Lantern clock conversions – a technical survey

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Before 1658 all lantern clocks were made with a balance-controlled verge escapement, there being no practical alternative. However, their timekeeping was very poor, with both large day-to-day variations and long-term drifting. When the short pendulum and later, in the late 1660s, the long pendulum were introduced, few balance lantern clocks escaped being updated to pendulum control. At the same time most had their duration increased and often the two weights were changed to a single weight on a Huygens endless rope or chain. This article discusses these different conversions and the various alternative constructions employed. It looks at examples of clocks that illustrate some of the variety of combinations that are found.

Timekeeping in the seventeenth century

From about 1590–95, when the earliest known prototype English lantern clock appeared,[1] until the introduction of the pendulum in England in 1658, all domestic clocks were controlled by an oscillating balance — there was no practical alternative.[2] Without the direct constant force of gravity to control the oscillations, time-keeping was notoriously unreliable. The only restoring force on the balance was provided by the recoil of the crown wheel teeth on the pallets, and its beat of about 1.3 seconds was very sensitive to variations in driving force. In addition friction from the escapement, pivots and the meshing wheels and pinions could cause variations in beat, resulting in erratic timekeeping.[3]

While a newly made and expertly set-up balance escapement can produce timekeeping to within a few minutes a week, in a real-life domestic environment short-term variations of ten or more minutes a day are likely, along with long-term drifting owing to deteriorating lubrication and wear. Unfortunately, there appears to be no documented confirmation of the actual variations experienced by owners of balance clocks in the seventeenth century. The rush to update these clocks once a suitable alternative oscillator was available, suggests that timekeeping was indeed very poor and a major concern for many owners, and an incentive to get their balance clocks converted.

In 1658, the Dutchman Christiaan Huygens published details of his application of the pendulum to a clock. Shortly afterwards the London clockmaker Ahasuerus Fromanteel advertised clocks for sale with a pendulum. This heralded a new era in timekeeping technology, which improved timekeeping consistently to a few minutes a week. After proposing various alternative configurations, Huygens's final solution was to replace the vertical crown wheel of a balance clock with a contrate wheel driving a crown wheel rotating in a horizontal plane. The verge was positioned across the top of the crown wheel, with a pendulum swinging at the rear. Not only did the contrate wheel turn the drive to the crown wheel through ninety degrees, it also provided a faster train, so that a short pendulum, with a beat of about half a second, could be used.

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1. John A. Robey, 'Prototype lantern clocks, Part 2: Newly discovered clocks', *Antiquarian Horology,* March 2023, 23–33.

2. No early British domestic clock is known with an original foliot.

3. Significant variations in beat can be clearly heard on a clock by Samuel Stretch of Leek, with an original balance, owing to wear on pallets, pinions and wheels.

The introduction of the domestic longcase clock with a long pendulum, initially with a cross-beat escapement, and then the invention of the anchor escapement in the late 1660s improved timekeeping even further. Since the pallets were now in the same plane as the escape wheel, it was much easier to make than the verge escapement, and it also avoided both the crown wheel and the troublesome contrate wheel completely, bringing a long-term variation within a minute a week.

Even though the anchor escapement accelerated the conversion of balance clocks almost to extinction, some clockmakers continued to make and sell them. Nicholas Coxeter is thought to have continued making balance clocks for twenty years after the pendulum clock was first known, while two lantern clocks by John Barnett, originally with a balance, could not predate 1682 when he was free of the Clockmakers' Company.[4] In the provinces, Samuel Stretch of Leek, North Staffordshire, made balance lantern clocks in about 1685–90.[5] In addition London-made balance lantern clocks continued to be available until at least 1696.[6] This is almost forty years after the introduction of the pendulum, though few customers are likely to have taken up this option.

There is limited documentary evidence to indicate how quickly balance lantern clocks were converted to pendulum control. However the number of survivors of unconverted clocks provides clues. So thorough was the desire to replace the balance that only about fourteen clocks are known to have survived with their balances intact.[7]

Many clocks were converted to a short pendulum with a verge escapement, while a good proportion of these were subsequently changed to an anchor escapement. Only a relatively small number are found retaining their initial conversion to a verge pendulum. Clocks originally made with a verge pendulum often survive intact, but many of them also subsequently acquired an anchor escapement. It is not possible to quantify with any precision how many balance clocks had a single upgrade and how many a double conversion. The publications of William Derham in 1696 and Henry Elliott in 1726[8] recommend the wheel counts to be used when converting a balance clock to a long pendulum (though with little practical details of how this was to be done). These texts indicate that such conversions were still popular well into the eighteenth century.

During conversion the opportunity was often taken to increase the half-day duration of balance lantern clocks. In addition to updating to a pendulum, the use of two separate weights to power the going and striking trains, was changed to a single weight on the now familiar Huygens endless rope principle.

To make these different conversions a variety of techniques were used to support the pallet arbor, while train wheels or motion-work might be modified, and the main types of arrangements are discussed in this article. Some conversions have been reversed in recent times, though there is now an increasing realisation that they are an important part of horological history and deserve to be conserved. The identifying features of reconversions back to a balance have been discussed elsewhere and are not repeated here.[9]

Methods used to update balance clocks

Verge escapement and short pendulum

Converting a balance clock to a verge pendulum required the replacement of the crown wheel by a contrate wheel. A potence was needed to support the lower pivot of the new crown

4. Brian Loomes, *Lantern Clocks & Their Makers* (2008, Mayfield Books), p. 125.

5. John A. Robey 'English lantern clocks with an original balance', *Antiquarian Horology*, June 2020, 185–8. Samuel Stretch was not born until 1657 and was unlikely to have been working until after 1678. Remarkably two lantern clocks by him have survived with their balance escapements intact. He initially made lantern clocks with a balance and later with an anchor escapement, none with a verge pendulum being known.

6. Loomes, *Lantern Clocks*, p. 126.

7. Robey, 'Original balances', 177–96.

8. W. D. [William Derham], *The Artificial Clockmaker*, 1696, pp. 62–8. Henry Elliott, *The Clock-Maker's Assistant*, 1726, pp. 11–14.

9. Robey, 'Original balances'.

wheel; this would have had fewer teeth than the original one, which could not be reused. New cocks were necessary to support the new verge and the top of the crown wheel, or the balance cock was reused (see Clock 1).

Anchor escapement and long pendulum

Conversion to an anchor escapement with a long pendulum was by far the simplest to achieve. In its basic form it involved replacing the crown wheel by a new escape wheel. Either the pivot hole in the original bridge on the central movement bar was reused, or the bridge was removed and a new pivot hole drilled in the bar, and a new horizontal arbor was fitted with a pair of anchor pallets. By using a 25-tooth escape wheel instead of the original 19-tooth or 21-tooth crown wheel, the beat was reduced from about 1.3 seconds to 1 second, resulting in a more convenient pendulum length. In addition the aperture in the top plate, necessary to allow the hammer head to pass through during assembly, had to be enlarged to accommodate the anchor pallets. Also the new pallet arbor needed to pivot at the front and rear.

The easiest position for a clockmaker to put the pallet arbor was just above the top plate, but then there was a larger distance between the pallets and escape wheel than desirable, and the escapement geometry was far from ideal. As a result, the pallet arms had to be extra long and created more sliding on the pallet faces.

Alternatively, the front half of the pallet arbor was cranked down so that the anchor sat below the plate with the front pivot located in the front movement bar. The pivots had an appreciable vertical separation and the axis of rotation was at an angle to the horizontal. Hence the pivot holes had to be larger to allow for this. An advantage was that the anchor now swung about a lower axis and closer to the ideal position. Fortunately the anchor escapement is quite forgiving and both arrangements work well enough, with few problems. The best solution was to insert an additional wheel in the going train, with the escape wheel pivoted just below the top plate and protruding through it. This has the added advantage of allowing the motion-work to be altered to extend the duration.

