by Tom Memel ©.

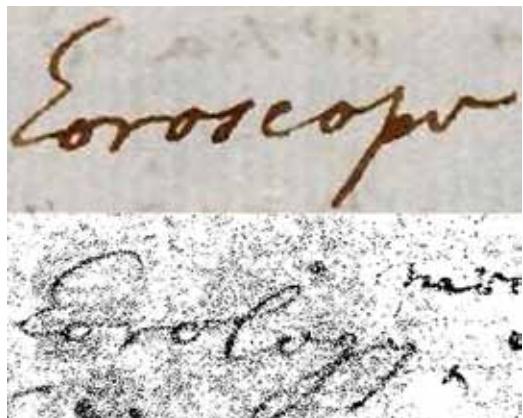


Fig. 5. Comparison of Huygens's handwriting. Edited by Tom Memel ©.

recto. In another handwriting is added *Tabula haec iteri incisa reperitur in Hugenii Horologio*, which means that this drawing has been copied into Huygens's *Horologium*.

Dr Mart van Duijn of Leiden University Libraries²⁹ has examined this document. His conclusions are:

1. The dark side is caused by rubbing with a dark fabric, which may be dirty but looks like pencil smudges. My suspicion is that this was caused after the pen drawing has been applied, possibly because the sheet lay at the bottom of a pile or was very deliberately swept over it. I don't think wiping away an existing drawing created the dark colour.

2. There are no signs of correction, wiping or anything to that effect. It is more like hiding the entire page altogether, by making dark streaks on it.

3. The pen note is complete and does not appear to be part of anything that has been corrected or deleted. The fact that the note is difficult to read is most likely due to what caused the dark smudges. It may have been the intention to conceal not only the pen drawing, but also the inscription.

4. There are no indications that there was a pencil drawing underneath the pen drawing. At least that is not visible. On the other side of the sheet there is a pencil drawing of exactly the same clock and it seems that the pencil drawing has been traced from the pen drawing on the other side, or vice versa (see also Yoder).

Examination of the illegible part of the inscription on top of the pen drawing with UV-light is unfortunately inconclusive.

After learning of Dr Mart van Duijn's findings, we examined a high-resolution image of the drawing with specialized professional software and discovered the 'illegible' word *Figura*. The complete text of the inscription is *Figura horologij mei edita anno 1657* ('Figure/drawing of my clock made known³⁰ in 1657') (Fig. 4).

We also compared the handwriting of the inscription with Huygens's handwriting in

29. Dr Mart van Duijn, Curator Post-Medieval Western Manuscripts and Archives at Leiden University Library. We are grateful to the editor for establishing the contact.

30. We believe that the translation of the word 'edita' as 'published' would make no sense as there is no evidence of a publication prior to September 1658. Therefore we opt for 'made known', which can refer to other ways of disclosure, for example physical, verbal or in correspondence. Crucial for us is that in our opinion this document provides evidence that the clock as illustrated in *Horologium* was already in existence in 1657.

original documents. For instance the letter ‘h’ of the word *horologij* looks like a letter ‘E’. And in a letter to Boulliau of 1 January 1660,³¹ Huygens writes the letter ‘h’ of the word *horoscope* in exactly the same way. We can establish that the handwriting of the inscription is the genuine handwriting of Christiaan Huygens. (Fig. 5) Thus, this is a drawing of Huygens’s pendulum clock with an inscription in his own handwriting and is identical to the illustration that Huygens published in the following year on 6 September 1658 in his *Horologium*. The darkened drawing shows a weight-driven pendulum clock with hour, second and minute indication, a vertical crown wheel, OP-construction,³² no cheeks and a ½ second pendulum without a sliding weight.

June 1657 – December 1657

After obtaining the patent in June 1657, Coster immediately noticed he had to expand the working capacity in his workshop. The further development with the matching demand for the much more accurate pendulum clock was expected to become great. In addition, the regular production as well as the repair of non-pendulum clocks and watches had to be maintained. At least during this period the apprentice Christiaan Reijnaerts and of course John Fromanteel worked for Coster. John Fromanteel is mentioned as a master-servant,³³ but according to the rules of The Worshipful Company of Clockmakers was still apprenticed to his father.³⁴ Fromanteel worked for Coster from September 1657 till May 1658.

Fromanteel was commissioned and supervised by Coster to make *horologien*. The Coster-Fromanteel contract unfortunately does not give any information about what type of timepiece is meant by *horologien*, because further specification is lacking. Nor does the contract explicitly refer to Huygens’s invention which makes timepieces much more accurate. It is therefore uncertain whether John Fromanteel, at Coster’s workshop, worked exclusively on the production of pendulum clocks or assisted in the ongoing production of non-pendulum clocks.

In the summer of 1658, the French master clockmaker Nicolas Hanet arrived in The Hague and worked for some time in Coster’s workshop.³⁵ As Coster’s agent, Hanet left for Paris in September 1658 with two or three pendulum clocks.³⁶

The first delivery of a pendulum clock

The very first evidence of a delivery of a pendulum clock can be found in the Archives of Florence. Twenty years after the death of Grand Duke Ferdinand II de’ Medici, an inventory of the Grand Duke’s assets was drawn up because of the appointment of a new *Guardaroba*, a new officer in charge of the *Guardaroba* office. This inventory of the objects in the private collection of the Grand Duke, dated 12 July 1690, is kept in the Archives of Florence.³⁷

Described is a clock with a small pendulum in an ebony case with a profiled door with glass, on a velvet-covered dial, a silver hour circle and a silver nameplate signed Salomon Croster [sic], present in the salon. This clock was sent on 25 September 1657 by Signor

31. *Codices Hugeniani*, Hug45 letter Huygens to Boulliau 1 January 1660 (OC III, pp. 3–4, no. 704).

32. A construction to minimize the amplitude of the pendulum by adding a pinion and a wheel, in the Figura drawing marked O and P. Huygens also experimented with non-cycloid arcs in the early phase. Both the OP construction and the non-cycloid arcs no longer exist with the invention of the cycloid shape at the end of 1659.

33. In the Coster-Fromanteel contract, Salomon Coster is mentioned as master-clockmaker (*Mr. Orilogie maecker*) and John Fromanteel as master-servant (*meester-knecht*). The contract (Municipal Archives The Hague – Oud Notarieel toegangsnummer 0372-01, inv. nr. 322, folio 409) is reproduced and transcribed in Frits van Kersen, ‘The Coster-Fromanteel contract re-examined’, *Antiquarian Horology* March 2005, 561–67.

