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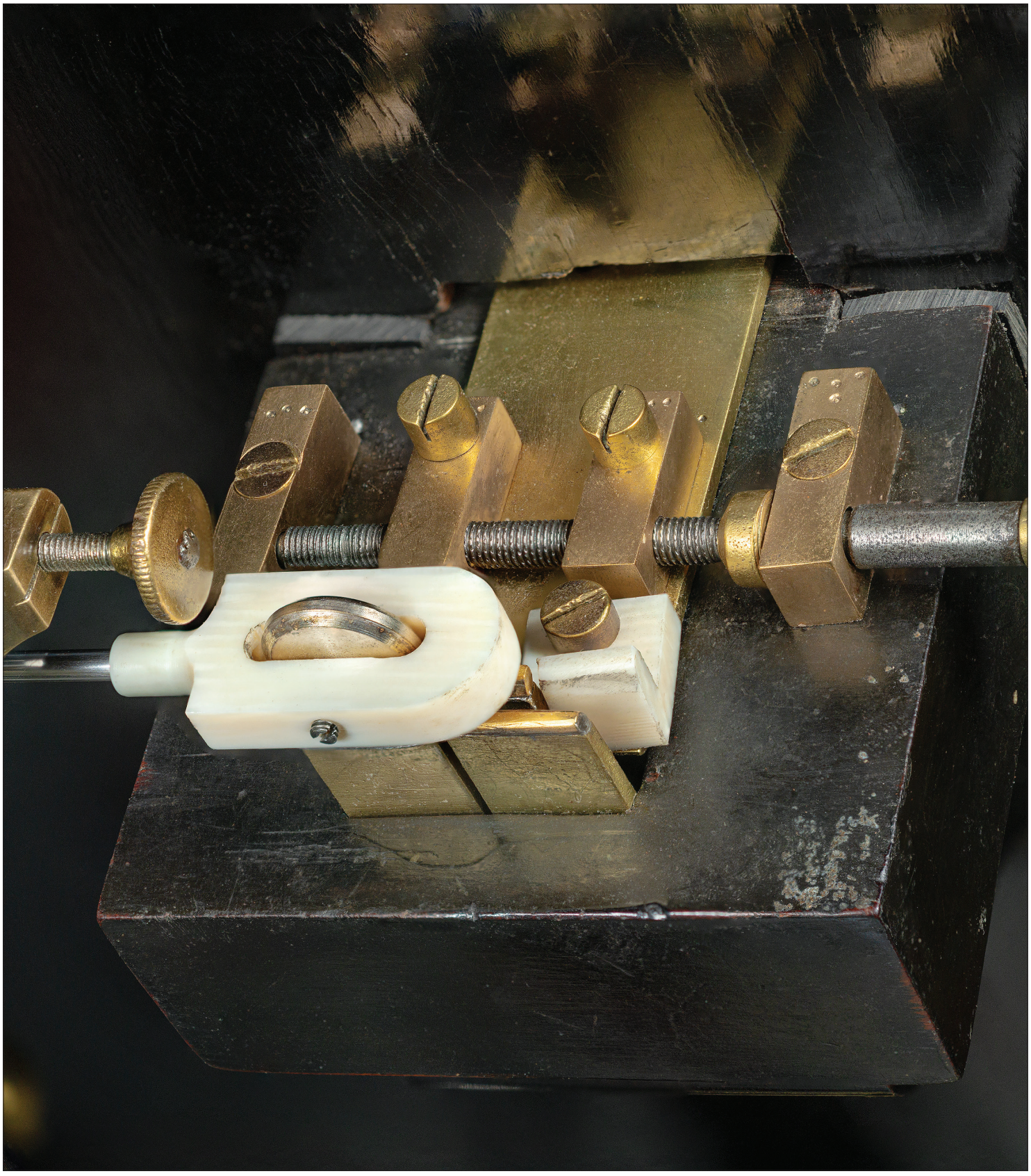
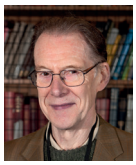


Rare Bentley Earth Clocks

A Pair of Pre-Patent Electric Clocks Brought Back to Life

Jim Arnfield FBHI



The story begins about twenty-five years ago when I was invited to visit the store room of a clock collector. The room contained many longcase clocks, mostly from the north west and particularly from Liverpool. However, leaning against the wall of the passage outside the storeroom were two ebonised electric wall regulators, which looked to be similar to the early Alexander Bain design. One was in very poor condition, very dirty, with the door broken in half and its glass missing. The other looked better, with its case intact, but it was obvious that the original contact assembly halfway down the pendulum rod had been removed and an attempt made to get it working on the Hipp-toggle principle using contacts out of an old relay, and re-wired with PVC-covered wire.

