Huguenin's Gate

A Late Jump Quarter-Seconds Mechanism

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Abstract

Léopold Huguenin, Le Locle, Switzerland, in circa 1880 made elegant jump quarter-seconds pocket watches. His mechanism for triggering the quarter-seconds hand differs substantially from precursors made by his predecessors and family members, and others in the Swiss Jura.[1] The mechanism can be described as a mechanical toggle or 'gate' (hence the term used in the title above). An extended tail on the lever of the otherwise conventional lever escapement carries a D-shaped detent that interacts with a four-tine flirt, which is run by a separate and independent mainspring and train of wheels. In this article, I will explain how this works.

Lightning and the Devil

Blitzende Sekunde (German, 'lightning seconds'), *foudroyante* (French, same meaning) or *diavoletto* (Italian, 'tiny devil') are terms that evocatively describe the swift, precise, stop-start motion of the jump quarter-seconds hand of an independent train watch.[2] Such watches were made by the Huguenin family in Le Locle, Switzerland, in the latter part of the nineteenth century.[3] These were special watches, and in many respects they represented the zenith of Swiss watchmaking complications at the time.

Jean-Moïse Pouzait in 1776 is credited with the idea for a mechanism that makes the seconds hand on a watch jump precisely from one second-indication on the dial to the next. The idea was adapted by later makers such as the Huguenins, to achieve quarter-second time resolution. This occurs in a subsidiary dial that is positioned where the seconds dial of a conventional watch is typically placed.

The jump quarter-seconds hand is run by a separate mainspring and wheel train, and its sixth arbor carries a flirt that interacts with a 30-tooth auxiliary wheel on the escape-wheel arbor. I described this mechanism in *The Horological Journal* in 2015.[4]

Not All is What it Seems

After writing the previous article, I thought: 'That is that!' Imagine my surprise, then, to find an alternative means of engineering the interaction between the going- and jump quarter-seconds trains, including in the watch that appears in **Figures 11 and 12** of the previously-mentioned article. I had not inspected under the dial of that watch, having assumed (wrongly as we will see) that it had the same mechanism as various watches that I had seen elsewhere, and analysed in detail.[5] While I fully intended to examine my watch at a later stage, I was encouraged to do so sooner by virtue of a lucky circumstance: a visit in July 2019 to the Rikketik fair ('Europe's largest vintage watch and clock fair') in Houten, the Netherlands.

At one of the large displays of antique watches, I found a movement that I surmised to be similar to the one in **Figures 11 and 12** in **Endnote 2**. Having negotiated a price and made the purchase, I waited in anticipation to get home to explore the inner workings.

What I Found

Figure 1A shows the dial of the Huguenin watch presented previously and the behind-the-dial complications in it, **B**.[6] The same view of the newly-acquired movement is shown at **C**. They are remarkably similar in overall layout. These high-quality movements from circa 1880 show extensive decorative spotting, Geneva stripes in the older of the two, and elegantly designed levers in the stop-work and split-seconds systems.

Two Trains

Figure 2 shows the movement with its two trains visible through the mineral glass back of the marriage watch.

Connection Between the Independent Trains

Figure 3 shows the peculiar tail extension of the escapement lever and the D-shaped plate that projects from the top plane of the tail. A pin projects from each of the four tines of the flirt, and these are arranged in diametrically balanced pairs, two at a smaller radius from the arbor and two near the tips of their respective tines. The offset of the D-plate from the tail ensures that the pins clear it as they slide off the distal edge of the D-plate, as the lever moves back and forth.

When the lever was allowed to pivot freely between the centres of a depthing tool, the D-plate and tail swiftly swung downwards, indicating that the centre of gravity of the lever lies significantly in the direction of the tail, and the anchor and jewels do not provide compensatory mass offset towards the fork.