34. The Worshipful Company of Clockmakers, Minutes of 1652.

35. Ben Hordijk, *The Life and Work of Nicolas Hanet* (EZ Book, 2018).

36. *Codices Hugeniani*, Hug 45, letters Petit to Huygens 29 November 1658/27 December 1658 (OC II, p. 281 no. 550 and p. 294 no. 558).

37. Dr Sabina Magrini, La Dirigente Archivio di Stato di Firenze, transcription preface *Guardaroba Medicea*.

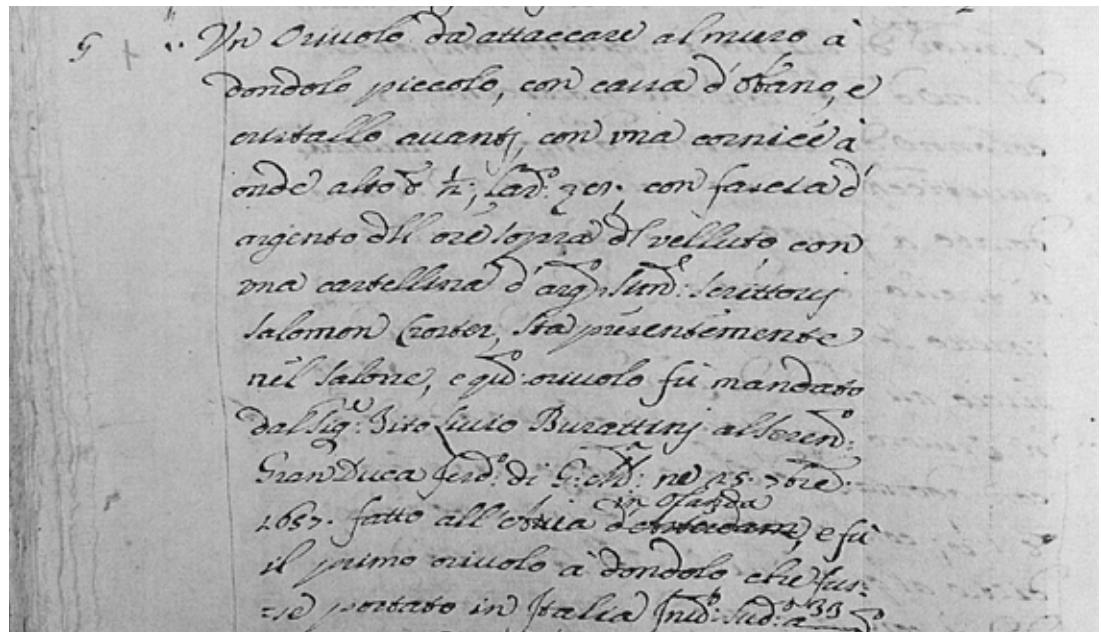


Fig. 6. Detail from *Guardaroba Medicea*, number 959, folio c.29v, in the State Archive of Florence. It describes the Coster clock in the inventory list of the assets of Grand Duke Ferdinand II de' Medici, drawn up in 1690. 'Un oriuolo da attaccare al muro a dondolo piccolo, con cassa d'ebano e cristallo avanti, con una cornice a onde, alto braccia 1/2, largo soldi 8, con fascia d'argento delle ore sopra del velluto, con una cartellina d'argento, similmente scrittovi Salomon Croster, sta presentemente nel salone, e questo oriuolo fu mandato dal sig.re Tito Livio Burattini al Serenissimo Gran Duca Ferdinando di gloriosa memoria ne' 25 settembre 1657, fatto all' Aia in Olanda, e fu il primo oriuolo a dondolo che fusse portato in Italia'.³⁸

Titio Livio Burattini to the Grand Duke Ferdinand of glorious memory, was made in The Hague in Holland, and was the first pendulum clock brought to Italy (Fig. 6).³⁸ Given the production and shipping time, Salomon Coster will have started working on this clock in July or August 1657, shortly after obtaining the patent. Unfortunately this clock has disappeared.

The description of the pendulum clock includes its dimensions: $\frac{1}{2}$ braccia high and 8 soldi wide. In the seventeenth century, sizes were indicated in Italy by, among others, *braccia* and *soldo* (plural *soldi*).³⁹ The dimensions of these units differed per region and even per city. For Florence, one *braccia* was equal to twenty *soldi*. On 2 July 1782, an

amendment to the law increased the length of a *soldo* in Florence by 17/16 (6.25%) to 29.18 mm. However, before that, one *soldo* was equal to 27.409 mm and therefore one *braccia* was equal to 20 times 27.409 mm is 548.18 mm. The dimensions of the case are $\frac{1}{2}$ *braccia alto* (high) and eight *soldi largo* (wide), so 27.46 cm high and 21.9 cm wide.⁴⁰ The ebony case corresponds with the cases of the well-known Coster clocks. The case has a profiled door, like Coster clocks with alarm and striking mechanism.

The description states that the movement had a small pendulum (*dondolo piccolo*). The pendulum of a $\frac{1}{2}$ second pendulum clock has a length of approximately 24.5 cm. Although we cannot determine this with certainty,

38. Daniella Dani, Archivio di Stato di Firenze, transcription *Guardaroba Medicea*, number 959, folio c.29v.

39. Grant O'Brien, <http://www.claviantica.com/index.html> > Historical Italian Metrology.

40. J. Drummond Robertson, *The Evolution of Clockwork* (EP Publishing, 1975), p. 101, mistakenly assumes the larger unit of measure after the law change in 1782 so that the height of the box is 23 inches (58.4 cm) high and the width 9 $\frac{1}{2}$ inches (23.2 cm). In addition, he assumes that the height is the equivalent of 1 *braccia* instead of the $\frac{1}{2}$ *braccia* as stated in the description.

given the height of 27.46 cm of the case, a short ½ second pendulum could well fit in this small case.

