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Roman Strike – *Grande Sonnerie*

A New Proposal for an Ancient Striking System

Eduard Farré-Olivé

After studying the many ways in which domestic and public clocks strike the hours, I paid particular attention to the discomfort that public belfries and domestic clocks can cause, especially for those who are not used to, or not interested in, receiving this acoustic 'information'. Of the many varieties of striking clock, I am now particularly interested in those that can give the maximum information with the least noise: that is, those which can 'inform' without much disturbance, though we must assume that certain sounds are acceptable to learn the time.

The most widespread clocks strike from 1 to 12 upon the hours and a single blow every half-hour. There is a more complete pattern that also chimes the quarters. However, the system that gives the maximum information is the so-called '*grande sonnerie*' that sounds the quarters from 1 to 3 followed by the last hour at every quarter. At the hours between 1 and 3 there is not much trouble but from there, the number of strokes that must be heard every quarter of an hour can be annoying until 12:45, when it sounds no fewer than 15 of them. In addition, from 9 onwards, it will have been sounding between ten and 15 blows every quarter.

How to Reduce the Bell Strikes of a Grande Sonnerie*: A Prototype with a Three-Hour Cycle*

Trying to obtain the maximum information with the least number of strikes, I was inspired by some Italian clocks and some domestic clocks built by the clockmaker Joseph Knibb.[1] Both use a six-hour strike cycle (two cycles of six hours every 12 hours). I also found the nautical clocks that sound a four-hour cycle (three cycles of four hours every 12 hours). In a first attempt, I opted for this latter model but finally I built a grande sonnerie system of three hours (four cycles of three hours every 12 hours).[2]

I could build this particular kind of *grande sonnerie* by transforming a common Westminster chime clock with four bells (notes E, D, C, G) as follows: on the chime pin barrel, I removed all of the pins corresponding to the Westminster melody and I left only the note E for the first quarter, the C and D notes for the second quarter and the E-D-C notes for the third quarter, **Figure 1**.[3] Notes are, therefore, played in a sequence. At the first quarter, a single note, E, is played. At the second quarter, the C and D are played in an ascending sequence that rises in tone, ending on D. At the third quarter, the sequence descends, ending on C. This helps us to distinguish which quarter has just been sounding. At the full hour, it does not sound any quarter, therefore technically renouncing the full definition of a *grande sonnerie*.[4]

I replaced the common hour snail of 12 steps with another one, cut specifically with four sectors from one to three

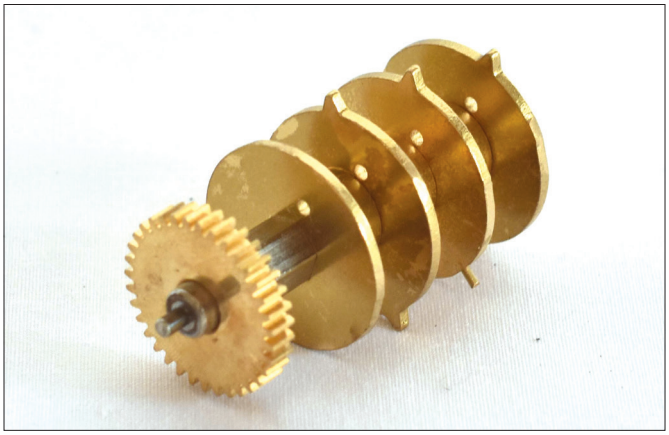


Figure 1. Simplified and modified cam roller.

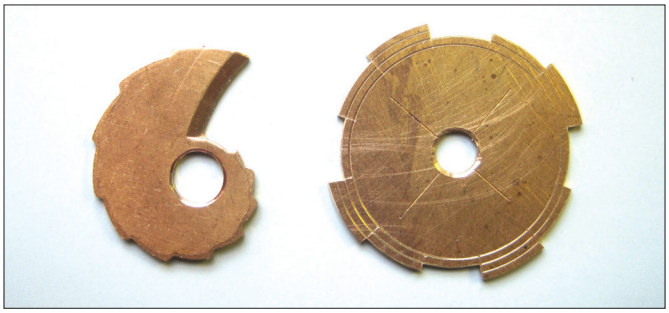


Figure 2. Common hour snail (left) and hour snail of four sectors from 1 to 3 hours (right).

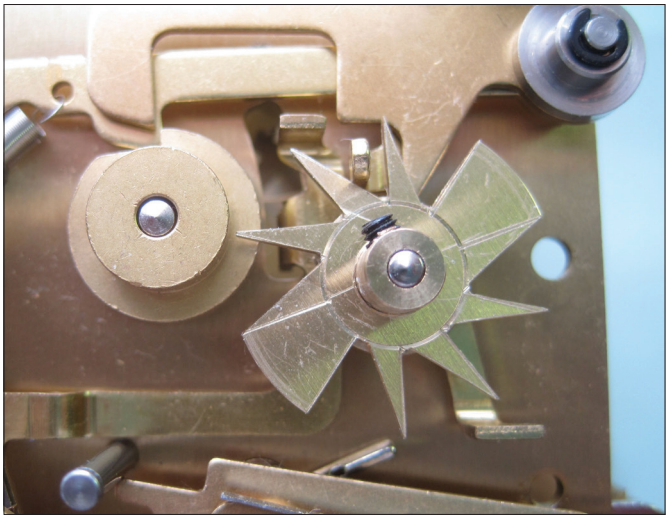


Figure 3. Quarter cam with the eight triggers for the hours.