Lantern clocks originally made with a short pendulum could also be updated to a long pendulum, though usually not those with a central pendulum. This was usually the only change, since they already had a thirty-hour duration and a Huygens endless rope or chain.

Increasing duration

The simplest way to double the duration of a balance clock was to loop up the two ropes, add pulleys, pass the ends through holes drilled in the bottom plate, and tie knots in the ends. The mass of the driving weights would then need to be doubled. As this resulted in a forest of ropes; it was not often used, and modifications to the movement were preferred.

For the same spiked rope pulley diameter and weight drop, the duration of the going train is solely determined by the ratio of the counts of the hour wheel and pinion-of-report. For an unaltered balance clock this is usually 48:4 giving a duration of about twelve hours. This could be doubled by replacing the pinion by a larger one of eight leaves, the hour wheel being reduced in diameter and its teeth recut. By filing alternative gaps deeper between the pinion leaves, it could be fitted firmly over the original four prongs. Despite this being the simplest and neatest method it was not often used, and fitting it onto a square spigot appears to have been preferred. An extension could be added to the front of the great wheel arbor after cutting off the four prongs, then filing the square, or even replacing the arbor itself. If an extra wheel had been added to the train the new pinion-of-report could be larger to give an even longer duration.

Since, unlike the going train, the counts of the striking train have to follow set rules, there was less scope to increase its duration, and it is limited to twice the usual duration of about fourteen hours for an unaltered striking mechanism. This increase was achieved by doubling the count of the pinion-of-report and the number of hammer pins. By cutting an extra gap in the locking hoop, the distance the train can run for each blow is halved.

Clocks were often modified with a larger going pinion-of-report, while the striking train retained its original four-pronged pinion. Alterations to increase the duration usually include conversion to a Huygens endless rope (see below), but unless the duration of both trains is increased, the overall increase will be limited, it being largely governed by the fastest running train (see Clock 8).

Huygens endless rope

Conversion to a single weight on a Huygens endless rope or chain was often done at the same time as a pendulum update. The main advantage was that the striking remained in its correct sequence if the weight ran down, and was probably why it was favoured. A Huygens loop produces no increase in overall duration (unless the motion-work is modified), since the weight falls partway to drive the going train and the remainder of the fall to power the striking train. With a true Huygens configuration the weight hangs on the left and turns each great wheel anticlockwise. Since the two weights of a balance clock rotate the great wheels in opposite directions, one train had to be reversed if the weight and counterweight were to hang on opposite sides of the movement.

A simple method — though it is not often seen — was to insert an idler pinion (its count being immaterial) between the going pinion-of-report and the hour wheel, which had to be slightly reduced in diameter and the teeth reprofiled. The going click was removed and the rope pulley pinned to the great wheel; the weight was then hung on the right-hand side.

There is an even easier method, which avoids modifying the hour wheel, though it is rarely seen. The four pins of the pinion-of-report were reduced in length so they no longer engaged with the teeth of the hour wheel. A tall idler, of any convenient count, was added between the shortened pins and the hour wheel. This reverses the going train without any increase in duration. A longer running time could be achieved by fitting a larger pinion, short enough to not engage with the hour wheel (and also clearing the star wheel behind it).[10]

A more drastic alternative was to reverse the direction of the striking train by turning over the countwheel, exchanging the positions of the hammer and strike-work, remaking all the detents, making a new lifting piece, removing the going click and pinning the pulley. Despite this being a major rebuild, involving much effort and expense to the owner (perhaps that was the point), it was sometimes done.

However, the reversal of either train was quite unnecessary, as was the removal of either winding click. A continuous loop of rope could simply be positioned so the weight pulled down on opposite sides of the two pulleys. Though the two loops of rope cross each other, in practice this causes few problems, especially if the bottom of the descending weight is rounded to guide it past the ascending counterweight. There is the advantage that the weight hangs centrally, with little tendency to slew the clock to one side if it is hung on the wall. The majority of converted balance clocks using a single weight run quite reliably with a crossed rope. Even if there is no conversion to a true Huygens endless rope, a clock with only the striking duration doubled is likely to have been run with an endless crossed rope to avoid a mis-strike.

Since there may be up to four different conversions that can be found on English lantern clocks, all with variations, the following clocks are presented as examples of the main types of update, including a Germanic conversion to a cowtail pendulum. They only include methods known to the author — other variants are likely to exist — and are limited by the availability of suitable images.

Clock 1. Peter Closon, *c.* 1650, conversion to a verge pendulum

The clock shown in Figs 1–3 is unusual in being converted from a balance to a short pendulum and a verge escapement, probably before 1670, but there has been no subsequent upgrade to an anchor escapement and long pendulum. The original four-pronged pinions-of-report survive with no attempt to increase the duration, nor to replace the separate weights by a single weight on a Huygens endless rope. The dial is signed ‘Peter Closon Neere Holburne Bridge Londini Fecit’. There are the expected ‘matchstick man’ casting marks on the hour, star and count wheels, as well as one underneath the top plate. The latter has not been recorded on any other clock. Peter Closon died about 1660–1, having lived just long enough to be one of the earliest

10. Information from Anthony Gray.

Fig. 1. Clock 1 by Peter Closon, London *c.* 1650.

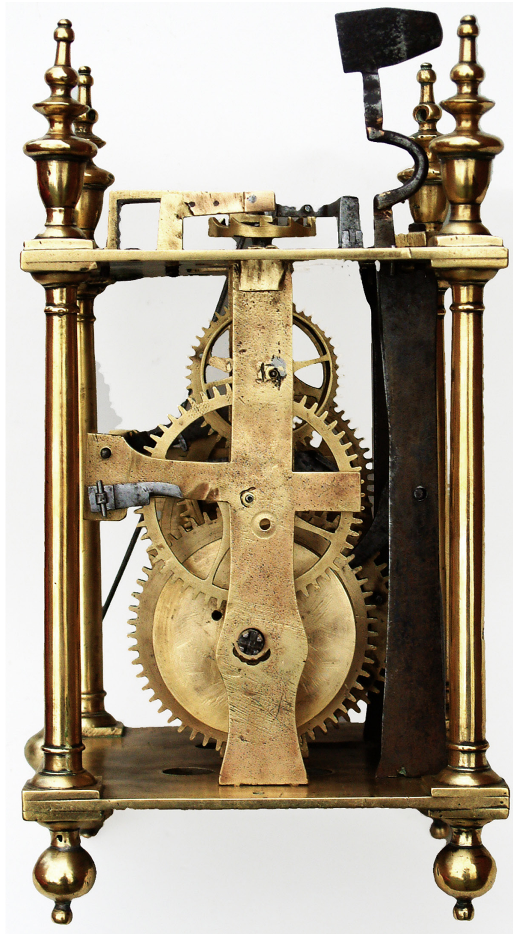


Fig. 2. Clock 1. Front of the movement with vertical iron support bars for the hammer arbor, and the truncated right-hand arm of the movement bar. Note the clearance on the hammer shaft to avoid the verge and crown wheel.

makers of clocks with the recently invented pendulum,[11] and there is a possibility that he was responsible for the conversion of this clock.

It is one of a very small number of lantern clocks with the hammer arbor pivoted between two dedicated iron bars — a feature unique to Closon. Consequentially the arms on the right-hand side of the front and rear movement bars are truncated.