Coster's advertisement in the *Tijdinghe*

A very important new discovery is a newspaper advertisement that can be seen as the earliest record of dating the production and availability of the pendulum clock for the general public. It can therefore be compared with the well-known advertisement in the *Mercurius Politicus* of October 1658 in which Ahasuerus Fromanteel announces for the first time that he can deliver pendulum clocks.⁴¹ However, ten months earlier, in a hitherto unknown newspaper advertisement, Salomon Coster announced that he could make and supply various types of pendulum clocks. (Fig. 7)

The advertisement appeared in the *Tijdinghe uyt versheyden Quartieren*, published in Amsterdam.⁴² Its publisher Broer Jansz (1579–1652) was one of the pioneers of the printed press in Holland. The first *Tijdinghe* appeared in 1619. The weekly edition in question, published by the widow of Broer Jansz, is number 51 and is dated 22 December 1657. As usual in the *Tijdinghe*, the various messages are printed in chronological order with the oldest news at the top left of page 1. Then, sorted by date, the more recent messages.⁴³ The last dated message of number 51 is from 20 December 1657. Then, beneath a horizontal line, undated messages are printed, for instance the latest news or an advertisement. The message shows a surprising amount of detail:

In The Hague, at Salomon Coster's, are being made and will become available shortly, with a patent for 20 years, certain kinds of clocks, with springs as well as with weight, according to the invention of Mr Christiaan Huygens, which measure time with much more precision and accuracy than until now could be achieved by any work, because they will be altered neither

by changes of weather or wind, nor by any small imperfection in the spring or the wheels; also is this invention such that it can easily be added to some special works already made, in order to make them correct, no matter how badly they may have run before, and especially very useful for turret clocks, where it can be added without much trouble depending on the configuration of the movements: which has already been put to the test. To be well understood that this all is relevant to hanging and standing clocks, this invention is not applicable to pocket watches.

(*In 's Graven-Hage, by Salomon Coster, worden gemaect en sullen eerstdaeghs uytgegeven worden, met Octroy voor 20 jaren, seeckere soorte van Hoorloges soo met Veeren als met gherewicht, van de inventie van d' Heer Christiaen Huygens, welck veel precyser en seeckerder den tijt zijn af-metende als tot noch toe door eenige Wercken heeft kunnen geschieden, aengesien sy door veranderinge van weer ofte wint, noch door eenige kleyne foute in de Veer oft Raderen, eenige merckelijcke alteratie subject zijn: Is oock deze inventie sulcks, dat bequamelijck aen eenighe Curieuze Wercken, die alreede gemaect zijn, kan by-gevoeght worden, om deseelve daer door Correct te maken, hoe qualijck die te voren oock soude mogen gegaen hebben, en insonderheyt seer nut tot Thoorn-Werck, also met kleyne moeite naer de gelegenthelyt vande Wercken kan by-gevoeght worden: waer van alreets een proeve genomen is. Wel-verstaende dat dit alles van hangend en staende Wercken geseyt wort, also deze inventie aen sack-werck niet dienstigh is.*)

The advertisement shows that the first pendulum clocks for the general public were widely marketed by Salomon Coster by the end of 1657; it is the earliest evidence of that

41. *Mercurius Politicus* issue nr. 439 London period 21–28 October 1658. The advert is reproduced and transcribed in David Penney, 'The earliest pendulum clocks: a re-evaluation', *Antiquarian Horology* September 2009, 614–20.

42. *Tijdinghe uyt versheyden quartieren*, no. 51, 22 December 1657, copy in the Royal Library in Stockholm.

43. Esther Baakman and Michiel van Groesen, 'Kranten in de Gouden Eeuw', in Huub Wijfjes, Frank Harbers (eds.), *De krant. Een cultuurgeschiedenis* (Amsterdam, 2019), pp. 21–45.

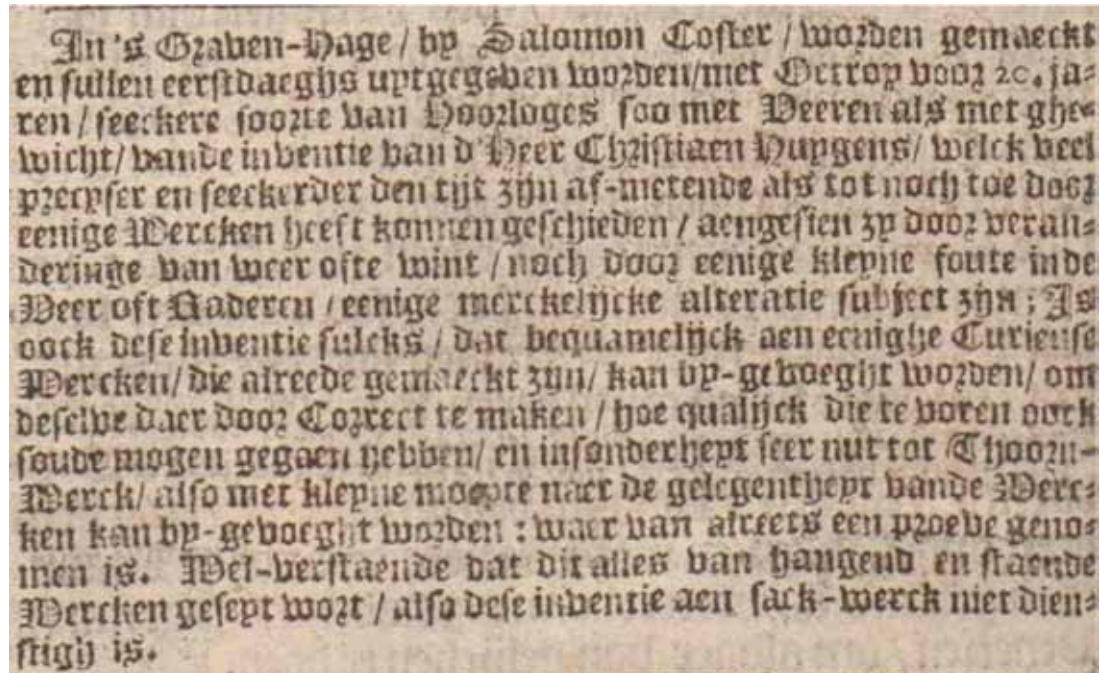


Fig. 7. Salomon Coster's advertisement in the *Tijdinghe* 51, December 1657.

specific moment. This also shows that Salomon Coster was the first to make all types of pendulum clocks, both with spring or weight. As further appears from the advertisement, modifying existing movements with balance or foliot to pendulum was also an option. Interestingly, the conversion of turret clocks to pendulum could also be carried out. It is known that the pendulum tests for the conversion of the movement in the church tower in Scheveningen took place in exactly the same period.