The pivots on the flirt arbor have a diameter of 0.27 mm, while those of the pallet arbor are 0.09 mm. This attests to the large difference in torque required to drive the jump quarter-seconds train versus the going train. In the former train, the blue-steel mainspring is much thicker and wider than the going mainspring. It is also interesting that the winding crown, acting via a shared upper crown wheel, winds both springs simultaneously. Since the jump quarter-seconds train is likely not to be activated all the time when wearing the watch, the going train potentially unwinds without the jump quarter-seconds spring unwinding. With them unwound an unequal amount, how can they safely be re-wound? The answer is that, unlike the going mainspring, the outer end of the jump-train spring is plain, with no physical attachment to the barrel – it operates by friction alone, in the same manner as the slipping bridle of an automatic watch mainspring.

Figure 1. **A**, *Léopold Huguenin former pocket watch, re-cased as a 'marriage watch', showing the sweep-seconds hands which are part of the split-seconds system; and the jump quarter-seconds hand and subsidiary dial at the VI position on the three-piece enamel dial.* **B**, *behind the dial of* **A**, *with the minute and hour wheels removed to expose the jump quarter-seconds flirt, and the serial number 12987 (cropped).* **a** *one of the four tines on the flirt;* **b** *cock with the flirt arbor jewel and the jewel for the fifth wheel arbor of the jump quarter-seconds train;* **c** *flirt arbor that carries the jumping hand;* **d** *spotted mainspring barrel cap of the jump quarter-seconds train;* **e** *barrel cap of the going train;* **f** *clutch (a steel bush) and 40-tooth wheel mounted on the extension of the third-wheel arbor of the going train; this wheel engages with the adjacent 40-tooth wheel seen here, and also with a third 40-tooth wheel (not shown) that rides over the post of the minute hand. The eight-leaf pinion on the second 40-tooth wheel engages with a 96-tooth hour wheel (not shown);* **C**, *behind the dial of the movement bought at Rikketik, serial number 13728 (cropped).*

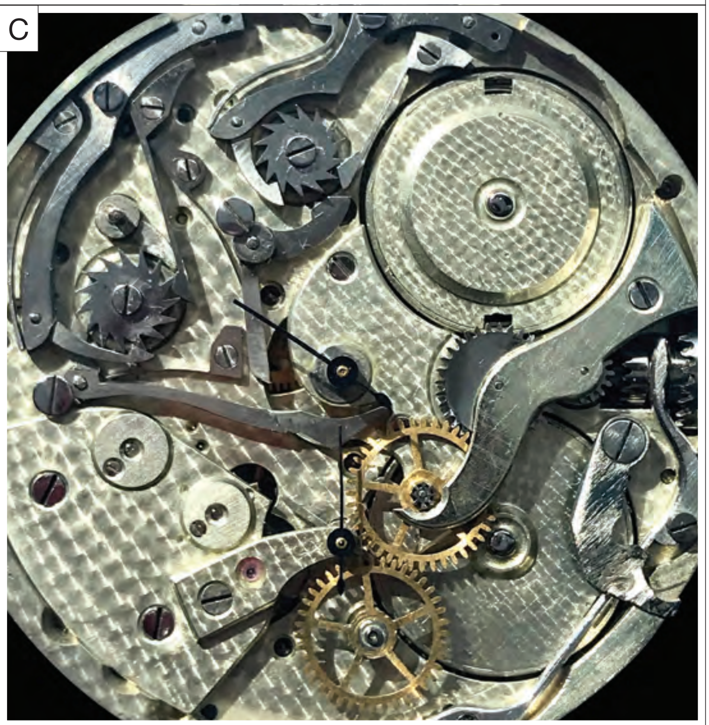

Figure 2. Back of the Léopold Huguenin watch, serial number 12987. Note the seven jewels with screwed-in gold settings. Both spring barrels are wound simultaneously via the crown.

Graphical Representation of the Gate Mechanism

Figure 4 shows the Huguenin jump quarter-seconds mechanical two-state gate. The action of the system is described in the figure caption.

Drawing Metrics

Figure 5 shows images of the lever and flirt that were measured and re-scaled to produce the correctly proportioned drawings, using SketchUp, for **Figure 4**. The handwritten index lines and numbers show the lengths measured on the images, and then by use of a scaling factor, the actual lengths of the various features were calculated.