Summary of Striking System of a Three-hour Cycle (for example, between 1 o'clock and 4 o'clock)		
Time	Note of Quarters	Sound of Hours
1.00	–	E+C+G (Struck once as a chord)
1:15	E	E+C+G
1:30	C, D	E+C+G
1:45	E, D, C	E+C+G
2:00	–	E+C+G, E+C+G
2:15	E	E+C+G, E+C+G
2:30	C, D	E+C+G, E+C+G
2:45	E, D, C	E+C+G, E+C+G
3:00	–	E+C+G, E+C+G, E+C+G
3:15	E	E+C+G, E+C+G, E+C+G
3:30	C, D	E+C+G, E+C+G, E+C+G
3:45	E, D, C	E+C+G, E+C+G, E+C+G
4:00	–	E+C+G
etc.		

Table 1.

hours, **Figure 2**. Since this had considerably reduced the number of melodies for each quarter, I modified the quarter cam with eight sectors that, in addition, must trigger the hour mechanism every quarter, **Figure 3**. This doubles the autonomy of the quarter train, since now it turns over in two hours instead of doing it in one hour as originally made (**see Table 1**).

This system has proved to be so practical that I have been using it for a long time and I still have some clocks running with it at home. It does, however, cause some confusion overnight. During a brief awakening in the dark, it is easy to confuse the strike for 2 with the one for 5, for example, as there are two blows at each of those hours. It is the inherent inconvenience of the three-hour sound cycle.

The Roman Striking

The next step in the research I proposed was to imagine a possible solution in Roman striking. This is where the hours are struck as though they were in Roman numerals, that is, with two different bells: a high-pitched one for the Roman I, and a low-pitched one for the V. X is played as two strokes of the V. This considerably reduces the number of blows struck per day, from 156 to only 60 — a reduction of nearly 60%.

The eminent clockmaker Joseph Knibb (1640–1711) thought about reducing strokes for two main reasons. On the one hand, he wanted to give the maximum information with the least noise, as in my case, but he also wanted to increase the autonomy of the clocks by the reduction of strokes.[5]

The Roman striking system was used not only by Joseph Knibb in a few of his clocks but also, as I have learned, by Thomas Tompion, Thomas Mudge and Daniel Quare.[6–8] Roman striking, obviously, was not accepted by society, as the 12-hour system prevailed to the present day. We have only a little evidence of people who had been interested in it. We can mention Johansen, who presented a didactic model at an unspecified date, and John Piguet, who transformed an ancient Morez clock into Roman striking and explained

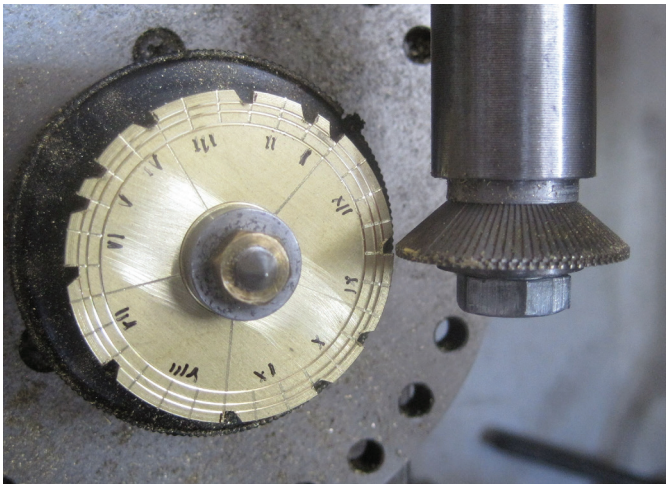


Figure 4. Cutting the hour count wheel.

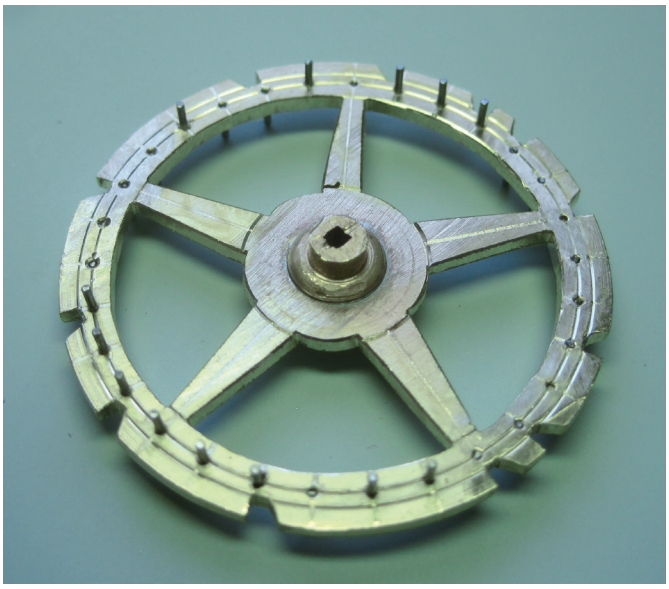


Figure 5. The counter is also the hammer wheel.