During conversion to a short pendulum the usual 19-tooth or 21-tooth crown wheel was replaced by a 40-tooth contrate wheel driving a new 11-tooth crown wheel set horizontally. The original balance top cock was modified to serve as the top cock for the new verge crown wheel, while a new brass cock to support the front of the new pallet arbor was screwed to the top plate. At the rear the hanging hoop was removed as it interfered with the new pendulum, while a knife-edge sits in a V-bed on a new iron L-shaped back cock. The knife-edge suspension and a relatively heavy pear-shaped brass pendulum bob is usually specific to English clocks with a verge escapement. Verge pendulum bobs are usually quite light on Germanic and Italian clocks, enabling normal pivots to be used at both the front and rear of the verge. French clocks often have a pendulum suspended by a silk thread and

11. Loomes, *Lantern Clocks*, pp. 92, 95, Fig 8.11, shows a clock by Peter Closon with an original central verge pendulum, and another was sold by Bonhams, London, 16 December 2015, Lot 4.

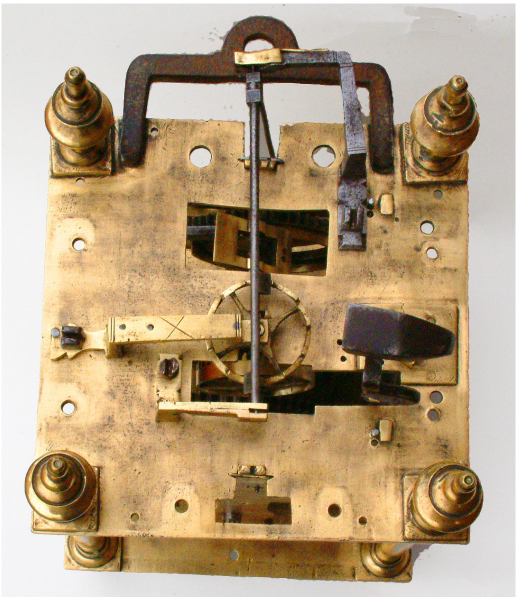


Fig. 3. Clock 1. Top of the Closon movement with new cocks for the verge conversion and a new hanging hoop.

Fig. 4. Clock 2. Balance clock by Ahasuerus Fromanteel converted to a cowtail pendulum. The later bob is a flat strip with pointed ends. (Brian Loomes)

connected to the escapement via a crutch.[12]

A wider replacement 'hoop' was added to the Closon clock with a separate hole for the wall hook. The spikes, which screwed into the rear feet, would have interfered with the wide swing of the bob and have been removed. To avoid the hammer shaft fouling the verge or crown wheel when it was pulled back, a semicircular section was inserted. Similar modifications to the hammer shaft, including filing a clearance notch, are often found on both verge and anchor conversions.

Clock 2. Ahasuerus Fromanteel, early 1650s, converted to a cowtail pendulum[13]

The manner in which the verge was constructed and supported can indicate where a balance clock had been converted to a short pendulum. Figs 4–5 show a clock converted to a short pendulum that swings in front of the dial, an arrangement known as a cowtail pendulum. A flat iron strip, or 'verge bar', is held by mortice and tenon joints and taper pins to two short uprights fixed to the top plate. The top cock for the crown wheel is fixed to the underside of the verge bar, with a removable pivot block at the front that is also held by a taper pin. The verge is inserted through a gap cut in the fret and a hole in the front support, then into a pivot hole in the rear support. The bob is supported by a conventional pivot rather than a knife-edge. The disadvantage of this construction is the difficulty of adjusting the height of the pallets above the crown wheel teeth, without means of lifting the crown wheel.

The earliest known cowtail pendulum is on an Augsburg clock of about 1670,[14] and

12. Loomes, *Lantern Clocks*, pp. 54–5, shows a balance lantern clock by Jacques Laylet of Paris, about 1640 or a little later, converted to a verge pendulum with a separate crutch.

13. Loomes, *Lantern Clocks*, pp. 115–16.

14. Jürgen Ermert, 'Eine Uhr von Caspar Hoffmann Augsburg mit ungewöhnlichem Gangregler', *DGC Jahresschrift*, 2010, 84–6, 90–8.

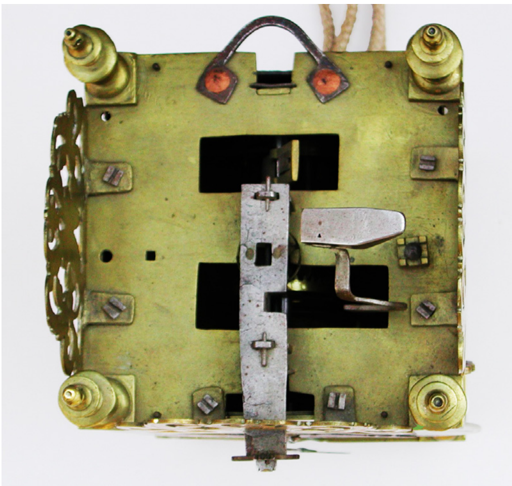


Fig. 5. Clock 2. Top plate of the Fromanteel clock. The verge is supported beneath a horizontal iron strip. (Brian Loomes)

the clock shown here has a typical South German arrangement that was also widely used in the neighbouring areas of Austria and Switzerland. It was converted to a cowtail pendulum in the German Lands and may have been exported at an early date. The pendulum bob has three pointed arms, quite unlike the usual disc used on eighteenth-century Germanic posted-frame clocks, and is later. Both pinions-of-report retain their original four prongs, so the duration has not been increased. It is unlikely to have been used with a single weight on a Huygens endless rope, as this was not generally used in these regions, where separate weights were preferred.

Clock 3. Large clock with galleried frets by Peter Closon, *c.* 1650, converted to a verge pendulum[15]

Peter Closon made a number of large clocks with two top plates separated by galleried frets, and the balance oscillating between them. They are often chiming, musical, or have a passing half-hour strike (as on this clock), with the hammer or hammers pivoting on the upper plate. The clock in Figs 6–13 has a similar signature to Clock 1, as well as a very tall and heavy bell with P. C. cast on its top and inside. Some wheels have the matchstick man casting marks.

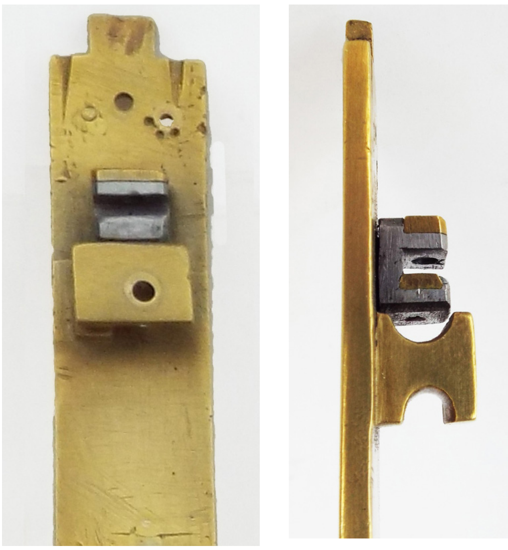
The balance escapement has been replaced

Fig. 6. Clock 3. Large clock by Peter Closon with a double top plate and separate galleried frets.

Fig. 7. Clock 3. Upper top plate with the verge escapement and hour hammer.

15. John A. Robey, *Gothic Clocks to Lantern Clocks*, (2021, Mayfield Books), pp. 246–51.

Fig. 8. Clock 3. Cocks, verge and crutch.



