A Drive Unit for the Great Clock 3

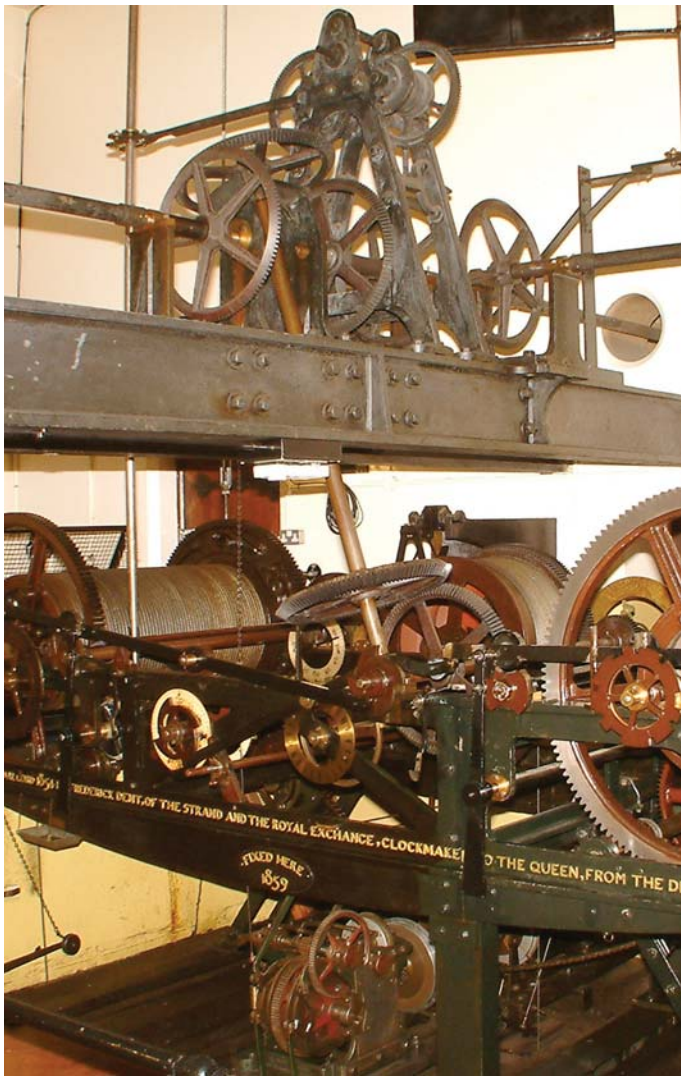
Chris McKay, BSc CEng MIEE MBHI concludes his series.

Dacre is a delightful village in the Lake District and home to the Cumbria Clock Company. For 17 years now this small company has specialised in quality heritage turret clock restoration work. It is no stranger to electro-mechanics having developed a powerful automatic winder with over 400 of the units now in service.

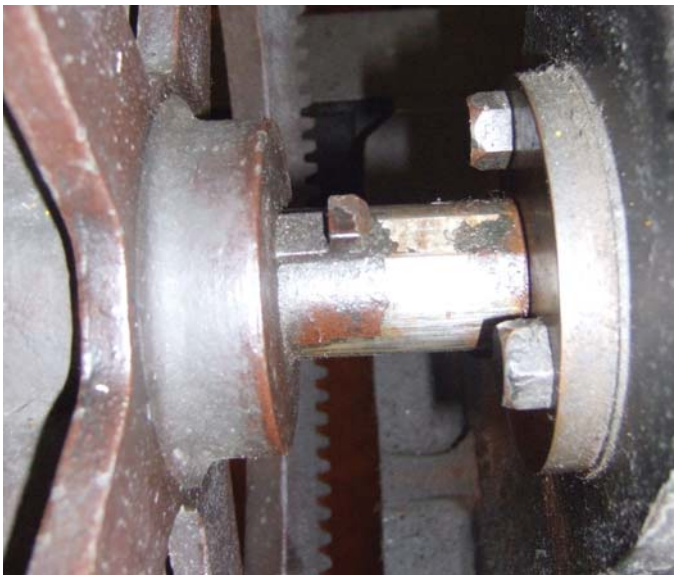
Design for a drive unit for the Great Clock dials commenced on the basis that the unit had to drive the four dials, and it had to be easily engaged and disengaged. A visit to the Great Clock and an inspection of the bevel gear cluster above the clock revealed that space was rather limited, **Photo 1.** Fortunately the bevels were secured to their arbors by keys **Photo 2** providing something secure with which to make a connection.