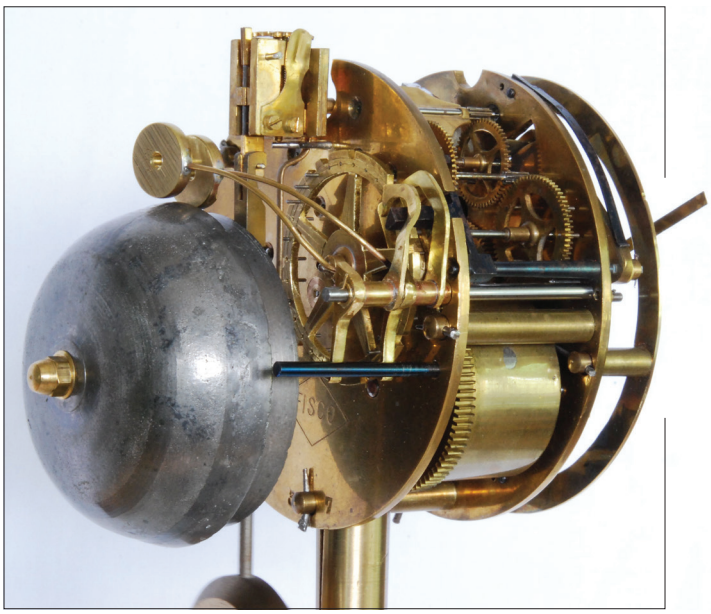


Figure 6. Final appearance of the French clock, transformed with two bells and Roman striking.

how, in the pages of the *HJ*.[9] Some 20 years later, also in the *HJ*, we could find a clock with Roman striking on three bells operated by an electro-mechanical mechanism.[10] There are also modern replicas of Joseph Knibb's clocks with Roman striking.[11]

My First Clock with Roman Striking

My first step in the construction of a Roman striking clock consisted of transforming a conventional French clock. The countwheel, or locking-plate, of a movement of this type is calculated to sound 90 strokes in the 12-hour cycle (78 hours and 12 half hours). For Roman striking I needed only 30 (without the half hour, which I had eliminated), so the transformation was simple. I cut a new countwheel with the segments for Roman striking, **Figure 4** and put the pins in the right places. In this way the countwheel also became a hammer wheel, **Figure 5**. I built a support for two hammers and adjusted the hood support to accommodate two different pitch bells: the high-pitch bell for sounding the Roman Is and the low-pitch one to sound the Vs. Technically speaking, the result did not differ much from the mechanisms of Joseph Knibb, **Figure 6**.

A Roman Striking Grande Sonnerie: First Prototype

With that precedent, I started to transform a common carillon movement into a Roman striking *grande sonnerie*. As for the quarter striking, I repeated the simple striking system already described in the first three-hour cycle clock. For the hours, I foresaw two different chords of two notes for figures I and V, according to the following partial scheme:

Summary of Striking System of a Roman Striking *Grande Sonnerie* (first prototype)

Time	Quarter	**I** chord	**V** chord	**I** chord
4.00	–	E+C	D+G	
4:15	E	E+C	D+G	
4:30	C, D	E+C	D+G	
4:45	E, D, C	E+C	D+G	
5:00	–		D+G	
5:15	E		D+G	
5:30	C, D		D+G	
5:45	E, D, C		D+G	
6:00	–		D+G	E+C
6:15	E		D+G	E+C

Table 2.

Mechanically, the solution was a bit complex. There was no snail for the hours. At every hour, the rack allowed the hammer wheel to rotate the equivalent of six full strikes. On the hour wheel I placed a 'selector' with steps of different heights to position the two hammers of I and V for each hour, **Figure 7**. The hammer wheel turned a full turn every hour and operated the hammers through pins of different lengths, **Figure 8**.

It worked well but the problem was that it consumed too much energy. The hammer wheel needed to make the same full turn, either at I or V, which has to make only a single blow, as at VIII or XII when it strikes four blows. This left the movement with a run time of only two or three days. This was not a good solution.

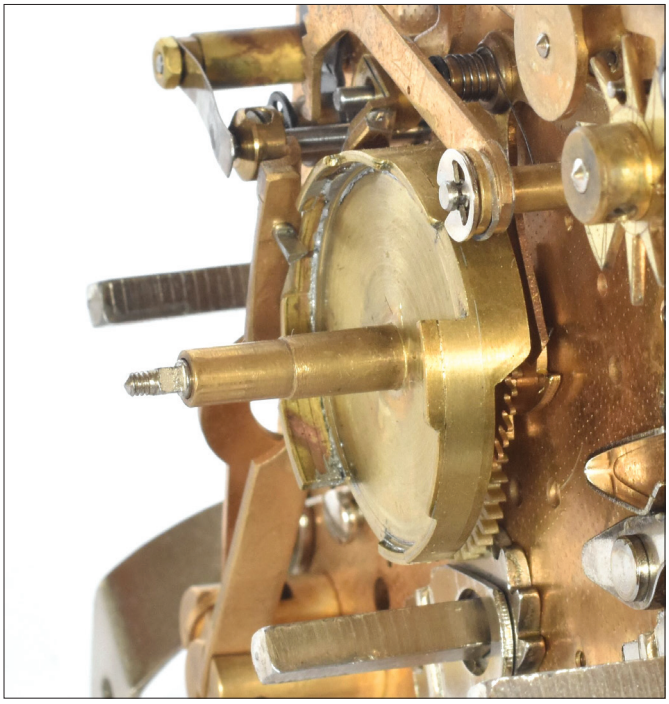


Figure 7. Position selector for hammers I and V.