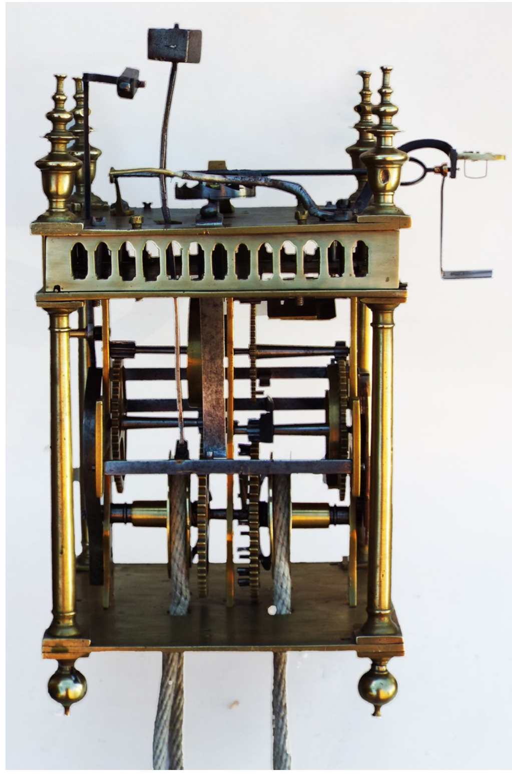


Fig. 13. Clock 3. Right-hand side of the movement showing the crown wheel and verge sitting above the upper top plate.

(left) Figs 9–10. Clock 3. Original bridge and a later iron potence on the central movement bar.

Fig. 11. Clock 3. Going train and motion-work, with the contrate and crown wheels and 8-leaf pinion-of-report.

Fig. 12. Clock 3. Striking train with later pinion-of-report, extra hammer pins and an extra slot in the locking hoop.

by a verge pendulum with the rear pivot of the 48-tooth contrate wheel sitting in the original bridge, which has been retained. The 13-tooth crown wheel is made of iron, as is the potence that supports its lower pivot. The crown wheel arbor is longer than usual so that the crown wheel sits above the upper top plate. The conversion of another very similar Closon clock has the crown wheel and verge on the lower top plate.[16] A brass top cock supports the crown wheel, with the verge pivoting between a brass front cock and an iron back cock. The verge has an unusual shape, with a circular ring for the vertical verge of an alarm (later removed) to pass through, and a crutch at the rear. Two hooks on a pendulum (missing) would have hung on the wire loop fixed to a brass support on the rear cock.

The duration of both trains has been doubled to provide daily winding, by replacing the original four-pronged pinions-of report with brass ones held onto squares on the front ends of the great wheel arbors. Also the number of hammer pins has been doubled, together with an extra slot cut in the locking hoop. There has been no conversion to a Huygens endless rope. The use of iron for some of the components of the conversion, the wire loop pendulum suspension, and Black Forest chain conversions (now restored) indicate that these changes took place in the German Lands.

Clock 4. Unsigned miniature prototype lantern clock, *c.* 1590–5, converted to an anchor pendulum[17]

This is the earliest known British domestic clock (Figs 14–16), now known as the 'Skelton clock' from the village near Penrith, Cumbria, where it was discovered in 2020. Features of the frame indicate that it was made in the Harvey family workshop in Little Britain, Aldersgate, London, probably by John Harvey. There are many constructional and technical features that are either unique or very unusual, confirming it was experimental and made before any other known lantern clock.

Traces of where the bridge and a potence had been riveted to the central movement bar indicate that it had originally been made with a balance, then converted to a verge pendulum. Finally it acquired an anchor pendulum, probably in the late seventeenth century. Further evidence for the conversion

16. Robey, *Gothic Clocks to Lantern Clocks*, p. 251.

17. John A. Robey, 'Prototype lantern clocks, Part 2: newly discovered clocks', *Antiquarian Horology*, March 2023, 23–33.

Fig. 14. Clock 4. The restored Skelton clock.

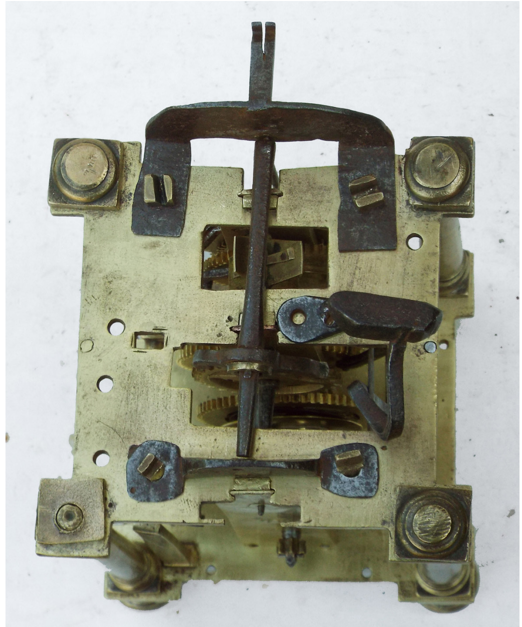


Fig. 15. Clock 4. The top plate with the later anchor pallets and two large iron cocks.

Fig. 16. Clock 4. The anchor escapement with long sturdy pallet arms.

to a verge pendulum is provided by holes left in the top plate where the cocks for the crown wheel and verge had been located. In addition, the rear feet and protruding rear corners of the bottom plate have been filed back to provide clearance for the wide swing of the bob.

The conversion to an anchor pendulum is the simplest arrangement, with the pallet arbor situated just above the top plate. It pivots in two large iron cocks, the rear one with a support for the pendulum suspension. The very sturdy pallet arms pass through the top plate, and are longer than usual so the pallets can reach the escape wheel teeth; this results in poor escapement geometry. While there is a reasonable impulse on the exit pallet, there is very little lift on the entry pallet. But it cannot be determined if the present pallet angle is similar to its original one, or is the result of filing at a different angle to remove wear pits.

The only other modification was to change the original four-pronged going pinion-of-report to a 7-leaf brass one. This increased the duration of the going train, leaving that of the striking train unaltered. The use of a Huygens endless rope with crossed loops would have the advantage of the strike remaining in sequence if the weight were allowed to run down. The modest increase in overall duration would

Fig. 17. Clock 5. Clock by Nicholas Snow, Salisbury, *c.* 1644, with an alarm disc. (Brian Loomes)

have been of little practical benefit.

Clock 5. Nicholas Snow, Salisbury, *c.* 1644, converted to an anchor pendulum[18]

The dial of this clock is signed 'Nicholas Snowe in Sarum fecit'. It was made about 1644 with a balance escapement and later converted directly to an anchor pendulum, there being no empty holes in the top plate to indicate a former verge pendulum (Figs 17–19). The frets have been replaced by the West Country lion-and-unicorn pattern, the front one being engraved 'NS 1678', which is probably when the clock was updated.

The conversion to an anchor escapement is the simple arrangement with the pallet arbor

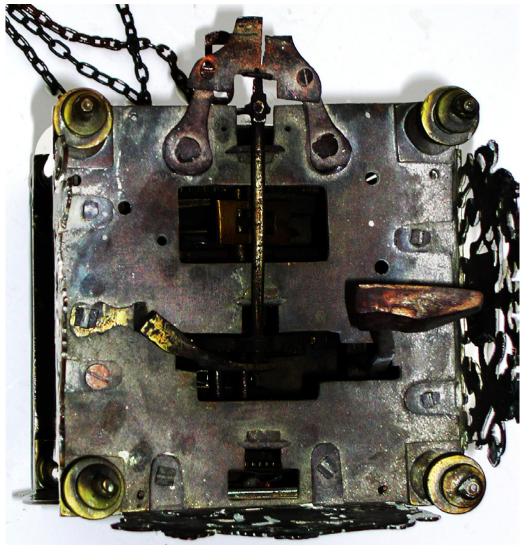


Fig. 18. Clock 5. The top plate with a later anchor escapement. (Brian Loomes)

Fig. 19. Clock 5. Front of the movement with a later iron pinion-of-report and iron idler pinion. (Brian Loomes)

18. Loomes, *Lantern Clocks*, pp. 165–8.

above the top plate. There is only a short section of the arbor in front of the pallets, and it pivots in the modified original balance top cock. At the rear a conventional back cock and pendulum support, of the type used on posted-frame clocks, was fixed to the original hanging hoop rather than to the more usual top plate. The pallet arms appear to be longer than ideal, but not excessively so. Since the alarm mechanism would have interfered with the swing of the pendulum, as usual it has been removed, though the setting disc survives.