The story of how the clock with the damaged case was found in Bolton near Manchester about ten years before I saw them both, and the other (with the altered contact system) discovered by the same person at the First International NAWCC convention in 1994 in Orlando Florida, is quite extraordinary.

Moving the story on to recent times, I received a phone call early last year from the owner to ask whether I would like to get them into running condition. After some discussion I agreed to examine them and report what I could do to achieve his aim. The clocks were delivered and carefully re-examined. This revealed that they were similar to Bain's design, but they must be much later because the construction used many BA threads which were first brought into use in the 1890s, 50 years after Bain's work. Clock Two (the clock with the undamaged case) has a silvered name plate, probably for a retailer, engraved 'E. Smith Leeds', **Figure 1**.

Clock One (with the broken door) has no identification anywhere on it. I know of the Bentley electric clocks using a cam-operated contact system, but the contact system in these two clocks was unknown to me so I contacted some of my electric clock friends and Jan Wright came up with what is certain to be the correct answer. He sent me a PDF of the patent illustrated in **Figure 2**, No. 19044 dated 1910, in which is described the first contact system used in early Bentley clocks, although there is a difference in that the patent drawing shows five contacts on each side of the pendulum, as shown in **Figure 3**, and Clock One has only three contacts as described in words in the first page of the patent. Although the contact system and wiring had been removed from clock two it was obvious from the grooves in the backboards that it originally also had the same contact system as clock one, **Figure 3**. My conclusions were that both clocks were made by the Bentley company, pre-dating the 1910 patent, and were pre-production models made before the first Bentley clocks were manufactured and advertised for sale.

There is a very good article by Dr A. Shenton, 'The Earth Driven Clock', in the December 1972 edition of *Antiquarian Horology*, describing the history of the Bentley company and

Figure 1. Silvered plate likely inscribed with the retailer's name, inside Clock Two.

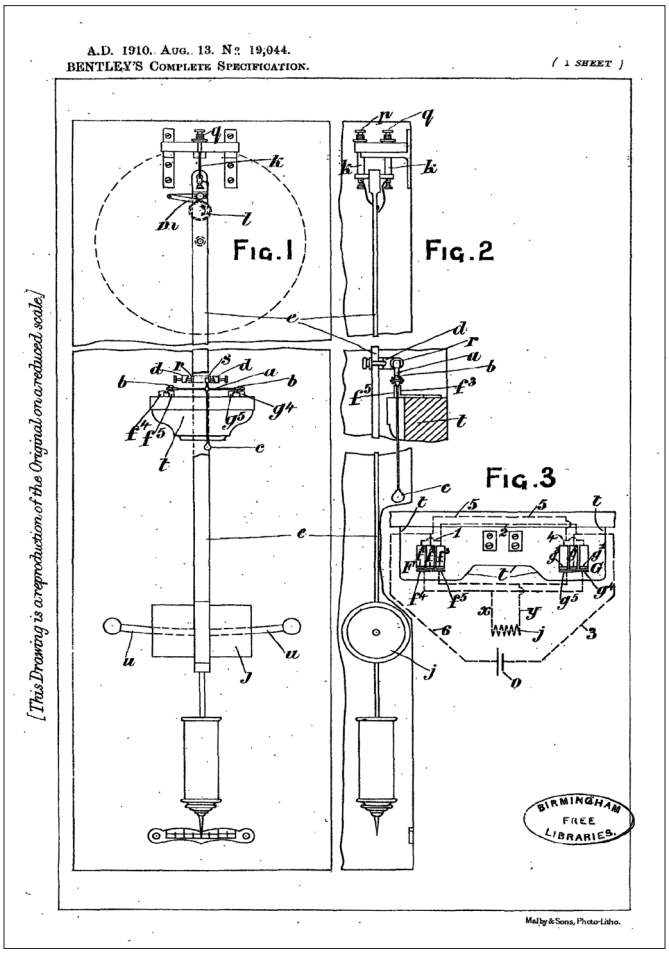


Figure 2. Drawing from the 1910 patent.