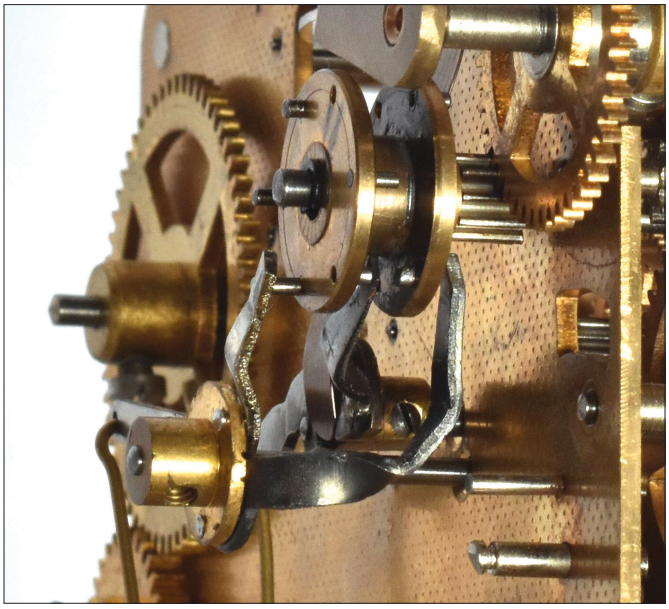


Figure 8. Hammer wheel with pins of different lengths.

Second Prototype

With the experience gained, in a different quarter-chiming movement from scrap, I repeated the simple bell system described above for the quarters. Regarding the hours, this time I made a snail appropriate for the hours of Roman striking, and fitted this to the hour wheel of the clock, **Figures 9 and 10**.

This system selects different hammers for each stroke, the unused hammer being lifted clear of the pin barrel. To select the hammer that was to be played at each stroke, I built a cam placed outside the backplate with two diameters to be read — the larger one for the I and the smaller for the V. This is partially visible in **Figure 11**. This cam is connected to a wheel in the striking train of the clock in such a way that it makes one turn in 12 hours. A lever reads the cam and makes

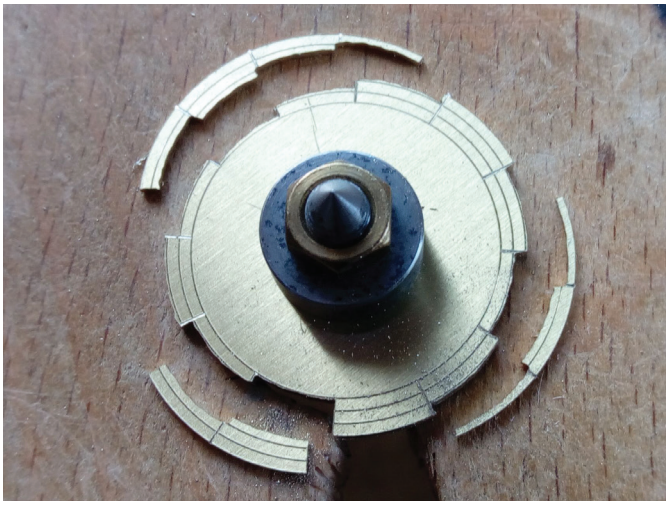


Figure 9. Construction process for the counting snail of hours for Roman striking.

the change of hammers at the right time. This mechanism is similar to that of the clock of Andreas Steib's change of bells described by Friess.[12]

The immediate result now seemed excellent, as long as the clock did not stop due to lack of power. The original striking train was designed to play 156 bells a day (78 × 2), but now plays 240 (30 × 2 × 4), and therefore runs down before the going train. The consequence was that the hour-striking train, with its countwheel, was outdated with respect to the new Roman counting snail mounted on the hour wheel, and re-synchronisation was very difficult to perform.

Third Prototype

All the acquired results pointed in the same direction. The solution had to be found by eliminating countwheel striking (what might be called 'sequential cams') and to control both hammers from an hour rack. There was already the precedent of Mudge in which the famous maker made a clock with Roman striking, with repeating quarters and hours on demand: a feat whose complexity can be appreciated only after very careful reading of the Hudson article.[13] Was it possible to get a similar result with more simplicity? I decided to try it.

The quarter mechanism did not change from what I have already explained. For the hours, I renounced to the two-note chord, to leave only two hammers and two gongs: the high one for 'ones' and the low one for 'fives'. Therefore, in the system of gongs there would be five notes, from treble to bass: **E**, **D**, **C** for the quarters and **G**, **E** (an octave lower) for the hours. This would be operated by five hammers, three driven by the quarter-chiming pin barrel and two actuated alternately by the hour strike-work, **Figure 12**.