January 1658 – September 1658

Work on turret clocks by Coster

In the period December 1657 / January 1658, Huygens and Coster worked together on the conversion of the movement in the tower of the church in Scheveningen (Fig. 8). They did experiments with a long pendulum. In a note to Huygens of 23 January 1658, Coster writes

Mr Christiaen: The work at Scheveningen is currently in progress, has run last night,

the ball is a weight of 50 pounds, but I am considering to hang a little less and change its spring and chain a little bit. I estimate it has lost a quarter in 14 hours. I intend to go there again tomorrow afternoon. (*Myn Heer Christiaen: Het werck op Scheverlingh is tegenwoordig aen de ganck, heeft deese nacht gegaen, den Bol is een gewicht van 50 pondt, doch dencke wat minder aen tehanghen en sijn veer en kettingh wat d'anders te maken. het heeft naer gissingh een quartier in 14 ure verlooren. ick meine op morgen naerdemiddach daer weer heen te gaan.*)⁴⁴

As a clockmaker for domestic clocks and watches, Coster was unable to forge large parts for turret clocks. For this type of work a turret-clockmaker / blacksmith was sought who could manufacture parts such as the escape wheel and pendulum. In the *Oprechte Haarlemsche Courant* of 11 February 1659 we found the following advertisement (Fig. 9):

44. *Codices Hugani*, Hug 45 letter Coster to Christiaan Huygens 23 January 1658 (OC II, p. 125, no. 452).



Fig. 8. Drawing of the seaside village of Scheveningen near The Hague by Christiaan Huygens, dated 29 July 1658, in *Codices Hugeniani* Hug 14, fol. 6v-7r. Leiden University Library. To the right the church where Huygens and Coster worked together on the conversion to pendulum of the turret clock movement.

Alle Heeren ende liefs-hebbetren wert hickendt ghemaecht / dat
binnen Heist / op Coenraed Harmansz: Brouckman Stadts uur-
werck maeker aldaer, woonende op de Oude Werck, werden ghe-
maecht ende verhocht uuwercken / soo Cooren als Kamerwer-
ken / soo soect in de af deelinghe des tijds / datse in eenige Wee-
ken maer weynagh minnen van den tijdt verschillen / die naer ver-
sueringe van Gewicht / of veranderingh van weer niet lopsteren /
met andere qualiteiten voor deelen gemaect / alles volgens de meestre
Inventien van de heer Christiaen Huyghens / welckers Invenitie
van Brouckman voornoght aldereerst in't werck is ghestelt / op den
Cooren van Scheveningen / nu een haer gheleden / daer naer in
den Haegh op de Nieuwe Werck / ende elvers / midien nu eenighe
Meesters van de Konst / binnen Rotterdam / Zutphen en elders /
noch wat beter hebben ghesinden / ghelyck onlanghs is aenghe-
gheven / die werden op desen vryendelijck versocht om aen te wijzen
de Cooren's haer haer eyghen ghesepde Inventie op de proeve is
ghestelt / soo haer aengheven waer bevonden wort / men sal haer
konst danckelijck komen af-koopen.

Fig. 9. The advertisement of the Delft turret-clock maker / blacksmith Coenraed Harmansz. Brouckman in the *Oprechte Haarlemsche Courant* of 11 February 1659, in which he records having worked on the turret clock in Scheveningen 'a year ago', and later on the turret clock in the New Church in The Hague.



Fig. 10. Parts of the tower clock from the church at Scheveningen, with the escape wheel made by Brouckman of Delft, on display in the Museum Hofwijck in Voorburg.

([...] all according to the new inventions of Mr Christiaen Huygens, which invention for the first time has been applied by Brouckman [...], in the tower of Scheveningen, a year ago now, and after that in The Hague in the New Church [...]. [...] alles volgens de nieuwe Inventien van de Heer Christiaen Huyghens, welckers Inventie by Brouckman [...] aldereerst in 't werck is ghestelt, op den Tooren van Scheveninghen, nu een Jaer

gheleden, daer naer in den Haegh op de Nieuwe Kerck [...].)

From this we learn that Coenraed Harmansz. Brouckman, turret-clockmaker / blacksmith in the nearby city of Delft, forged the iron parts for the Scheveningen clock tower. This means that the escape wheel, which nowadays is on display in the Museum Hofwijck in Voorburg (Fig 10), was made by Brouckman of Delft.

The new movement of the Nieuwe Kerk in The Hague was installed in the tower in May/June 1658.⁴⁵ The original timepiece is still present in the church, which means that it is the oldest surviving turret clock with pendulum.

Less than two months after the aforementioned advertisement in the *Tijdinghe* and within a few weeks after the conversion in Scheveningen, it was discussed in the meeting of the Dom Chapter in Utrecht on 19 February 1658 'that Coster knows some means to make the clock run accurately' (dat Coster eenige middelen weet om het Horologie secker te doen gaan). On 3 May 1658 Salomon Coster was indeed commissioned to convert the turret clock of the Dom Church in Utrecht into a pendulum clock for the sum of 350 guilders. Master blacksmith Bartholomeus Wijnbron, city blacksmith of Utrecht, was commissioned by the Dom Chapter to forge the escape wheel, the pulleys and the hands. The movement was equipped with an OP-construction.⁴⁶ For this assignment Coster resided in Utrecht and the work was carried out under his guidance and responsibility.⁴⁷

Preparations for *Horologium*

In the *Codices Hugeniani* we found notes that can be seen as preparation for *Horologium*, Huygens's first publication (6 September 1658) of his invention of the application of the pendulum on a clockwork. A good example of this is a working copy in folio format of a letter sent by Christiaan Huygens to R.F. de Sluse dated 13 August 1657.⁴⁸ Sebastian Whitestone rediscovered part of this letter for

45. Municipal Archives The Hague, inv. nr. 329, folio 74 and 78^{vo}.

46. *Codices Hugeniani*, Hug 45 letter Huygens to Petit 1 November 1658 (OC II, p. 273, no. 546).

47. Wed. A. Loosjes, *Algemeene konst en letterbode voor het jaar 1821*, first part, pp. 131–32.

48. *Codices Hugeniani*, Hug 45 letter Huygens to R. F. de Sluse 13 August 1657 (OC II, pp. 45–47, no. 399/400).