As also usual, the clock was changed to a Huygens endless loop arrangement and the duration increased. The original going pinion-of-report (presumably with four prongs) was replaced by a 17-leaf pinion, and the hour wheel (presumably with the usual 48 teeth) was replaced by a 72-tooth one. This approximately tripled the duration of the going train. To achieve a correct Huygens configuration the direction of rotation of the going train was reversed by adding a 19-leaf idler pinion to the motion-work. Both new pinions are rather crudely made of iron. As a result of the train reversal the weight hangs on the right-hand side to turn the hand clockwise. Evidence provided by other photographs of the movement indicates that the number of hammer pins has not been doubled, so it is likely that the duration of the striking train remains unchanged. Hence the Huygens loop was primarily to preserve the striking sequence with a modest increase in overall duration. At some undeterminable date the spiked rope pulleys were changed to accept a chain.

Clock 6. Unsigned iron-framed balance lantern clock, *c.* 1640, converted to an anchor pendulum[19]

Despite the loss of its side frets, doors and rear cover, the movement of the clock in Figs 20–3 has its conversion from a balance to an anchor escapement without an intermediate conversion to a verge pendulum. It is one of a small number of lantern clocks that have iron frames and movement bars, brass wheels, and most of them with English-style brass dials and frets.[20] The dial of this clock was intended to have an alarm-setting disc, but it and the alarm mechanism were never fitted.

Fig. 20. Clock 6. Iron lantern clock, intended to have an alarm, but never fitted.

The counts of both trains are identical to those found on brass balance clocks, so the replacement of the original crown wheel by a 25-tooth escape wheel gives a pendulum of exactly 1-second beat. The anchor escape wheel pivots in a brass block, which replaces the original bridge. To achieve a good escapement geometry, the new pallet arbor was cranked near the centre so the anchor sits below the top plate and pivots in the front movement bar. The rear of the arbor pivots in a conventional cast brass back cock screwed to the top plate. As a result the axis of the anchor's swing is now at an angle to the horizontal and the pallet arms are effectively shortened. This gives a better escapement geometry than if the pallet arbor had been

19. Robey, *Gothic Clocks to Lantern Clocks*, pp. 284–7.

20. John A. Robey, 'English Lantern Clocks with Iron Frames', *Antiquarian Horology*, March 2011, 689–70.

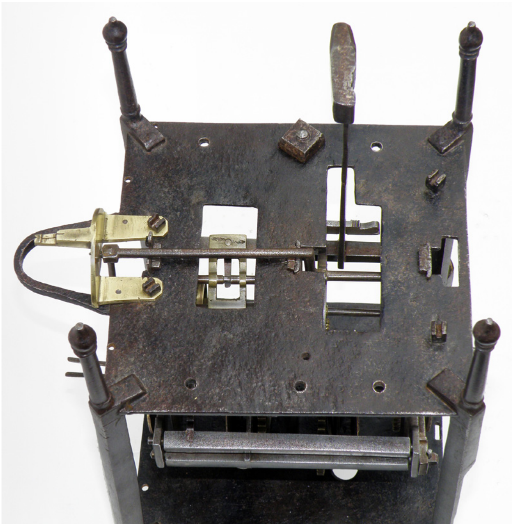


Fig. 21. Clock 6. Top plate with the rear of the pallet arbor pivoting in a brass back cock.

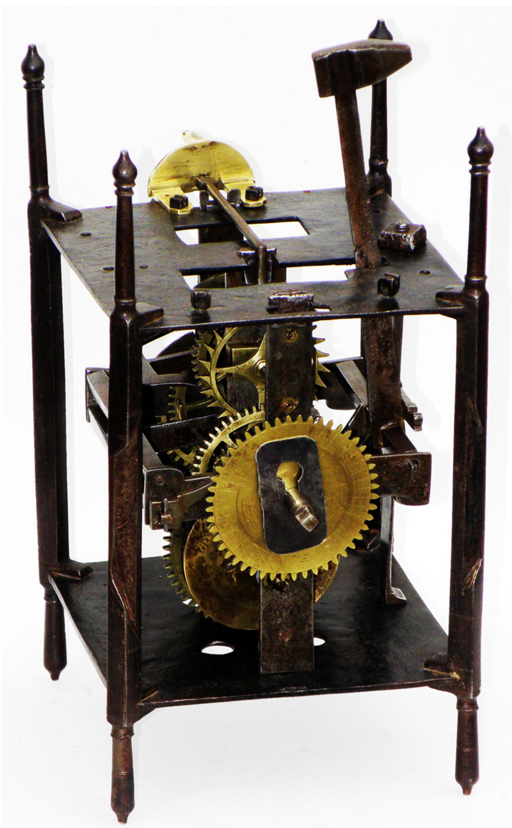


Fig. 22. Clock 6. Front of the movement showing the pallet arbor passing through the top plate.

Fig. 23. Clock 6. Crutch and cranked pallet arbor.

straight and wholly above the top plate.

Since both original four-pronged pinions-of-report survive, there has been no attempt to increase the half-day duration. Also both circular spring clicks on the spiked pulleys remain operational, and there has been no conversion to a single weight to power both trains using a Huygens endless rope. There is no evidence that a single weight was used with a crossed rope, though it cannot be discounted.

Clock 7. Balance lantern clock, *c.* 1660, converted to an anchor pendulum *c.* 1708 by John Fordham, Dunmow[21]

About 1708 John Fordham of Dunmow (now Great Dunmow), Essex, updated a balance clock of about 1660 by fitting a new dial, converting the escapement to an anchor pendulum, increasing the duration and using a single weight with a Huygens endless chain (Figs 24–7). The more fashionable dial, number 190 dating it to about 1708, has a wide chapter ring, typical of the early eighteenth century, while the original twin-dolphin pattern frets, side doors and rear cover were retained. There are no signs of a hoop or spikes for hanging the clock on a wall, so it has probably always been supported on a wall bracket or in a tall case.

The escapement was converted directly to an anchor pendulum, without an intermediate verge pendulum, using the popular arrangement with the pallet arbor above the top plate and an additional wheel in the going train, though done in a rather unconventional manner. The crown wheel of the balance escapement was replaced by a 42-tooth third wheel meshing with a large 14-leaf brass pinion on the same arbor as a 25-tooth escape wheel. This arbor sits just below the top plate so the large escape wheel

21. John Robey, 'John Fordham's anchor conversion', *Clocks*, October 2022, 37–42.

Fig. 24. Clock 7. Balance clock *c.*1660 redialed *c.*1708 by John Fordham and converted to an anchor pendulum.

protrudes significantly through it to engage the pallets of a large anchor. This arrangement usually uses either a brass cock at the front or a vertical pivot support riveted to the top plate. However, Fordham forged an iron bell stand intended for a posted-frame clock to act as a front cock, into which the very short front end of the pallet arbor is pivoted. This iron cock is at an angle of about 45 degrees and is held by a screw in the hole originally occupied by the balance top-cock screw. At the rear a posted-frame back cock casting has been modified to raise the pallet arbor.