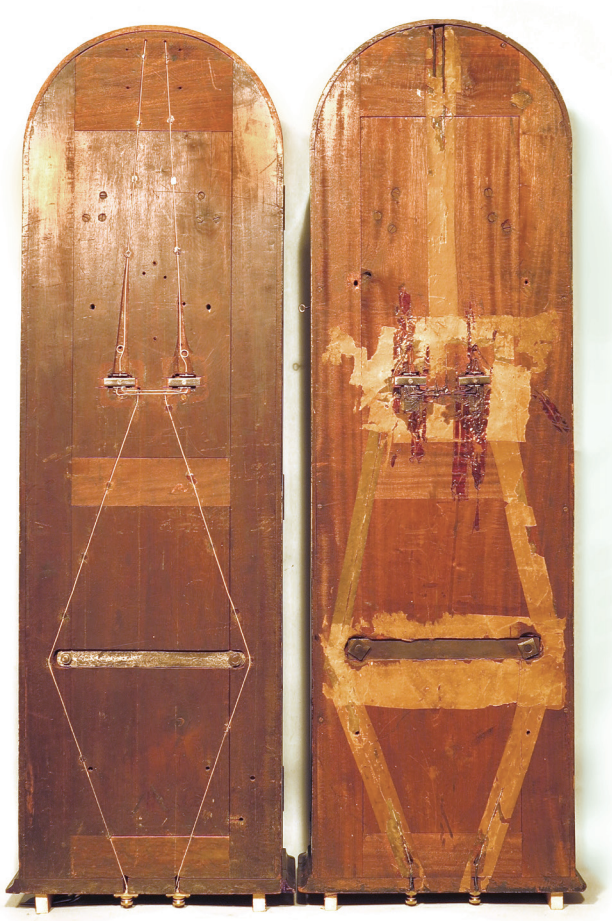


Figure 3. Backboards of the two clocks, seen from the rear.

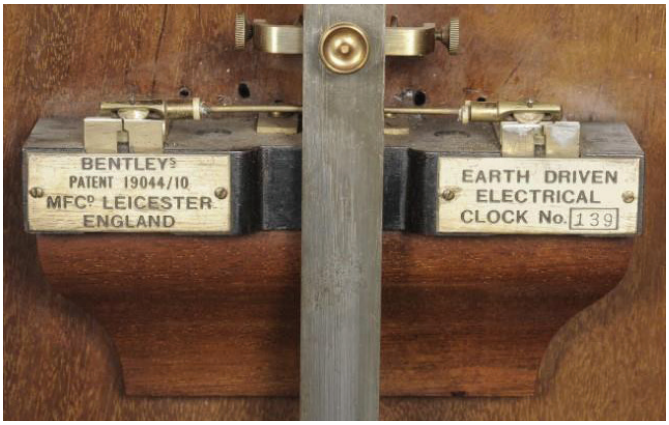
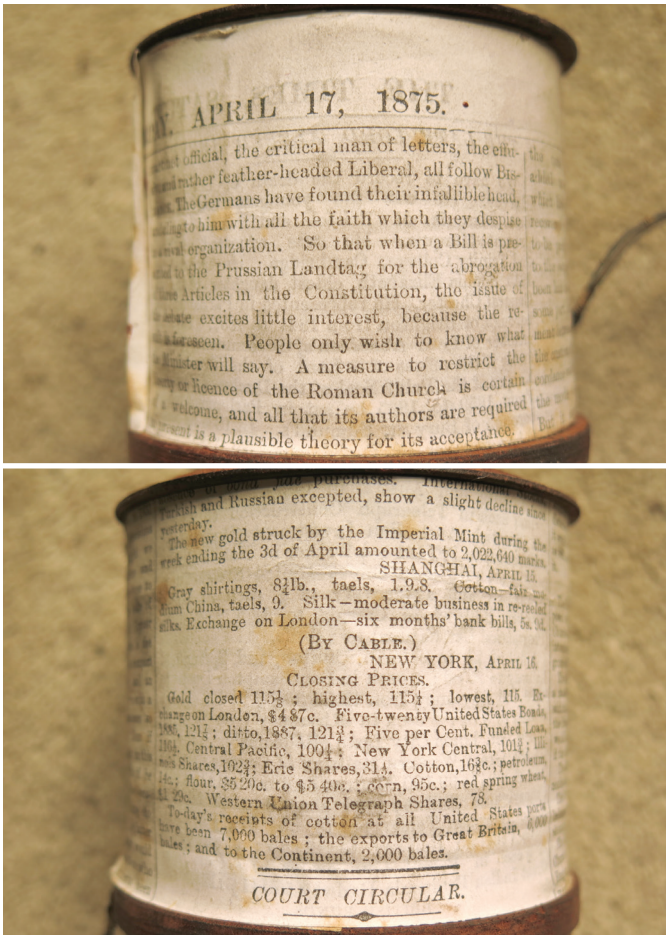