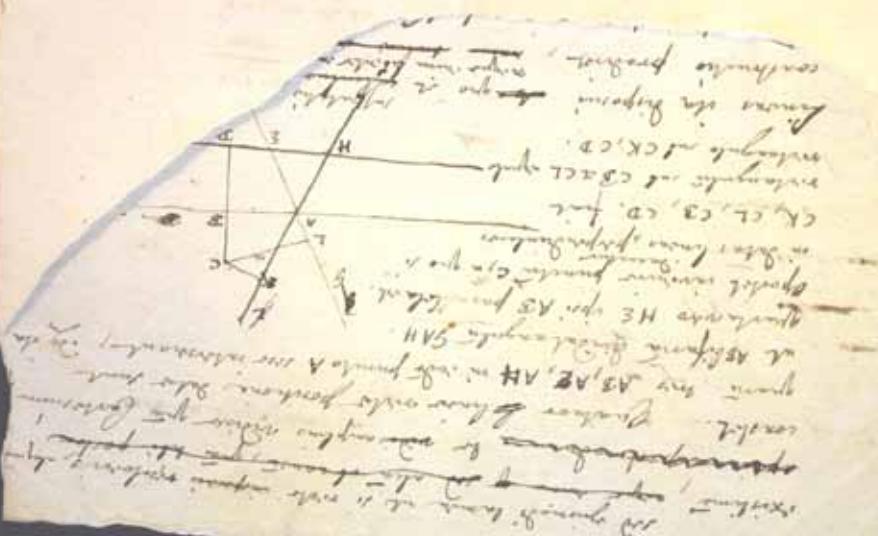


Fig. 11. Draft note no. 400, *Codices Hugeniani*, Hug 45.

his publication ‘Revelation in revision’ and sees it as a pre-*Horologium* release.⁴⁹ However, it is important to study the entire document, as it is only part of a larger one. The entire document consists of a folded sheet, creating a kind of booklet of four pages. The first two pages are the working copy of the outgoing letter to De Sluse. The letter is closed at the end of page 2 with a greeting, Huygens’s name and the date 13 August 1657. Then page 3 is largely torn off and, upside down with respect to pages 1 and 2, is filled with calculations. This has clearly been used as scrap paper. Page 4, the back of the folded booklet, is known as no. 400 in volume II of *Oeuvres Complètes* and is quoted by Sebastian Whitestone. It is no more than a note from Huygens, although it is included in *Oeuvres Complètes* as a separate letter. No. 400 is undated, has no opening or ending and is also upside down with respect to the letter to De Sluse. Pages 3 and 4 were certainly made some time after 13 August 1657. Unfortunately, it cannot be proven when page 4 or note no. 400 were written. It is quite possible that months after writing his working copy to De Sluse, Huygens picked up the letter again and then drafted note no. 400 (Fig. 11).

Although the note is interesting, and a nice rediscovery by Whitestone, the tenor of the text has many similarities with the introduction to *Horologium*. We believe that these are early *Horologium* thoughts by Huygens, which he entrusted to paper sometime at the end of 1657 or perhaps even in the first half of 1658. The American Huygens expert Dr Joella G. Yoder shares this view and confirms it in her catalogue.⁵⁰ In our research we have found no evidence whatsoever that there has been an earlier publication before *Horologium*. No previous edition of a pre-*Horologium* publication is known and Huygens himself has never

referred to it. The correspondence between Huygens and Chapelain also shows that there was no previous publication. In the letter from Huygens to Chapelain of 28 March 1658,⁵¹ in recto Huygens gives a description of his invention for the first time outside the Netherlands with two sketches of a vertical balance wheel to which a pendulum is attached (Fig. 12) and in verso two sketches of the endless cord. To protect his rights, Huygens further writes that it is his wish that his invention will be notified to all his Parisian acquaintances, because his pendulum clocks are already shown and sold in Holland. However, on 18 April 1658,⁵² Huygens withdraws his wish to Chapelain and asks for secrecy. Even in *Horologium*, where he refers to Coster’s patent of 16 June 1657, Huygens shows that *Horologium* is the first publication in which he explains his invention to third parties.

A comparable situation is found on the back of a working copy of the letter sent to Boulliau on 13 June 1658.⁵³ Here Huygens wrote a first draft of page 3 of *Horologium*. The text, including cross-outs, corresponds almost literally to the original *Horologium*. It therefore resembles note no. 400, and, like many notes on Huygens’s outgoing correspondence, is another example of his working method.

Horologium

Horologium appeared on 6 September 1658. It was distributed to many scientists, high-ranking people and relatives. Salomon Coster was also included in the distribution list as the only clockmaker.⁵⁴ *Horologium* contains a phrase that is important for the development from weight-driven to spring-driven clocks. Thus Huygens writes: ‘We have already found such applications on movements with him, whose labour we have used in making these

48. Sebastian Whitestone, ‘Revelation in revision. How alterations to a woodcut block change the history of Huygens’s pendulum clock’, *Antiquarian Horology* June 2020, 197–208; Fig. 6, p. 206.

50. Yoder, *Catalogue of the Manuscripts of Christiaan Huygens*, Inventory of Letters p. 250 no. 400 (see description).

51. *Codices Hugeniani*, Hug 45 letter Huygens to Chapelain 28 March 1658 (OC II, pp. 157–162, no. 477).

52. *Codices Hugeniani*, Hug 45 letter Huygens to Chapelain 18 April 1658 (OC II, p. 169, no. 482).

53. *Codices Hugeniani*, Hug 36 folio 111^r letter Huygens to Bouilliau 13 June 1658 (OC II, p. 184, no. 490).

54. *Codices Hugeniani*, Hug 10 folio 22^v (OC II, p. 209 footnote 2).