In addition, the original four-pronged going pinion-of-report was replaced by a 12-leaf brass pinion and the 48-tooth hour wheel reduced in diameter and recut. As a result of

Fig. 25. Clock 7. Top plate with anchor escapement.

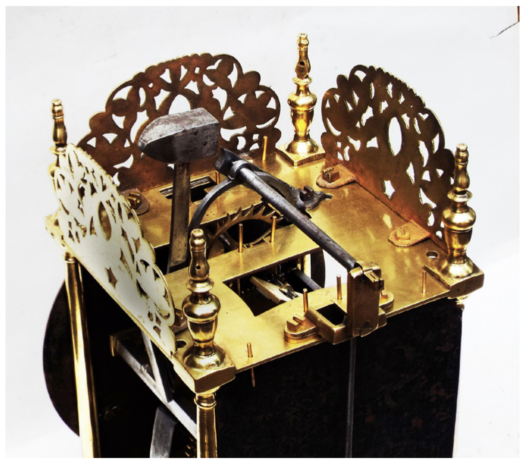


Fig. 26. Clock 7. The large anchor, iron front cock and tall back cock.

these changes the pendulum has a 1-second beat and the going duration was tripled. The duration of the striking train was doubled by changing the pinion-of-report to an 8-leaf one, cutting an extra slot in the locking hoop and doubling the number of hammer pins on the striking great wheel. The spiked pulley was not pinned to the great wheel. There would have been little point in changing the striking mechanism unless the clock was intended to be run with a Huygens endless crossed chain. The duration is now 36 hours, needing daily winding with plenty of leeway if it is not wound promptly each day.

Fig. 27. Clock 7. Movement front with recut hour wheel, later pinion-of-report, third wheel and large anchor escape wheel.

Fig. 28. Clock 8. The Adam clock with restored chapter ring and hand.

Clock 8. Unsigned balance lantern clock, *c.* 1630-40, converted to an anchor pendulum[22]

This early provincial lantern clock, probably made in East Suffolk, is now known as the Adam Clock (Figs 28–31). Its primary importance is its unique pillars, each cast with an image of Adam wearing breeches, the Devil's head and a large apotropaic X-cross to ward off evil spirits that might upset the mechanism. It has had the expected update to pendulum control, firstly to a verge pendulum, then to an anchor escapement and a long pendulum. Duration appears to have been of concern from an early date and drastic measures were taken so the going train would run for a week, though the striking train was unaltered and still retains its original four-pronged pinion-of-report.

The conversion to an anchor escapement was similar to Clock 7, though with different counts, adding a new 56-tooth third wheel and a 24-tooth escape wheel to the going train. The escape wheel protrudes through the iron top plate to engage with the pallets. The front of the pallet arbor pivots in a small vertical iron cock riveted to the top plate and in an iron back cock.

At an indeterminate early date, possibly even when it was first made, daily winding was achieved by looping up all the free ends of the two ropes, passing them through holes in the iron bottom plate and knotting them. The mass of the weights and counterweights needed doubling, as well as the addition of rope pulleys. This cumbersome system probably continued in use until conversion of the clock to a pendulum. Instead of just doubling, or

22. John Robey, 'An Unusual English Lantern Clock', *Antiquarian Horology*, September 2010, 405–16. This article includes an illustration of the top plate with all the holes identified from the balance, verge and anchor escapements.

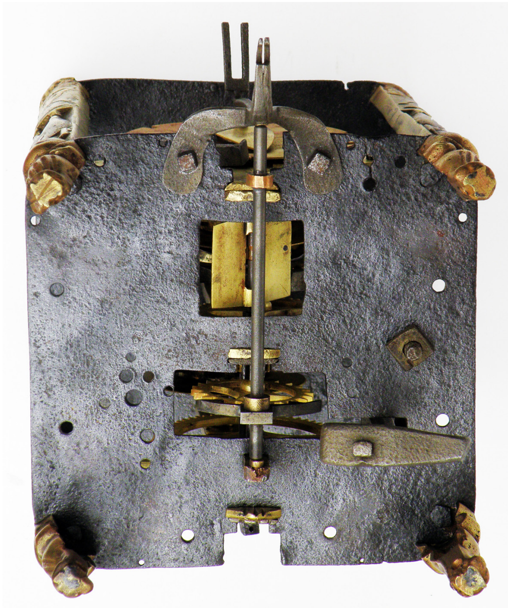


Fig. 29. Clock 8. Iron top plate with the later anchor escapement and empty holes from previous escapements.

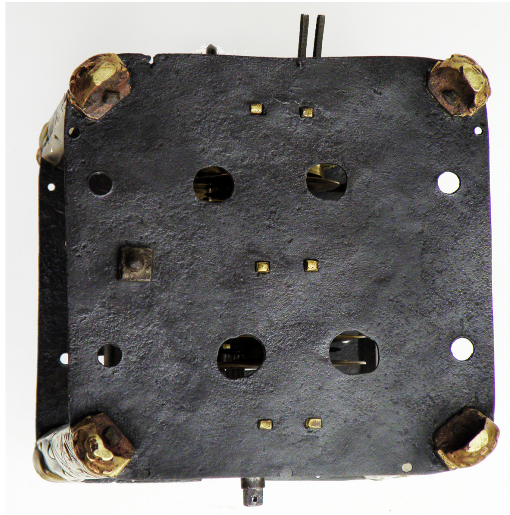


Fig. 30. Clock 8. Holes in the bottom plate for doubled ropes to increase the duration when using two weights.

even tripling, the pinion-of-report to give a corresponding increase in going duration, the motion-work was substantially modified. A large brass 21-leaf pinion replaced the original one, while a smaller 36-tooth hour wheel of unknown previous use (possibly from a small turret clock), replaced the original 48-tooth one. The changes to both the going train and the motion-work resulted in a pendulum beat of 1.1 seconds and a going duration of seven days. The going winding click has been removed and the spiked pulley pinned to the great wheel, so after its conversion to a pendulum the clock was run using a single weight with a crossed Huygens endless rope. However, since the striking train has not been altered, and bearing in mind that the total duration is largely determined by the fastest running train, the clock would only run for 24½ hours and still need daily winding to operate it as a striking clock. The wear from the winding click on the crossings of the going great wheel is twice that seen on the striking great wheel. The conclusion is that even when powered by separate weights the striking train was rarely wound. Full advantage of the long duration of the going train could only have been achieved by silencing the hourly strike — most simply done by blocking the fly. It is

Fig. 31. Clock 8. Front of the movement showing the later very large pinion-of-report and smaller hour wheel.

very likely that this was the original intention all along and after conversion it was run as a 7-day timepiece. Regardless of how it was operated, these changes ensured that this remarkable piece of horological folk history remained in use into the twentieth century when a 'more modern' chapter ring and frets were added, but now removed.

Clock 9. West Country lantern clock with a verge pendulum, *c.* 1680, converted to a longcase clock[23]

English lantern clocks made after 1658 with a verge escapement and a short pendulum almost invariably have a 30-hour duration and a single weight on an endless rope or chain. The hammer was on the left-hand side and the strike-work detents on the right, and the correct Huygens layout was used. Hence when they were converted to an anchor escapement and long pendulum there was little need for further modifications. While many lantern clocks simply had a new escapement and pendulum and continued as wall clocks, others were used as the basis of a new longcase clock. The example in Figs 32–4 is such a conversion with many features of the original lantern clock that are quite different to London work.