Figure 4. A later trolley contact clock with Bentley labels.



Figures 5 and 6. Paper covering of the coils of Clock Two.

the electric clocks they made. Some readers may not know what an earth-driven clock is. Before WW1 a reliable mains electrical supply and the dry cells as we have today were very new and had only recently become available. The mains supply then was often DC at 110 volts, intended for lighting and difficult to reduce to a level suitable for electric clocks. Batteries were used for low voltage applications, but as they mostly used a liquid electrolyte, required regular attention and therefore not suitable for use in powering clocks. In the mid-nineteenth century when Bain was designing his clocks the situation was much worse so he used what is usually called an earth battery, and the Bentley company adopted the same idea.

To make an earth battery a pit is dug about a metre square and a metre deep. Into the bottom is placed 200 mm of carbon in the form of charcoal or coke. In this layer copper wires are buried which make the positive connection. Then earth is replaced for about 400 mm and heavy plates of zinc with insulated wires sealed with pitch are placed on top, becoming the negative connection. The pit is then filled in and tamped down. This provides an output of about 1 volt at enough current to drive an electric clock for many years, although the output voltage varies with changes in ground humidity and temperature.

In the 1840s Bain developed a contact system which helped to keep the pendulum amplitude constant and the early Bentley clocks used a complicated contact arrangement for the same purpose.

In the Bentley clocks that are the subject of this article, there is a large bar magnet across the rear lower backboard with iron pole pieces continuing through the backboard and into the pendulum coil. The ends of this looped magnet are separated by a gap of about 20 mm, concealed within the pendulum coil. The pendulum coil is wound on a brass-covered wooden former with 18-gauge cotton-covered wire. The coil is in two halves, wound from the centre out, producing what are termed coincident poles. When the current is in one direction the pendulum coils have north poles in the centre and south poles at the outer ends, and of course when the current is reversed the poles reverse. The coils in the first clock have a resistance of 4 ohms and in Clock Two, wound with slightly thinner cotton-covered wire, the coil resistance is 8 ohms. The cotton covered wire coils in Clock One had no covering whereas interestingly in Clock Two each coil was wrapped in old newspaper, one dated April 17, 1875, **Figures 5 and 6**.