Explanation of the Action

The stages in the operation of the mechanism are given in the caption of **Figure 6**. The

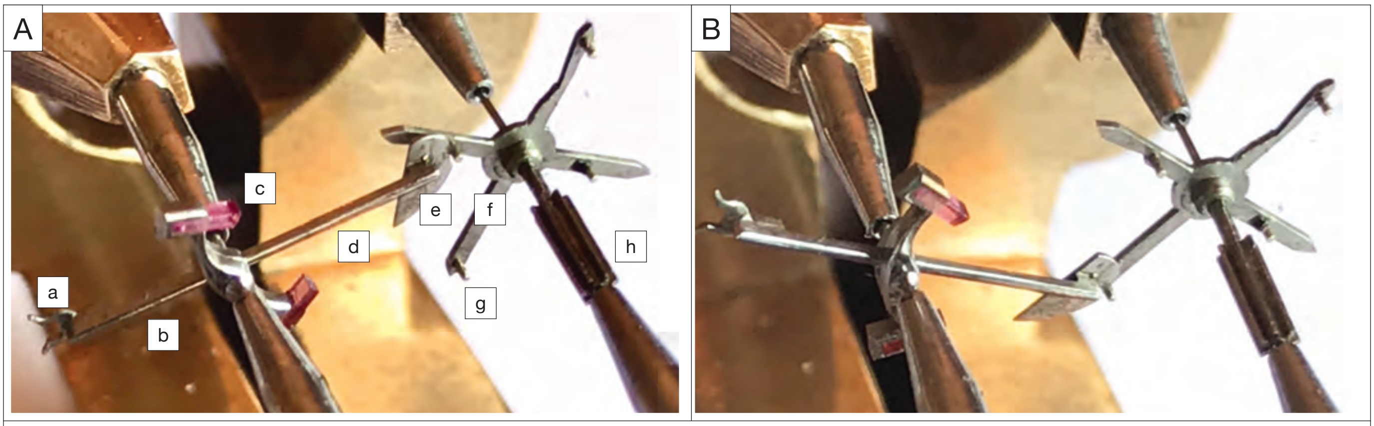

Figure 3. Huguenin's gate mechanism. **A**: *D-plate interacting with a tine-pin at the shorter radial position:* **a** *pallet fork;* **b** *lever arm;* **c** *ruby pallet;* **d** *tail;* **e** *D-plate;* **f** *flirt with four tines;* **g** *tine-pin;* **h** *seven-leaf pinion.* **B**: *D-plate interacting with a tine-pin at the longer radial position: The D-plate (the gate) on the tail of the lever (in the going train) alternates in position between the pins on the four-tine flirt of the jump quarter-seconds train.*