The Roman hour snail described previously did not vary either. Successive steps for the number of strokes in the Roman system ran thus: 1, 2, 3, 2, 1, 2, 3, 4, 3, 2, 3, 4, **Figure 14** (left side), read by a rack that counts only up to four, **Figure 13**.

A second snail, **Figure 14** (right side), and a second rack, **Figure 15**, are added to the hour snail and its rack. Both are used to distinguish between the treble strokes of the 'ones' from the 'fives' bass strokes. Without this second rack the clock would strike only one note. This second rack moves a lever to change the hammer position axially to strike the bass note for the 'fives'.

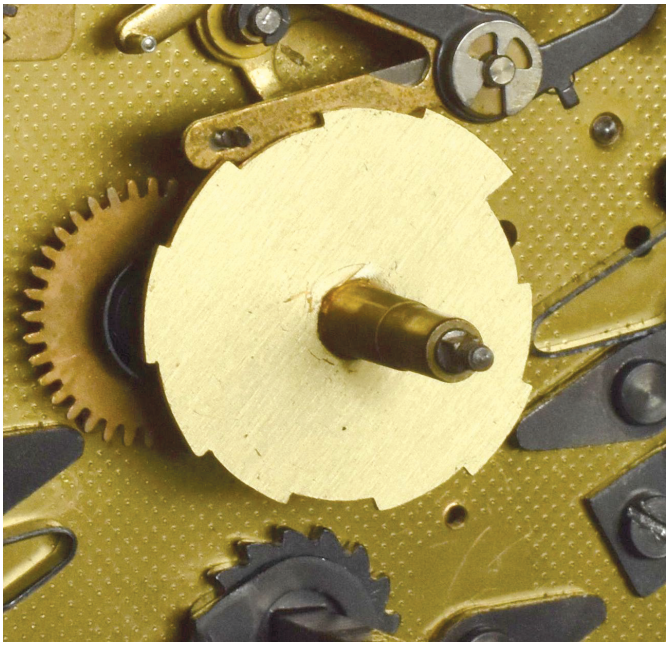


Figure 10. The hour counter snail for Roman striking mounted.

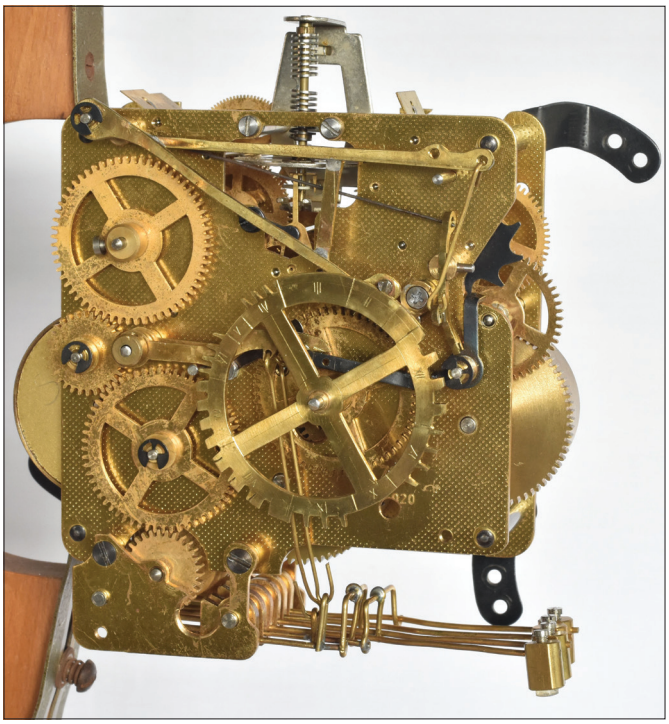


Figure 11. The cam for the hammers selection.

Both racks are read by a reading-lever, **Figure 16**, which operates front-to-back when the clock is viewed face-on. This performs an axial change in position of the hammer-lever that drives the hour hammer. This reading-lever changes the position of the hammer-lever and selects which one of the two hour hammers must be activated for any stroke.

The racks therefore fulfil a dual function: they determine how many blows are to be struck by being raised one tooth at a time by the gathering pallet in the normal way. Also, their variable combined thickness serves to drive the reading-lever front-to-back as the racks rise; this pumps the pin-barrel along its axis, dictating which hammers are selected for sounding.

The IV hour is the most emblematic of this system and

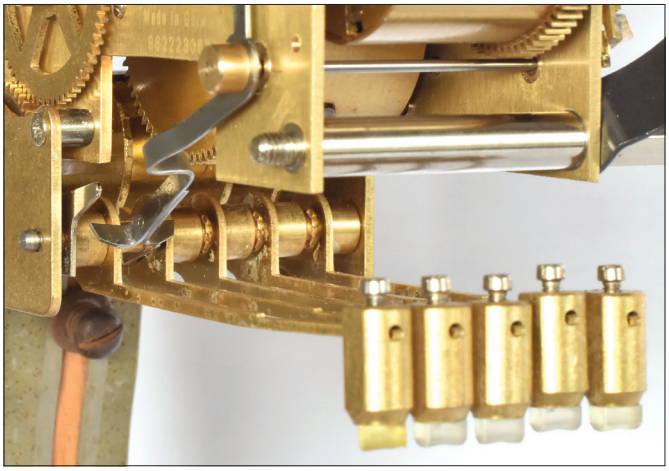


Figure 12. System of five gongs and five hammers.