The plates are larger than on London clocks and the pillars, finials and feet were cast in one piece, though the finials and feet were sawn off when it was used as a longcase movement. Instead of the top of each movement bar being located in a slot in the top plate and held by a wedge, a recess in the bar fits over a brass block riveted underneath the top plate and it is held by two taper pins. The bars stand on legs, similar, but not identical, to those used by Thomas Veale of Chew Magna, Somerset. The arms of the front and rear bars have T-shaped ends, not the more usual up- and down-turned ends. An extended lug on the rear of the original chapter ring would have fitted into a square hole in the front movement bar to attach the dial, rather than taper pins through the top plate. The chain pulleys have twin spikes that engage with the outside of the links, not single spikes passing through alternate links.

When the lantern clock movement was used as the basis for a longcase clock, all unnecessary appendages were removed: i.e. the finials, feet, frets, doors, rear cover, and the bell strap, which was replaced by an iron bell stand screwed to the top plate.

Fig. 32. Clock 9. Rustic longcase clock made using a converted lantern clock movement.

The conversion to an anchor escapement involved the removal of the crown wheel and the replacement of the contrate wheel by a 45-tooth escape wheel. The new pallet arbor pivots between iron cocks, while the pendulum hangs from small brass chops fixed to the back-cock. Since the pallet arbor sits quite close to the top plate, and the escape wheel and anchor are quite large there is a satisfactory escapement geometry. As expected the original 30-hour duration has not been altered, with a 12-leaf brass pinion-of-report meshing with a 48-tooth hour wheel providing three times the going duration of a balance clock. While this brass pinion fits on

23. Robey, *Gothic Clocks to Lantern Clocks*, pp. 276-9.

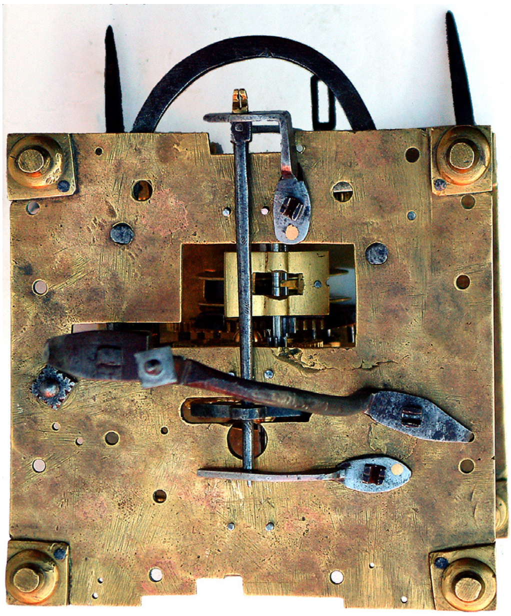


Fig. 33. Clock 9, Top plate with the pallet arbor pivoting in iron cocks. The hoop has been moved but the spikes were not shortened.

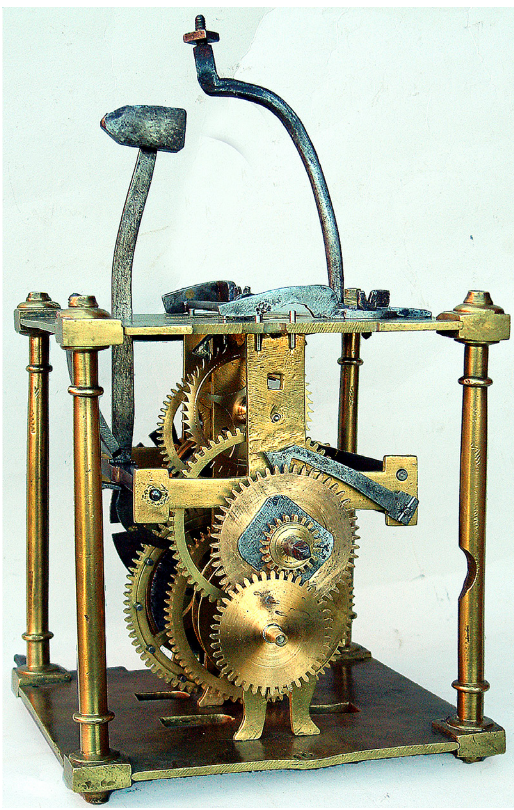


Fig. 34. Clock 9. Movement with a large escape wheel and calendar-work.

a square on the great wheel arbor, the 6-leaf striking pinion-of-report is filed directly into the end of the great wheel arbor.

Instead of the movement sitting on a seat board, the original hoop and spikes were retained to hang it from a hefty forged iron hook fixed to the backboard. To avoid the case being excessively deep the hoop was moved forwards on the top plate, but the spikes were not reduced by the same amount. Instead blind holes were drilled in the very thick backboard. The final part of this conversion was to fix to the hour wheel pipe a 20-tooth wheel that meshes with a 40-tooth wheel to advance a daily calendar ring. Clearance had to be provided on the right-hand front pillar for the ring to turn freely.

Clock 10. Lantern clock movement originally with a verge pendulum, *c.* 1680, converted to an anchor escapement

The lantern clock movement in Figs 35–37, now missing its original dial, is primarily of interest owing to the method of supporting the pallet arbor and especially for the large separation between the pallet and escape wheel arbors.

A horizontal front cock, probably from the previous verge escapement, is screwed to the top plate, while the extra-long pallet arbor pivots in a back cock fixed to the large hoop originally used for hanging the clock on a wall hook. The contrate wheel of the original verge escapement was relatively small and low down in the movement. When it was replaced by a similarly sized 48-tooth escape wheel of 2.15in (57mm) diameter, its teeth were an appreciable 0.7in (18mm) below the top plate. Since the wheels of a clock train must clear the arbor directly below them, the contrate wheel cannot simply be replaced by a larger escape wheel that pivots higher up the movement, or even protruded through the plate. As a result this movement has a large distance between the escape wheel and pallet arbors. So that the pallet nibs can reach the escape wheel teeth, they hang from a long stem and only span 7½ teeth, a significantly smaller fraction of the total than usual.

There are several disadvantages to this escapement geometry. Firstly, with such a large nunber of teeth and a large arbor separation, and a relatively small angle of engagement,

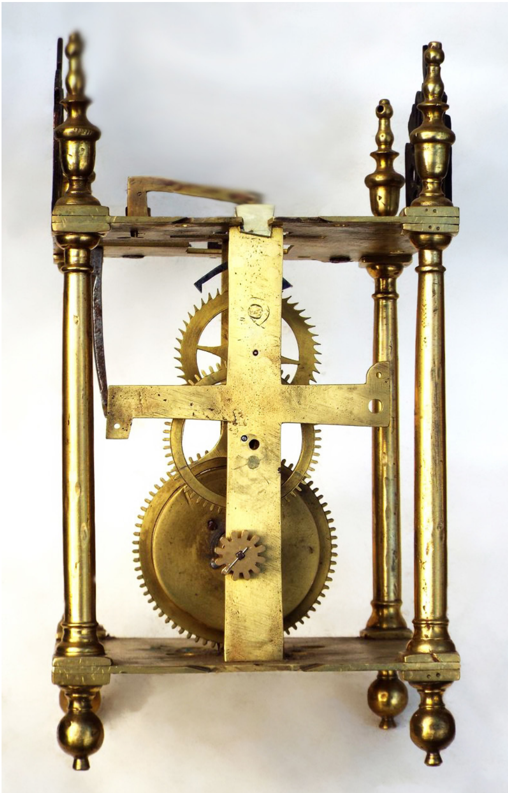


Fig. 35. Clock 10. Movement with only the going train assembled. The anchor escapewheel is a long way below the top plate.