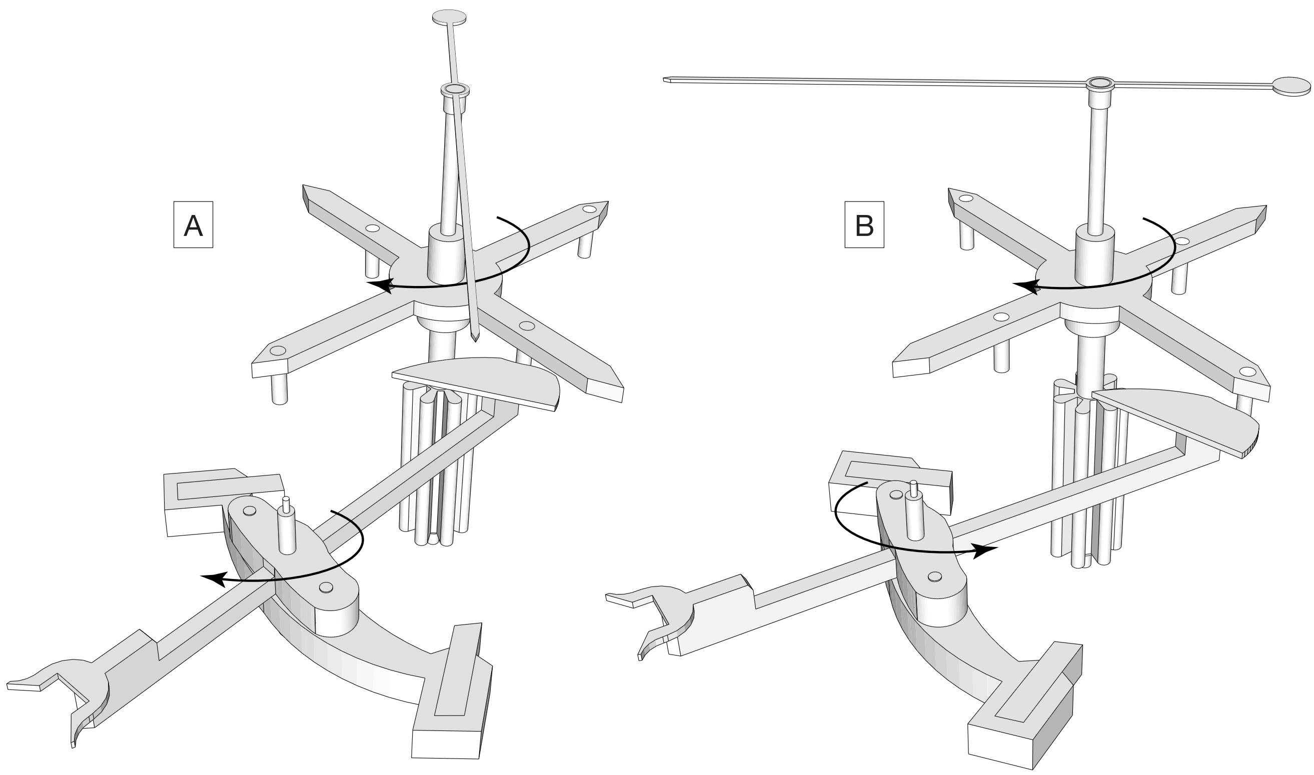

Figure 4. Huguenin's gate mechanism in two states: **A**, *with one of the flirt tine-pins resting in the small indentation on the edge of the D-plate. The upper arrow indicates the clockwise rotation of the flirt, while the lower one shows that the pallet arbor is about to rotate clockwise and thus disengage the D-plate from the pin. This disengagement is initiated by the impulse jewel on the balance roller pushing on the left flank of the slot in the pallet fork.* **B**, *with the D-plate now in line with the next pin on the flirt, which is at a larger radius than the previous pin. The top arrow indicates that the flirt continues to rotate clockwise in jump fashion, while the pallet arbor is about to rotate anti-clockwise and thus unlock the D-plate from the pin. This makes the flirt jump forward by 90°, with the pin passing above the top of the lever tail, until the next tine-pin is arrested by the outer edge of the D-plate.*

sequence shows three relative positions of the escapement lever tail with its D-plate, and the pins on the four-tine flirt in the jump quarter-seconds train. The back-and-forth motion of the lever gates the motion of the flirt because pins arranged at alternately smaller and larger radii on successive tines of the four-tine flirt have their motion arrested by the D-plate (gate) on the lever tail. In **Figures 3A, 5A and 5B** it is readily seen that the D-plate has a shallow notch on its outer edge. This imparts some stability to the extreme positions of the tail. In fact it helps stabilize the conventional locking of the pallet jewels on the club teeth of the escape wheel. Further details of the sequence of events are given in the caption of **Figure 6**.

Continued overleaf

Conclusions

The mechanism that gives 90° quarter-seconds jumps is described in **Figure 6**. What, however, specifies that these jumps occur every quarter second? The answer is that the going train is designed with a balance that gives 14,400 beats per hour. This corresponds to four beats per second, which means that the D-plate moves clockwise and then anticlockwise, alternating four times a second. Hence, a pin on a tine of the flirt comes to rest and then escapes from the D-plate every quarter second, and the attached hand advances successively between four positions at right angles to each other, four times a second.

A gate in a sheep-drafting race alternately moves from right to left and back again, allowing one sheep each time to move forward into one or other of two pens. In the watch mechanism, a pin slides across the D-gate, in a direction that depends on its radial position on the tine of the flirt. This constitutes a two-state binary gate or toggle.