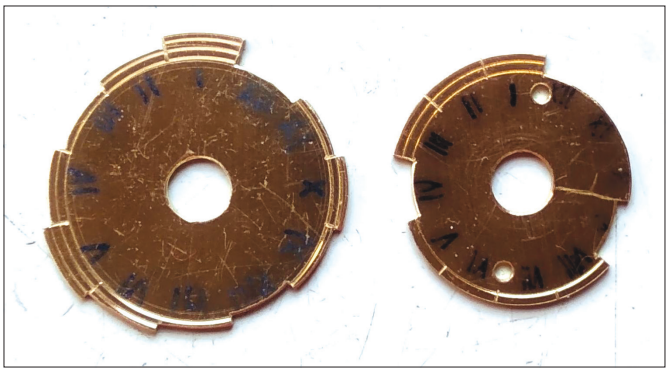


Figure 14. Hour snail (left) and 'five's' hammer positioning snail (right).

Figure 16. Reading-lever.

on the dials of Knibb's clocks it serves to distinguish Roman striking from other striking systems. This is precisely what has forced a modification of the second rack. It is for this IV hour alone that the rack has had to be divided into two parts; these will separate only when striking that hour, **Figure 17**. The three parts of the rack can be seen in **Figure 18**. The separation is made possible by yet a third cam on the hammer selection snail. **Figure 19** shows the three levels of the hour snail.

In order that the multiple rack can fall freely under its own weight during the strike warning, the front-to-back reading-lever must be pushed out of contact with the faces of the racks. This is done by an extension to the lower part of the rack hook, **Figure 20** (oriented to the right in this photo). This acts on a single roller bearing fitted to the rear of the reading-lever, **Figure 21**.

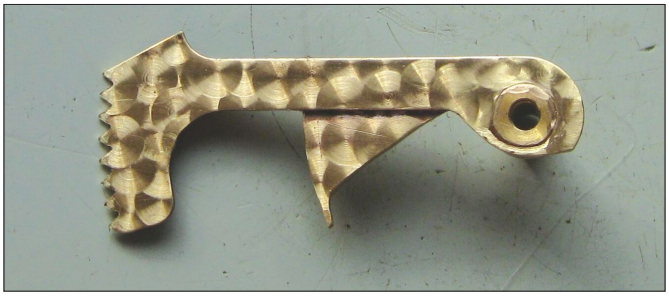


Figure 13. Rack to account the number of strokes.

Figure 15. V Hammer positioning rack.

Figure 17. The hammer positioning rack in the open position for hour IV.

A bearing has also been added to the reading-lever of the quarters, **Figure 22**, to facilitate the action of the added elements not provided in the original movement. This reduces the friction added by the new mechanical elements.

The hour strike now needs to be unlocked at each quarter. Therefore the height of the four lobes on the quarter cam have been extended in diameter (originally only one lobe of this cam would have been tall enough to release the hour strike), **Figure 23**.

In operation, for example striking 9:45, the process is as follows:[14]

1. Warning and release of the quarters (operation without modifications to the base movement).
2. Striking of the three quarters by three successive notes on the descending scale **E**, **D**, **C**.
3. Simultaneously, the quarter lifting lever is raised high enough to prepare the striking of the hours.
4. The warning of the hours involves slightly raising the reading-lever away from the racks, to allow them to fall freely.

Figure 18 The three parts of the rack (from bottom to up rack counting, rack V positioning and rack for the IV hour).

Figure 19 The three levels of the hour snail.

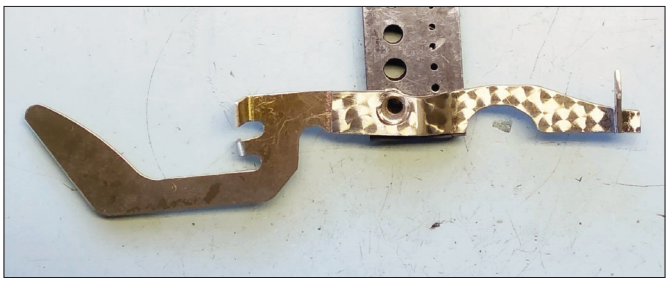


Figure 20 Extension (right side) of the retaining-lever of the racks.