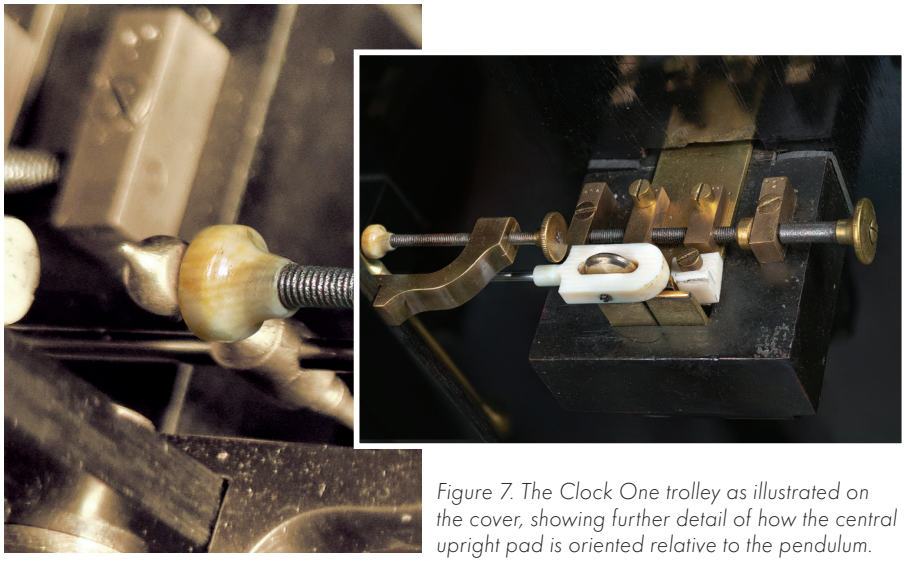


Figure 7. The Clock One trolley as illustrated on the cover, showing further detail of how the central upright pad is oriented relative to the pendulum.

Figure 8. Clock One with original, if somewhat temperamental electrical contacts.

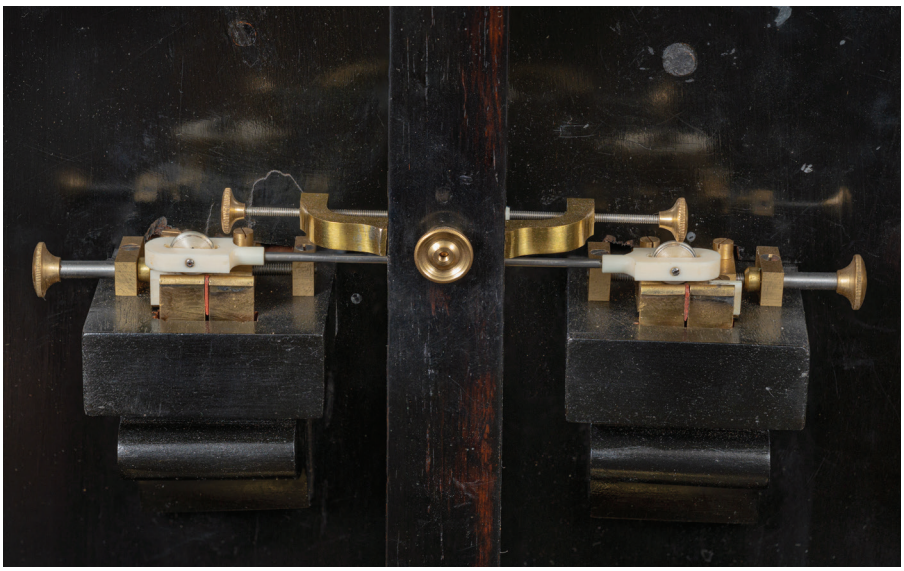


Figure 9. Clock Two; much of the contact assembly was missing. The replacements were made longer by about two millimetres to prevent the trolley running off, as sometimes experienced with Clock One.

The twin contact assembly is arranged to reverse the current to the pendulum coils near the end of the pendulum's swing, **Figures 7, 8 and top view 9**, so the centre magnetic pole of the coil is attracted to the approaching permanent magnet pole and repelled by the other. This is achieved by having what in the Bentley patent is called a jockey carriage, or trolley, **Figure 10**. This consists of two insulated metal wheels mounted tandem fashion at the same distance apart as the gap between the cross-connected front split contacts. The position of the rear contacts is sideways adjustable by a screwed rod, and each has an insulated section at its outer end. This disconnects the current when the trolley wheels move on to it at the end of the swing and is how the pendulum amplitude is controlled when using an earth battery.

The first page of the 1910 patent describes the system clearly. The patent document goes on to describe an improved system in which the insulated outer end section of the rear contact, is replaced by another electrically cross-connected contact so at that position the current is again reversed, thereby using the electromagnet poles to oppose the permanent magnet poles and more effectively limit the pendulum amplitude.