It is interesting to reflect on the fact that the two different radial positions of the pins on the tines of the flirt encode information on which side of the D-plate the pins move to escape. This encoding of mechanical outcomes based on radial position of markers is fundamentally similar to the encoding that exists in the recently described radial surrerwerk strike mechanism.[7,8] In the latter, the sampling of the code is done by a sliding (pumped) vane that intersects with one, two, or more pins (up to 12) that are arranged at decreasing radial position from the start of the cycle. However, the radial positions decrease incrementally from a maximum to a minimum value. In Huguenin's gate mechanism, only two states are encoded; this is achieved by two different radial positions of the locking pins, one on each of the four tines of the flirt.

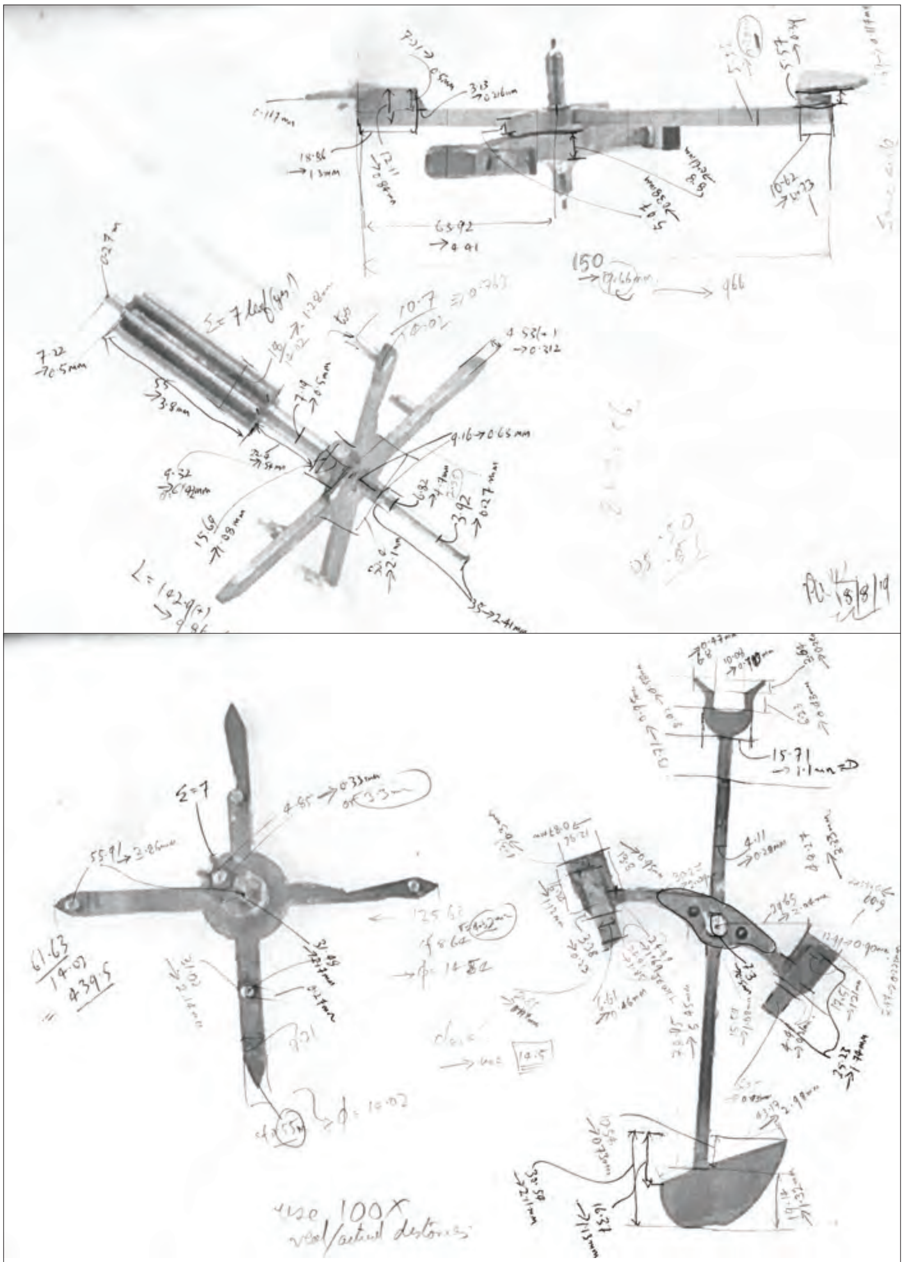

Figure 5. Preparation notes for Figure 4. The flirt with its seven-leaf pinion and the lever with its extended tail and D-plate were measured in order to make a faithful scale drawing. The scale of the PDF image was measured and related to a key measurement on each of the actual components; specifically, the width of the lever is 0.28 mm while the tines are 0.312 mm thick. This factor of 14.02 was used to revert to millimetres for SketchUp.

The deliberate absence (in the interests of avoiding clutter) of the anchor and jewel-pallets from the diagrams of **Figure 6** perhaps suggests that this is an escapement in its own right. In fact, it does not look too dissimilar from Alexander Kaiser's lyre escapement: if instead of a 15-tooth escape wheel there were only four teeth (pins) then the similarity becomes clearer.[9] The present tail-and-lever corresponds to the lyre-lever in Kaiser's escapement. This idea is reinforced by the observation that the amplitude of the balance in the jump quarter-seconds watch is increased when the stop-watch mode is activated, implying that the flirt does indeed add some impulse energy to the lever. As this assists the balance to maintain a stable amplitude, the effects on its isochronism are minimised.

Overall, Huguenin's gate mechanism for controlling quarter-seconds resolution of the *diavoletto* is ingenious. Its relative rarity suggests that it lacked reliability in the longer term, or was it too complex to make? It is interesting to note that the extension to the lever, and its D-shaped gate are all skillfully filed from a single piece. In any case, time resolution down to a quarter second given by such a mechanism was rapidly achieved by other more readily reproduced and robust chronograph mechanisms.[10] On the other hand, the watch which contains this unique mechanism is also of spectacular quality in the rest of the movement and a work of (technical) art in its own right.