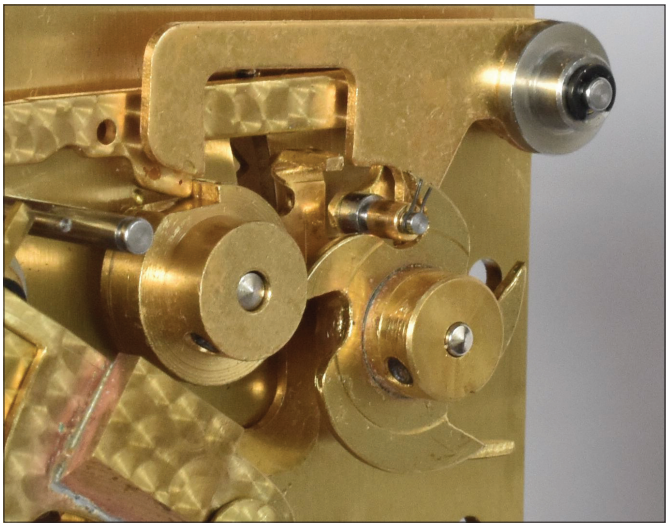


Figure 22 Bearing in the reading lever of the quarters.

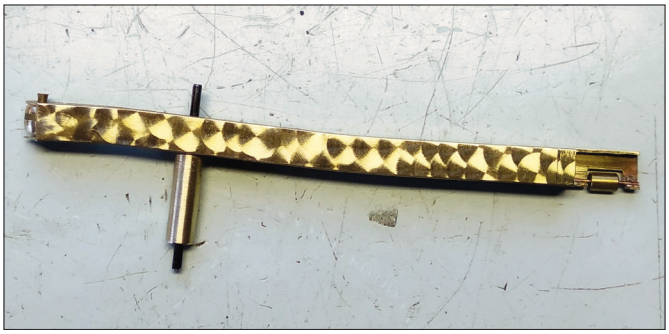


Figure 21 Bearing of the reading-lever (in the far right).

5. The counting rack falls three positions for three strokes I, V, V.
6. The hammer-selection rack also falls three positions.
7. When the quarter lifting lever falls, the racks are already positioned and the hour strike begins.
8. The reading-lever is in a low position: stroke of a **I** on the **G** note.
9. The reading-lever is in a high position: strikes a V twice on note **E** (lower octave).
10. As a result, the clock strikes I + V + V = IX

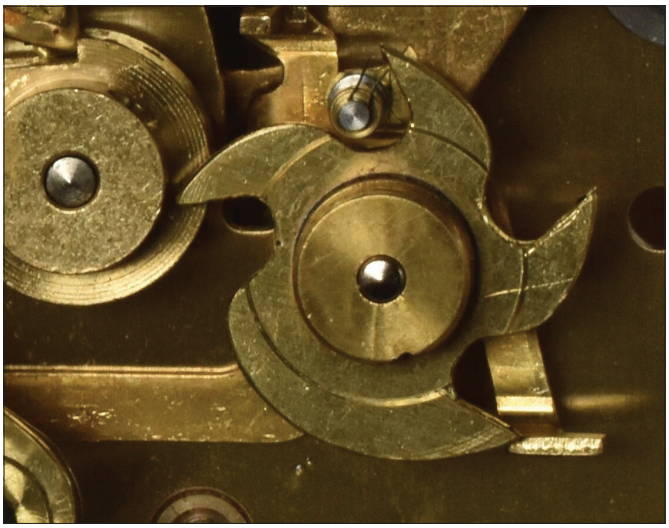


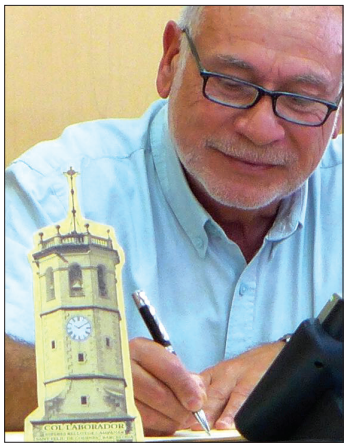
Figure 23 Modified quarter cam.

Conclusions

I decided to use single strokes in the quarters looking for the minimum noise but there is no problem in adding notes to play the quarters in the ting-tang system or with a traditional Westminster chime. Neither would it be a big complication to add the fourth quarter in both systems and even the Roman form IV (ting-tang one time) in a full *grande sonnerie* with single blows in the quarters. There is still a wide range of possibilities to explore. The main achievement explained here is to command the hammer selection by a combination of racks and hour snails.