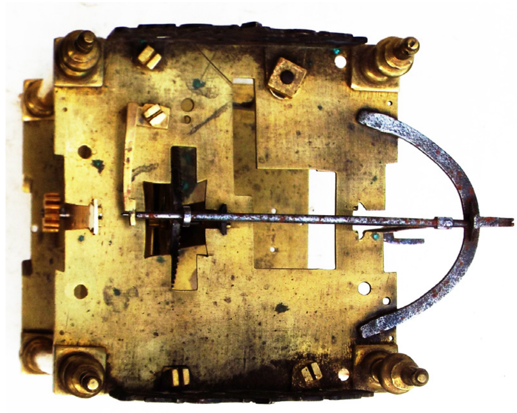


Fig. 36. Clock 10. Top plate with the back cock fixed to the large hoop.

Fig. 37. Clock 10. The escapement with the pallets hanging from a long stem.

the escapement will be much less tolerant of wear on the pivots and on the pallet faces. Secondly, the angles between the pallet faces and the teeth circumference mean that there is almost no impulse given by the entry pallet and almost all of it is on the exit pallet, which will have quite severe recoil (see also Clock 4). For the escapement to work satisfactorily there needs to be very little wear on the bearings of the escape wheel and pallet arbor pivots, and the pallet faces need to be in good condition. This situation was forced onto the clockmaker converting the clock to an anchor escapement by the layout of the original verge going train. It may well have been better if he had left well alone.

There have been no changes to the original 30-hour duration.

Clock 11. Edward Webb, Chew Stoke, 1682, long duration verge lantern clock converted to an anchor escapement[24]

This large and very heavy Somerset clock is one of only two known English lantern clocks made with a long duration. Both clocks originally had a verge escapement and a short pendulum, then converted to a long anchor pendulum. The other one is an 8-day clock made in 1672 for Sutton Court,[25] not far from Chew Stoke which is eight miles south of Bristol. Though unsigned it was almost certainly the work of the same clockmaker; it has since been reconverted back to a short pendulum. The clock discussed here

24. Robey, *Gothic Clocks to Lantern Clocks*, pp. 263–7.

25. David Evans, 'The Great Lantern Clock from Sutton Court', *Antiquarian Horology*, March 1998, 47–54.

Fig. 38. Clock 11. Long-duration lantern clock by Edward Webb dated 1682.

(Figs 38–40) is signed in the dial corners 'Edward Webb of Chewstoke Fecit 1682', and has many of the same West Country features as Clock 9. There is a passing half-hour strike on a small bell positioned vertically inside the large hour bell. There is a sturdy iron hoop at the rear, but no spikes. In view of its total weight of about 35lb (16kg) it probably, like the Sutton Court clock, originally sat on the seat board of a tall case, with the hoop used for extra stability. Edward Webb is the only English clockmaker known to have fitted sheet-iron dust covers over the escapement and fly apertures, the screw holes being visible in the top plate. Most of these covers are now missing, but one survives on a Webb clock now in the Netherlands.[26]

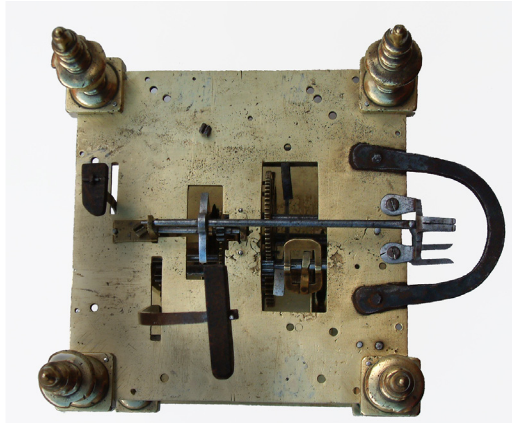


Fig. 39. Clock 11. Top plate with conversion to an anchor escapement. Note the screw holes near the fly aperture that held a sheet-iron dust cover.

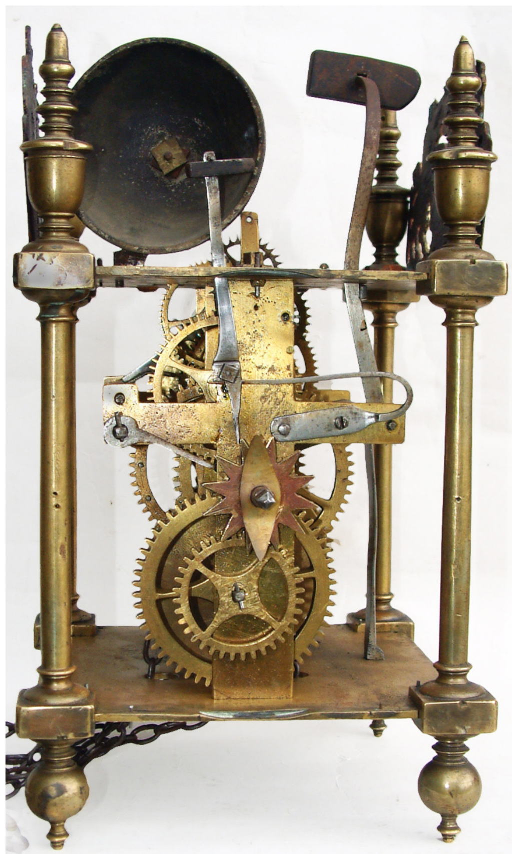


Fig. 40. Clock 11. Front of the movement. The very large pinion-of-report drives the small hour wheel hidden behind the star wheel.

26. Information from Michiel van Hees.

To produce a longer running time it was made with an extra wheel above the great wheel of both trains, with the hammer pins now on the additional second wheel of the striking train. This allowed the motion-work to be a large 36-tooth ‘pinion-of-report on the going great wheel arbor that drives a small 23-tooth hour wheel. The going great wheel and chain pulley turn only 1.3 times a day, giving a going-only duration of 6.8 days. The longer duration of the striking train was achieved by locating the 7-leaf pinion-of-report on an extended pin-wheel arbor to drive the 39-tooth countwheel gear, which is set higher up the rear movement bar than usual. The striking great wheel and chain pulley now rotate only 1.8 times a day with a strike-only duration of 4.5 days, and an overall duration of 5.7 days. The extra wheels necessitate the hammer being on the right-hand side and the strike-work on the left.

The conversion to an anchor escapement followed similar principles as on the previous two clocks, but with extra wheels. Instead of the fourth (contrate) wheel being replaced by an escape wheel it was changed to an arbor with a 32-tooth wheel and a 12-leaf pinion, and after removing the crown wheel a 30-tooth escape wheel and an 8-leaf pinion were inserted. These extra wheels allowed the use of a 1-second pendulum. The going train now consists of five wheels: the usual three wheels of a normal 30-hour clock, plus an extra one for the longer duration and another for the anchor conversion. As might be expected there was no need to make further increases to the duration.

Conclusions

Few balance lantern clocks escaped being converted to a pendulum to greatly improve long-term timekeeping, and many clocks originally made with a verge pendulum were converted to an anchor escapement. Conversions often included increasing the inconvenient half-day duration, as well as running the clock with a single weight on a Huygens endless rope or chain. There are different ways in which these changes were achieved, sometimes involving a major rebuild of the movement. While these later upgrades have often been regarded as debasing the clock, with a desire to revert it back to how it was originally made, these conversions are interesting in their own right. Each conversion has a tale to tell and is an important aspect of the clock’s long history, which may even indicate in which country it resided a couple of centuries or more ago.

Acknowledgements

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