Both cases required much work particularly Clock One, the curved top to the door of which was broken and of very thin section. Some re-making was necessary so the metalwork of both clocks was removed and the cases sent off to a casemaker. When the cases were returned everything from case one had a preliminary cleaning and was replaced so that experiments could be started on trying to get the clock running. This proved very difficult as the contact track was uneven and as the jockey carriage ran to and fro along the track it frequently fell off.

After many dismantlings and adjustments to the track I gained enough experience to start work on making a completely new contact assembly for the other clock. I decided to make the new contact assembly 2 mm wider than the original. The reason was that Clock One still had problems; if the pendulum amplitude increased by a small amount then the trolley would run off the end of the track. Also, as USB phone chargers are readily available at very low cost the decision was made to use these to power the clocks. A variable resistor

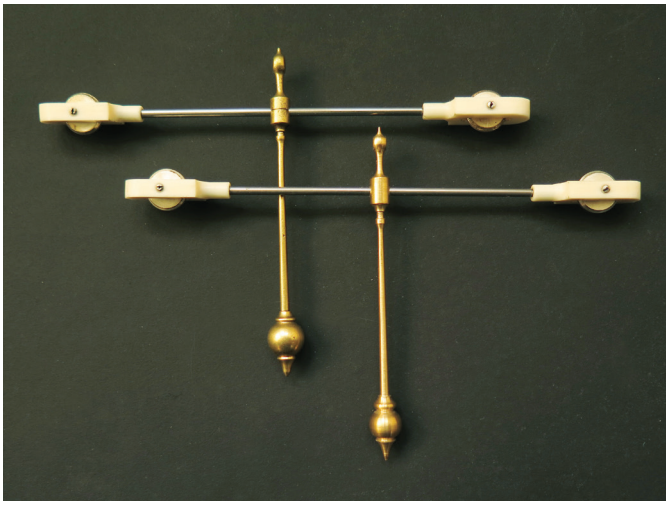


Figure 10. The contact trolleys.