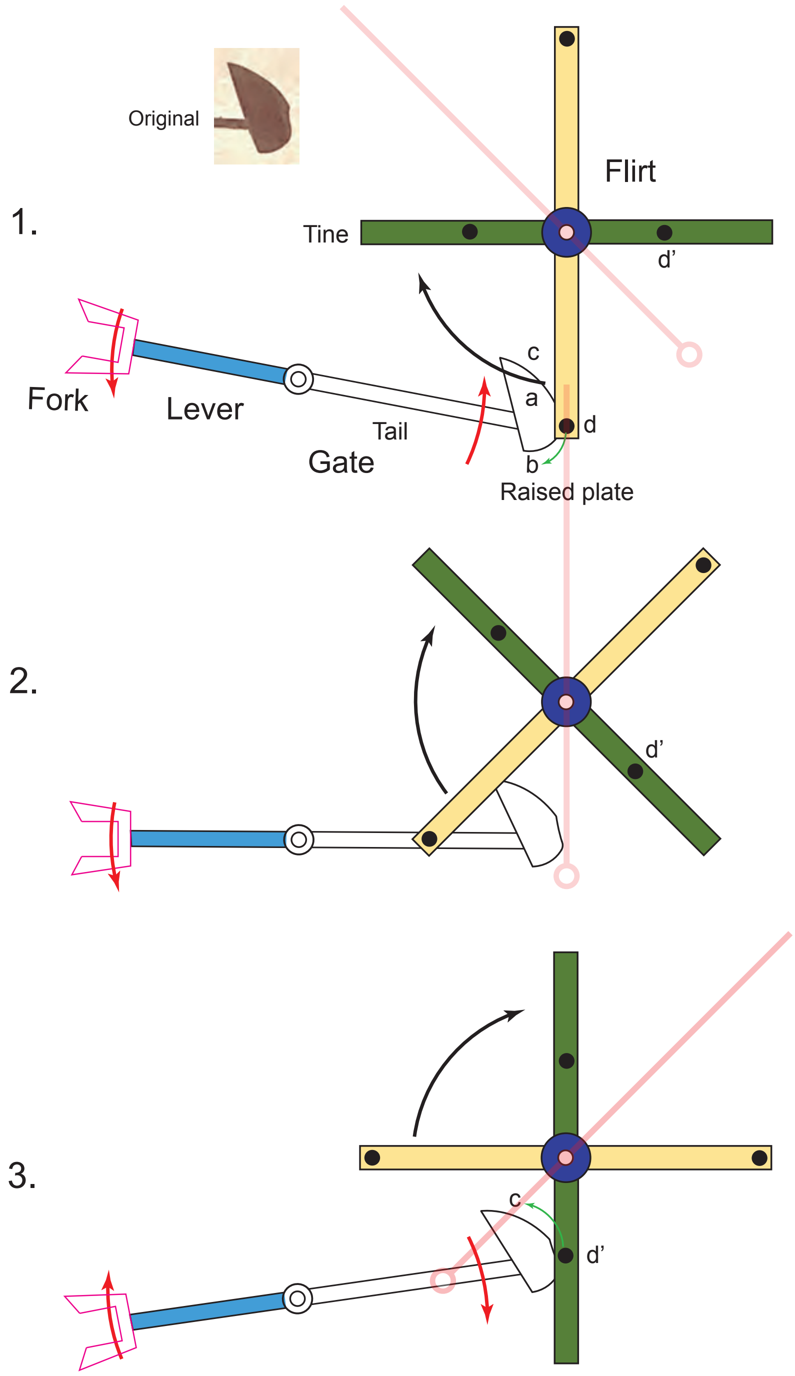

Figure 6. Schematic of the jump quarter-seconds gate mechanism. ***1****.The lever (blue) with its fork is indicated by the red arrow to be about to move anti-clockwise. This means that the tail with its attached D-plate,* ***a****, will move anti-clockwise as well. The pin,* ***d****, on the tine (yellow) of the flirt will slide across the outer edge of the D-plate as the flirt rotates clockwise towards* ***b****. The relative motion of* ***d*** *and* ***a*** *is indicated by the small green arrow.* ***2****, The flirt is shown having rotated through 45° as the lever continues to rotate anti-clockwise delivering impulse to the balance via the impulse jewel.* ***3****, The rotation of the flirt is stopped by its pin,* ***d'****, on the next tine (green) coming to rest on the outer edge of the D-plate (****a*** *in* ***1****.). The cycle then repeats itself as the lever rotates clockwise under the influence of the impulse jewel unlocking the escapement. Simultaneously, the flirt escapes from the D-plate by its pin,* ***d'****, sliding across this time in the direction of* ***c****, indicated by the small green arrow. Thus, overall the jump quarter-seconds hand (pink pointer) flicks between transient resting positions that are 90° apart.*