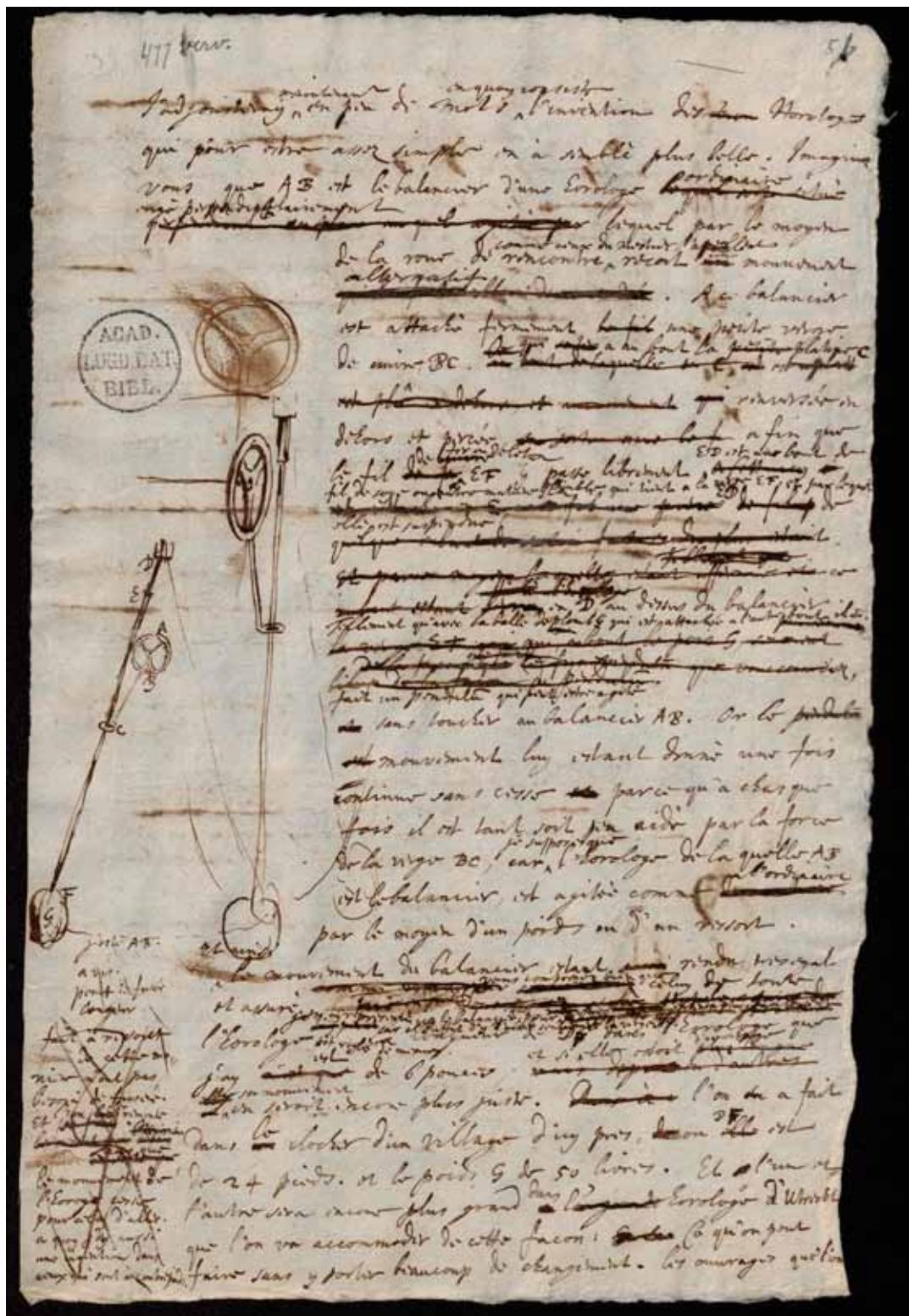


Fig. 12. Letter from Huygens to Chapelain of 28 March 1658, with the two sketches of a vertical balance wheel to which a pendulum is attached. Note the non-cycloid cheeks which are applied to the early balance-pendulum clock. *Codices Hugeniani* Hug 45.

movements, on movements, set in motion not by a weight but by a spring.' The editors of *Oeuvres Complètes* assume that with *him* is meant Salomon Coster. In our opinion this is indeed most likely, in view of the accumulation of evidence in documents from the period 1657/1658 and the absence of direct contemporary evidence of any other clockmaker.

According to the above quote, Huygens saw the spring-driven clock at Coster's workshop and it seems he had only indirectly been involved in this development. This is confirmed by him a few sentences earlier: 'Much that I could add to this I leave to the ingenuity of the makers, who, once they have understood my invention, can easily find out how it can be applied on the different types of movements.' The primary importance for Huygens was that the invention was his creation. Although he continued to work on making his clock more accurate, such as the cycloidal cheeks and later the sea clock and balance spring, the spring-drive was less interesting to him in the early days. In the *Codices Hugeniani* and in Huygens's correspondence in the year 1657 we have been unable, after extensive search, to find any documents or drawings of a winding spring or a spring-driven clockwork. All movements that Huygens describes and draws in this period are without exception weight-driven. Only years later, with Huygens's interest in the development of a sea clock, we find a drawing of a barrel.

The *Horologium* clock

After Huygens has listed the most important milestones in the history of timekeeping in the introduction to *Horologium*,⁵⁵ and criticized several persons who wanted to take advantage of his invention, including competitors from abroad, the invention is announced and a clock is described in detail. It concerns a weight-driven pendulum clock with an endless Huygens cord, a large chapter ring with a long central seconds hand, a central hour hand and a separate smaller chapter ring with minute indication. Huygens mentions in *Horologium* that the pendulum approaches the length of a

5/6 Roman foot (*Pes*). The length of a 5/6 Roman foot is 24.66 cm. Based on the gear ratio stated by Huygens in *Horologium*, the length of the pendulum is 24.5 cm, which is very close to the 24.66 cm of the 5/6 Roman foot. The calculated frequency is 7200, which equates to $\frac{1}{2}$ second pendulum. The off-centre minute hand turns counter-clockwise and the central long seconds hand makes one revolution every five minutes. This dial layout is difficult to read for a private user, but this is not important for an experimental clock. After all, it concerned the invention of the pendulum as a regulator. For Huygens, the long central seconds hand was most effective and very practical to register accurately certain scientific observations. We therefore have simulated the layout of the dial using the instructions from *Horologium*. (Fig. 13).

Many clock lovers know only the side view drawing of the movement in *Horologium*. However we wondered what the dial from the front view of the *Horologium* timepiece would look like. It seems we have found the answer. On the first page of a working copy of a letter sent by Huygens to J. Wallis dated 6 September 1658 – publication date of *Horologium* – an illustration of the layout of a dial is found upside down through the text of the letter.⁵⁶ (Fig. 14). In this case, Huygens first made the drawing of the dial and then used it upside down as a working copy of his letter to Wallis. The drawing is not dated, but must have been made before the date of this letter, as it is unlikely that he would have made a detailed drawing like this over a letter. This drawing of the dial matches almost flawlessly the illustration of the movement in *Horologium* (Fig. 15).