ENDNOTES

1. Richard Garnier and Leo Hollis, *Innovation and Collaboration. The early development of the pendulum clock in London. Exhibition at Bonhams London, 3-14 September 2018* (Isle of Man: Ed. Fromanteel Ltd., 2018). In the great work of Garnier and Hollis, one can find a wide range of clocks with all kinds of striking systems, among which are the six-hour *grande sonnerie* and the Roman striking.
2. Usually employed in the so-called 'double ship's bell striking clocks.'
3. To give an example of different notes, I use the international nomenclature La A, Si B, Do C, Re D, Mi E, Fa F, Sol G
4. John Winterton, 'English Grande Sonnerie Clocks. A Classification', *Antiquarian Horology*, vol. 19, no. 3 (Spring 1991), pp301–308. This outlines the different types of *grande sonnerie* and their classification.
5. Mike Cowham, 'Joseph Knibb's Roman Striking', *Antiquarian Horology*, vol. 33, no. 6 (Dec 2012), pp803–805. This gives a clear and exact explanation of Roman striking and the solution adopted by Joseph Knibb.
6. I could not find Thomas Tompion's Roman striking clocks described or studied, but just briefly mentioned in a sale by Christie's, reported in 'Tompion, Roman notation hour strike', *Antiquarian Horology*, vol. 18, no. 2, (Summer 1989), p133 and pp143–144, and in *The Horological Journal*, vol. 131 no. 12 (June 1989), p17.
7. The only known clock by Thomas Mudge with Roman striking and repetition is exhaustively described in F. Hudson, 'Thomas Mudge, London. Roman Striking Bracket Clock, circa 1770', *Antiquarian Horology*, vol. 15, no. 1 (Sep 1984), pp53–71.
8. Daniel Quare's Roman striking clock is briefly described with only one picture in Anthony Woodburn's article 'Daniel Quare No. 111. A month duration Roman Striking longcase. Believed to be the only known example by this maker', *Antiquarian Horology*, vol. 17, no. 2 (Winter 1987), pp114–115, and in George Kenney's article 'Daniel Quare's numbered clocks', *Antiquarian Horology*, vol. 37, no. 1 (March 2016), p49, with this brief description: 'No. 111, Square dial, Month duration, Roman strike (very rare), Seconds dial, calendar, Mask spandrels, Month duration, with Equation of Time Paper Signed '111 Dan Quare London' in an oval on the dial.'
9. John C. Piguet is an amateur watchmaker who created a Roman striking clock by transforming an old Morez. See the interesting process that he followed and his explanation in his letter, 'Morez with Roman Striking', *The Horological Journal*, vol. 121, no. 3 (Sep 1978), p38.
10. J. I. Missen, 'A Free Pendulum Clock. A mains powered clock with an electromagnetically impulsed free pendulum with Roman Striking', *The Horological Journal*, vol. 140, no. 6 (June 1998) pp201–205.
11. https://www.jobsonclocks.co.uk/blogs/case-studies/roman-striking-joseph-knibb-longcase-clock-replica-build (accessed 26 October 2019).
12. See Peter Friess, 'Rediscovering Josef Weidenheimer (1758–1795)', *Antiquarian Horology*, vol. 24, no.6 (Summer 1999), pp523–538, Figures 2 and 3, where a change of bell through a cam wheel is described.
13. F. Hudson, 'Thomas Mudge, London. Roman Striking Bracket Clock, circa 1770', *Antiquarian Horology*, vol. 15, no. 1 (Sep 1984), pp53–71 describes the characteristics of the Mudge clock designed for a commission that asked precisely for a clock the maximum silence at its striking.
14. A film has been produced by the author to clarify and to show more easily the functions of the new created mechanism. You can find it at: https://tinyurl.com/romanstrike



About the Author

Eduard Farré-Olivé is a retired watch-making teacher who spent 38 years at the Watchmaker's School of Barcelona (Catalonia). He was the founder, and is now vice-president, of the *Societat Catalana de Gnomonica* (Catalan Gnomonic Society). He was a member of The Antiquarian Horological Society from 1986 to 2000, during which time he published the article 'A Medieval Catalan Clepsydra' (1989). A few years ago, he re-joined the Society.

Complementary Bibliography

Carter Marsh Co., 'The Hay Knibb. Circa 1680. A very fine and extremely rare ebony Roman-striking, three-month-going', *Antiquarian Horology*, vol. 37, no. 1 (Mar 2016), p148.

Ed. Cloutman, 'Restoration of a Joseph Knibb Clock', parts 1–3, *The Horological Journal*, vol. 142, nos. 2–4 (Feb–April 2000).

George Daniels, 'Thomas Mudge, the complete Horologist', *Antiquarian Horology*, vol. 13 no. 2,(Dec 1981), pp150–173.
George Daniels, 'Tompion's Two-Train Grande Sonnerie Mechanism', *Antiquarian Horology* vol. 28, no. 3 (Sep 2004), p370.

John A. Robey, 'Who Invented Rack-and-Snail Striking? The Early Development of Repeating and Rack Striking', *Antiquarian Horology*, vol. 28, no. 5 (March 2005), pp584–601.

Complementary Visual Material

Roman Striking made on a French Table Movement
by Eduard Farré
https://tinyurl.com/frenchtable1

Roman Striking Clock EF3: 2/4 past IV
Grande Sonnerie Roman Striking made on a Carillon Kieninger
by Eduard Farré
https://tinyurl.com/carillonkieninger

Roman Striking Clock EF3: 3/4 past VIII
Grande Sonnerie Roman Striking made on a Carillon Kieninger
by Eduard Farré
https://tinyurl.com/carillonkieninger2

Roman Striking Clock EF3: 3/4 past XII
Grande Sonnerie Roman Striking made on a Carillon Kieninger
by Eduard Farré
https://tinyurl.com/carillonkieninger3

Roman Striking Clock EF3: XII o'clock
Grande Sonnerie Roman Striking made on a Carillon Kieninger
by Eduard Farré
https://tinyurl.com/carillonkienniger4

Roman Striking Clock EF3: The Mechanism
Grande Sonnerie Roman Striking made on a Carillon Kieninger
by Eduard Farré
https://tinyurl.com/carillonkieninger5