Acknowledgements

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ENDNOTES

1. Kathleen H. Pritchard, *Swiss Timepiece Makers 1775–1975* (West Kennebank, Maine, USA: National Association of Watch and Clock Collectors, Inc, Phoenix Publishing, 1997) H-55 – H-60.
2. Philip W. Kuchel, 'Independent-Train Watches and Jump Quarter-Seconds: An Explanation of How They Work', *The Horological Journal*, vol. 157 (Oct 2015) pp442–446, and Figures 11 and 12.
3. Pritchard, op cit.
4. Kuchel, op. cit.
5. Ibid.
6. Ibid.
7. P. W. Kuchel, 'Radial Surrerwerk': A New Clock-Hand Synchronised Strike Mechanism, Installation on a Condliff-Inspired Skeleton Clock, Part 1', *The Horological Journal*, vol. 161 (March 2019) pp118–123.
8. P. W. Kuchel, 'Radial Surrerwerk: A New Clock-Hand Synchronised Strike Mechanism, Installation on a Condliff-Inspired Skeleton Clock, Part 2', *The Horological Journal*, vol. 161 (March 2019) pp150–153.
9. Philip W. Kuchel, 'Alexander Kaiser's Lyre Escapement', *The Horological Journal*, vol. 158 (Feb 2016) pp66–71.
10. François Lecoultre, *A Guide to Complicated Watches*, 3rd English edn. (Neuchatel: Simonin, A., 2004) pp24–57.