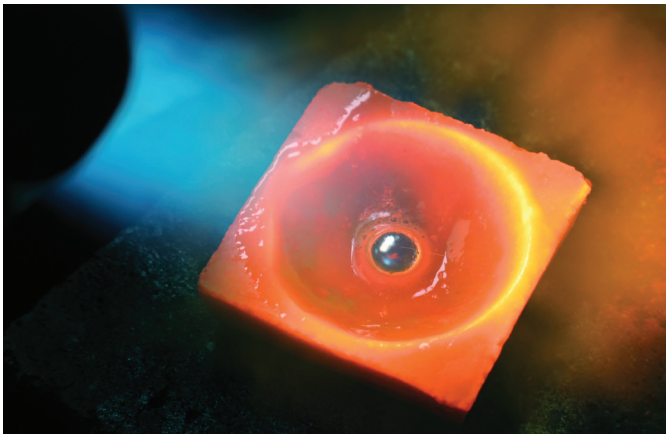
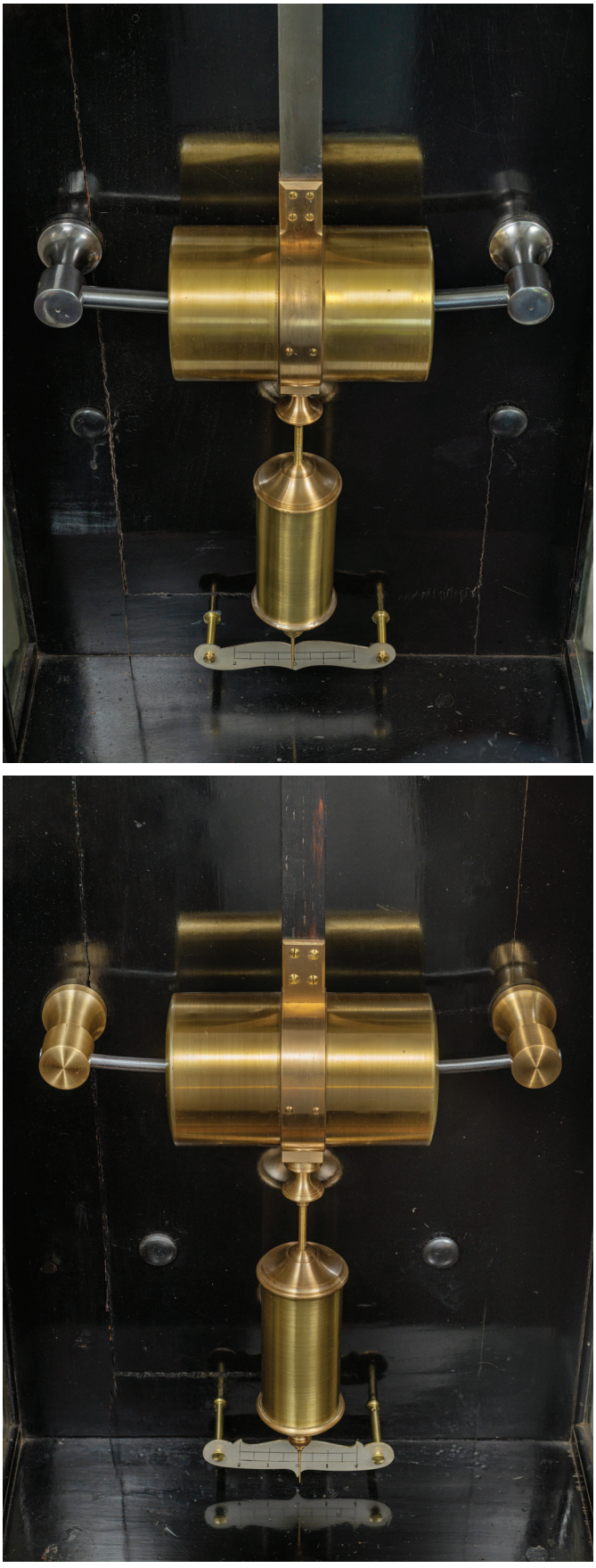


Figure 11. Melting the silver into a button.

Figure 12. Turning the button to size, in the background one button hammered flat, the other part turned.

was added in series with the output of the regulated supply enabling close control of the pendulum amplitude.

Work then started on making the replacement contact assembly for Clock Two. I had asked the casemaker to copy the wooden brackets and the blocks to which the contacts are fixed. When the cases were returned Case Two was ready for the newly made wider contacts which had otherwise been



Figures 13 (Top: Clock One) and 14 (Bottom: Clock Two). The pendulums each have a pair of electrical coils concealed within the horizontal brass casings, swinging over the ends of what is effectively a horseshoe magnet whose pole gap is hidden within the brass casing. The rest of each magnet body passes through its backboard and is hidden at the rear of the clock. Each pendulum has a further bob extension below, filled with lead shot.

copied closely from those in Clock One. Case Two was then re-wired with double cotton-covered wire using the original grooves at the rear of the backboard as it would have been when first made. Large terminals to connect an earth battery were originally fitted to the bottom of both cases, but those on Case Two were missing, so again they had to be re-made. The original tandem trolley with Clock One had at some time had the wheel insulators replaced by ones made out of Perspex (acrylic plastic), a material only discovered in the 1930s. I therefore made four sets of new wheels and insulators, **Figure 10**, in more appropriate materials and, of course, the rest of trolley one was copied for Clock Two. The new wheels were made from old sterling silver coins, **Figures 11 and 12**, and run on 18-carat gold-covered tracks. The movements and dials were in quite good condition, which again is remarkable considering the early history of the clocks and that the dials are of window glass with gold leaf numerals applied from the rear. However, the pendulums were in poor condition with active corrosion on the brass casings.