The dial shows a large chapter ring on which the hours are indicated on the inside by means of an hour hand. The seconds are indicated on the outside by a long seconds hand. Inside the chapter ring is a small chapter ring at the bottom at the level of the VI on which the minutes are indicated with a small minute hand. In contrast to the *Horologium* drawing, the minute indication moves clockwise instead

55. Compare the similarities between *Horologium* and note 400. The authors have used the Dutch translation of *Horologium*, published in *Tijdschrift voor Horlogemakers*, Vol 1 Nr.5, 1 March 1903, available online at <https://adcs.home.xs4all.nl/Huygens/17/Horologium-Ned.pdf>

56. *Codices Hugeniani*, Hug 45, letter Huygens to J. Wallis 6 September 1658 (OC II, pp. 211–214, no. 512).

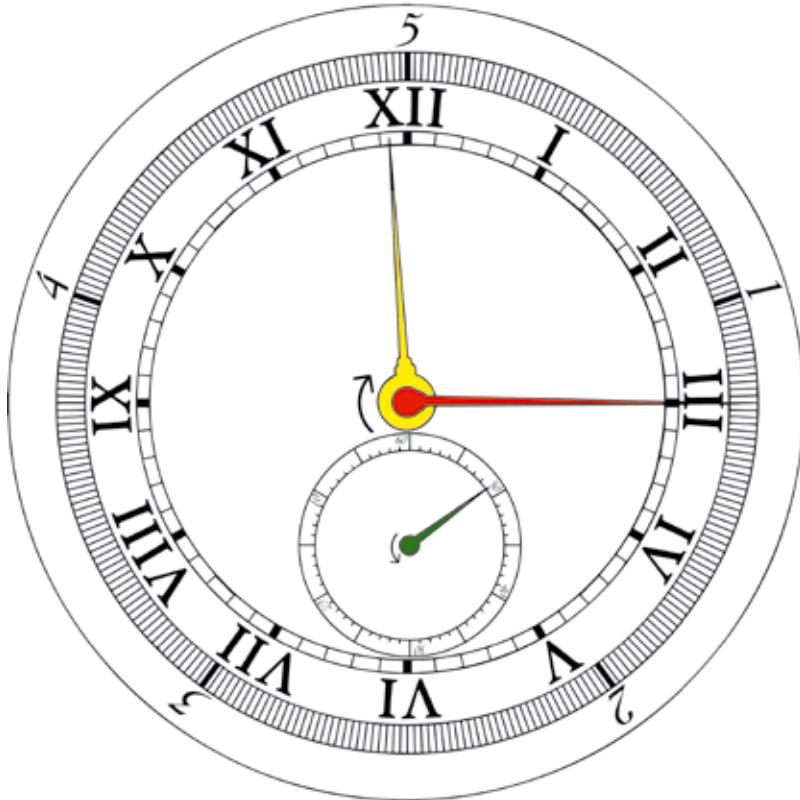


Fig. 13. *Horologium* dial lay-out simulation. Red seconds hand, yellow hour hand, green minute hand. Drawing edited by Tom Memel ©.

of counterclockwise, while the position of the hands is slightly different. The clockwise rotation of the minute hand can technically easily be achieved by adding an extra wheel in the motionwork, which allows the locations of the hands to change fractionally compared to the *Horologium* clock. On the other hand, the pendulum length and the position of the weight correspond in the layout of the dial with the *Horologium* drawing. We calculated the dial sizes on the basis of the assumed pendulum length associated with the half-second pendulum of *Horologium*. This measures approximately 13.5 cm by 18.4 cm and is therefore slightly smaller than the well-known early Hague clocks.

It can be concluded that the layout of this dial is a small improvement / adaptation on the *Horologium* clock published in September 1658, which formed the basis for the further development of the pendulum clock such as the use of cycloid arcs, the disappearance of the OP-construction, the introduction of the

long pendulum, etc., about which more in a future publication.

Summary

- Huygens's very first design of his invention was a weight-driven pendulum clock with a vertically positioned balance.
- From the correspondence between Huygens and Frans van Schooten, Mylon and Huygens, Huygens and Kechelius, Huygens and Boulliau, it appears that in the period up to 31 May 1657, the weight-driven pendulum clock was the only subject of discussion.
- Between 1 and 15 May 1657, Salomon Coster applied for a patent.
- Huygens was in possession of a working pendulum clock on 18 May 1657 at the latest.
- On 14 June 1657, two days before the patent date, the clock designed according to the invention of Huygens, for which Coster applied for a patent, had to be inspected by



Fig. 14. Dial lay-out on letter Huygens to Wallis 6 September 1658, in Codices Hugeniani, Hug 45.