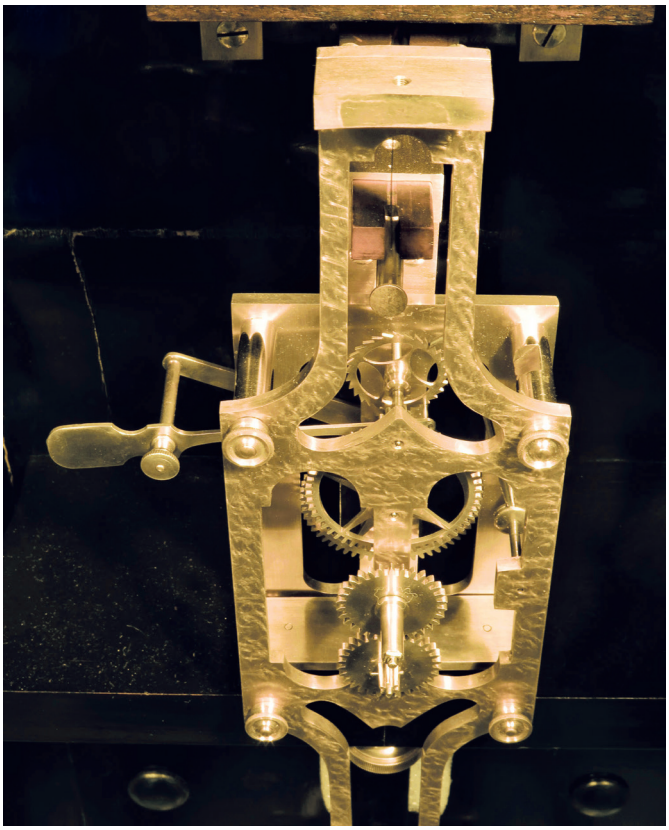


Figure 15. The movement of Clock Two.

Figure 16. Cutting the new count wheels.

Clock Two pendulum had received cleaning attention in the past, probably when the original contacts were removed. Removal of the original lacquer and an attempt to clean the brass work had been done by a previous workman with the pendulum in-situ in the clock! This was very evident by very thick tears of lacquer running down the back of the cylindrical bob. It took many applications of paint remover to get all the lacquer off. Because the finish on Clock Two bob had been lost and because of the corrosion on both bobs, it was decided that they would have to be refinished in a close copy of the remains of the finish on Clock One, **Figures 13 and 14**.

When all this work was completed, the clocks were set up for testing, which included re-magnetising the backboard-mounted magnets. After the usual adjustments to the switching point both clocks ran successfully for a day or two, but still, even with the extended contacts on Clock Two the trolley ran off the end of the track stopping the clock. After carefully considering the problem, I noticed that the Clock Two pendulum gathering pallet had originally been fitted above the count wheel (as Clock One still is), and at some time its position had been changed to below the wheel, **Figure 15**. Obviously, there were the same trolley problems when the clock was first made, so the gathering pallet had been moved down below the wheel to have more motion to safely gather the teeth of the wheel at the same amplitude. Also, Clock Two had a slightly smaller diameter count wheel than Clock One, so I decided that the only way of getting a reliable action was to make slightly smaller count wheels, **Figure 16**. Two new count wheels three-quarters the diameter of the originals were cut. The originals were mounted on brass collets soft soldered to the arbors and the new wheels are mounted in the same way. The originals will be kept with the clocks. After this modification the clocks ran very reliably, were then brought to time and run on test for several weeks before they were returned to the owner.

Postscript

Since the article was written some interesting additional information has been given to me by Ian Shinnie. In 1857 Henry Kerr was awarded a prize of three sovereigns in Edinburgh for the quality of his workmanship in the construction of an electric clock with a trolley contact system working in exactly the same way, and with a pendulum also very similar to the clocks described above. Ian points out that Edward Smith of Leeds comes in to the story in the late nineteenth century: there are two other electric clocks known, signed E. Smith and both are very similar to Clock Two above.

Ian has done much work in order to find the connection between Bain, Kerr, Smith and Bentley, but so far, no close connection has been found. The clock description on page one and the diagram on page three of the 1910 Bentley patent give very convincing evidence to suggest that Clocks One and Two were pre-production Bentley clocks. It may be useful to know that Bentley patented a much-improved contact design only three years after the 1910 patent, proving how out of date the 1910 contact system was.

Photographs: Figures 1, 7-9 (except inset image) 13 and 14 by Yarek Baranik.