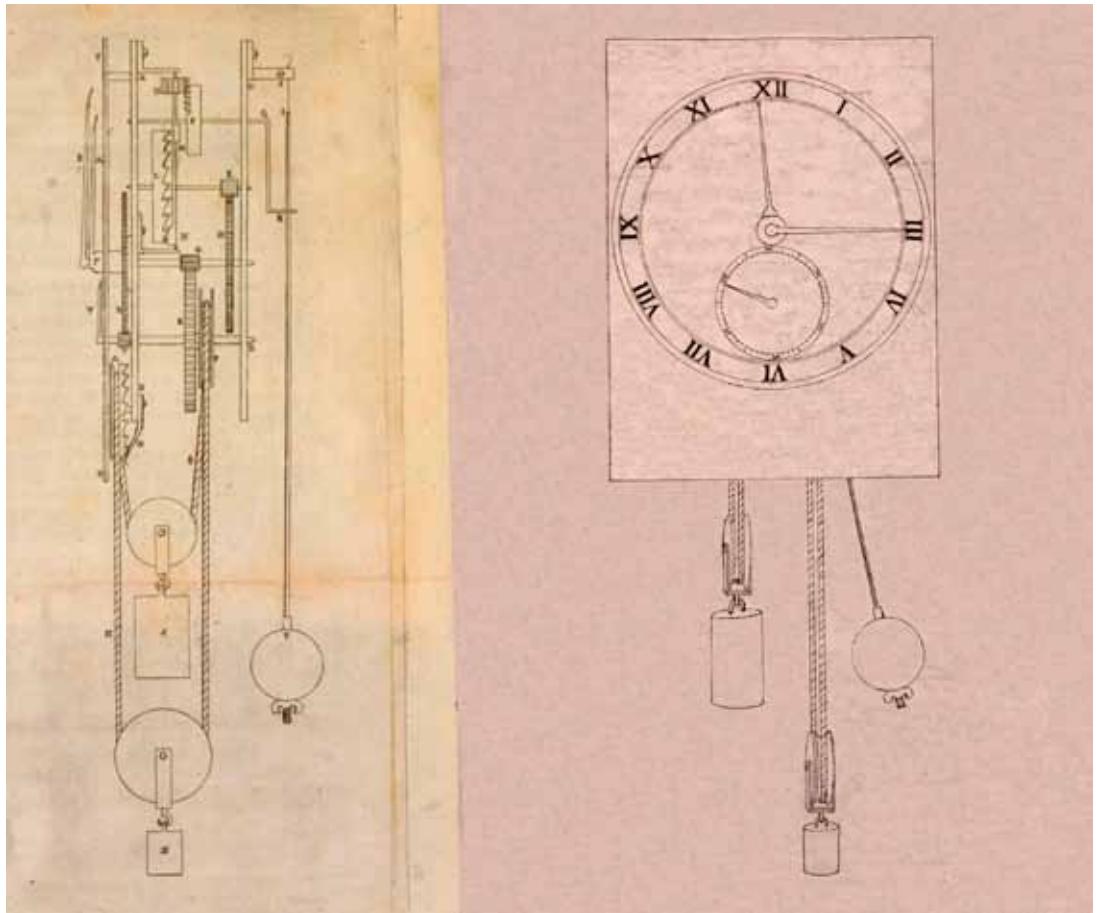


Fig. 15. Comparison *Horologium* movement and dial lay-out on letter Huygens to Wallis. Edited by Tom Memel ©.

deputies Glas and Mauregnault. This is the earliest direct contemporary evidence of a pendulum clock of a clockmaker.

- Two days later, on 16 June 1657, the patent was granted to Salomon Coster; he received the privilege for twenty-one years.
- On 16 July 1657 the States of Holland and West-Friesland granted attachment to Coster and he got the exclusive right to practice the patent in this Province.
- The drawing *Figura horologij mei edita anno 1657* is the earliest known original drawing of a complete timepiece movement marked by Huygens himself. The drawing is identical to the illustration of Huygens's weight-driven *Horologium* clock. This confirms that this clock was the property of Huygens himself and that he already owned it in 1657.
- Taking into account the production process and the shipping time, Salomon Coster

probably started in mid-July / August 1657 (this is prior to the date of the Coster-Fromanteel contract, i.e. 3 September 1657) the construction of the pendulum clock that was sent on 25 September 1657 by Burattini to the Grand Duke Ferdinand II de' Medici in Florence.

- At the end of December 1657, Salomon Coster was ready to deliver various types of pendulum clocks, both weight- and spring-driven, to the general public. This is confirmed in the newspaper *Tijdinghe* of 22 December 1657.
- At the end of 1657 / early 1658, Huygens started writing *Horologium* and the notes of these drafts can also be found on the back of the pages in the workbooks of his outgoing correspondence.
- In the period December 1657 / January 1658 Coster worked on the conversion to

pendulum of the movement in the tower of the church in Scheveningen. Coster kept Huygens informed of the progress.

- On 19 October 1658, at the request of Huygens, the Province of Gelderland granted an attachment to the patent to Coster in collaboration with Jan van Call during the *landdagsreces* of Nijmegen.
- Salomon Coster was the only clockmaker to receive *Horologium*
- *Horologium* shows that Huygens was indirectly involved in the further development of the pendulum clock, such as a spring-driven clockwork, which he left to the clockmaker he used. At that time, Salomon Coster was the only one who had the right to make pendulum clocks.
- In the archives, the National Archives in The Hague and the *Codices Hugeniani* in Leiden University Library, no name of any clockmaker other than Salomon Coster has been found in the period studied.
- In the archives, the National Archives in The Hague and the *Codices Hugeniani* in Leiden University Library, no indication of an earlier *Horologium* publication was found in the period studied.

Conclusion

From the foregoing discussion it can be concluded that Huygens focussed on the weight-driven pendulum clock with a long seconds hand. As can be seen from *Horologium* published in 1658, Huygens was only indirectly involved in the development of the spring-driven pendulum clock. We think this development started a few months after Huygens's first design of his invention and was left by Huygens to Coster.

It is not certain but plausible that the clock of the patent application was a weight-driven clock with a long seconds hand. It could well be the *Figura horologij mei edita anno 1657* clock, although we must emphasize that the patent application has not been found in the National Archives and the patent itself does not mention the type of clock being weight- or spring-driven.

Considering the similarity between the movements of the drawing *Figura horologij*

mei edita anno 1657 and *Horologium*, it is most likely that the logical next step in the further development of Huygens's first design, the application of the pendulum to a weight-driven movement with a vertical balance wheel, led to the weight-driven movement with a vertical escape wheel and verge of the *Figura horologij mei edita anno 1657/Horologium* clock.

Moreover, we conclude that the design of the clock, including the OP-construction and maintaining power endless cord, depicted in the 'Figura' drawing is identical to the drawing of the clock illustrated in Huygens's *Horologium* (6 September 1658). It strongly implies the existence of the *Horologium* clock at least nine months before its publication, and possibly more.

Despite the fact that Coster made at least two clocks in a much earlier phase of 1657, the Coster advertisement in the *Tijdinghe* is the earliest evidence that by late December 1657, in addition to weight-driven, also spring-driven pendulum clocks came onto the market for the general public.

Considering the timing of this announcement it is possible that Coster's Hague clocks for the public market with the signature plate *with privilege 1657* actually may have been made later than 1657 until Coster's death in early December 1659. The text could then indicate the year of the patent rather than the year of production. So this could mean that signature plates *with privilege 1658* are at least doubtful.

We further state that Coster was Huygens's only clockmaker in the period studied from 1657 to September 1658, the *Horologium* moment. Salomon Coster was responsible for all types of timepieces, both weight- and spring-driven and modifications to pendulum of turret clocks. No contemporary evidence has been found to prove otherwise.

Our search in the archives continues in order to gain deeper insight into the development of the first pendulum clocks.

For more information, see also Hans van den Ende, Ben Hordijk, Victor Kersing, Rob Memel, 'The Invention of the Pendulum Clock' on the Horological Foundation website.⁵⁷

57. <http://www.antique-horology.org/> > Articles > Early Pendulum Clocks. A compilation page on the subject of early pendulum clocks.