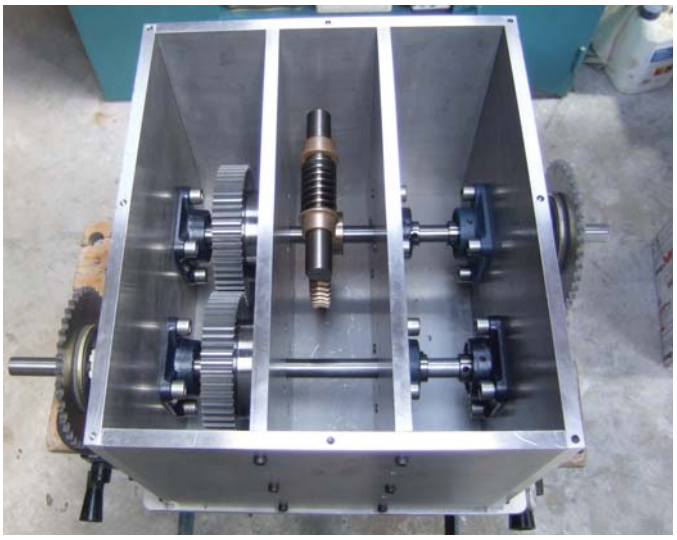
Basic data in the book *A Rudimentary Treatise on Clocks Watches and Bells* by Edmund Beckett Denison, (later Lord Grimthorpe), gave train counts and sizes. However it does not give specific information on the going train weight. In deCarle's book *British Time* the going weight is listed as 1cwt, so calculations were made on this basis. To give a worst-case scenario it was assumed that all the driving torque arrived at the centre wheel, the train being 100% efficient. Figures were double checked. Fortunately Managing Director of the Cumbria Clock Company, Keith Scobie Youngs, checked the figures with Ian Westworth of the Westminster Palace's team of horologists. Ian immediately identified that the going train weight is closer to 2½ cwt, so the figures had to be re-run. Luckily this was before the design was firmed up and parts ordered.

The final design comprised two chain sprockets that are split, enabling them to be clamped with bolts onto the bevel gear arbors without having to dismantle anything. These were designed on CAD and laser-cut for accuracy. A slot in the sprocket arbor engaged with the projecting head of the securing key on the bevel gear providing a positive non-slip drive. Two sprockets were decided upon; one on one arbor, the other on the opposite arbor. Since there was a nest of bevels in-between, the sprockets would rotate in opposite



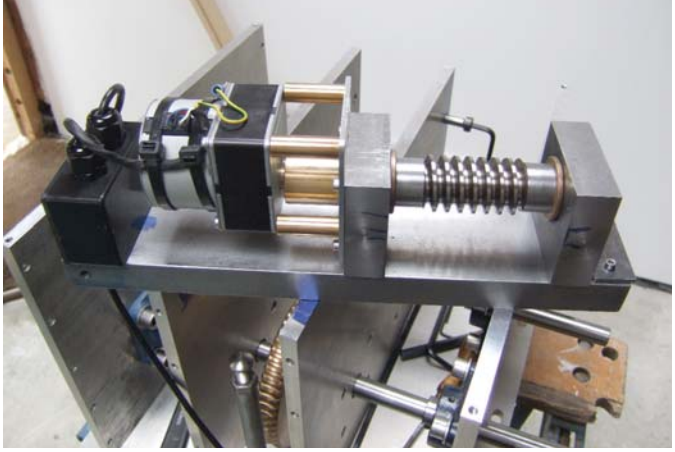
1. The Great Clock's leading off on the girders above the clock. The A–shaped frame is not part of the bevel gears, it is a lifting winch known as a double-barrelled crab. Drive to the dials is through the diagonal rod from the clock to the left-hand bevel cluster. The drive then goes to the other side of the crab where it is split by more bevels into three drives for the other dials.





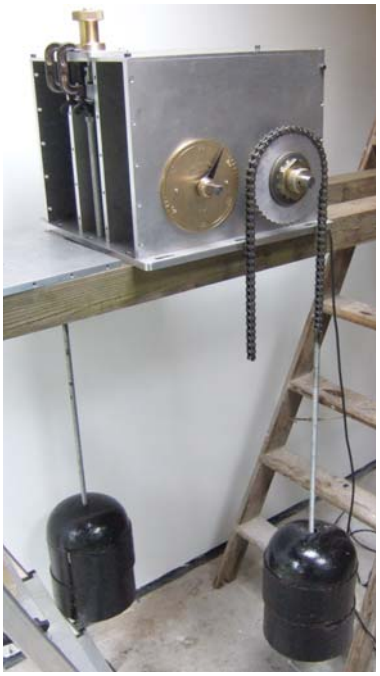
2. (Top) Part of one of the bevel gears showing its fixing key.

3. (Above) Inside the drive unit showing the reversing spur gears. The motor has not been installed; the worm has been placed on top of the worm wheel to show its position.



4.Synchronous motor and its worm on the swinging frame.

5.The hand-made setting dial.

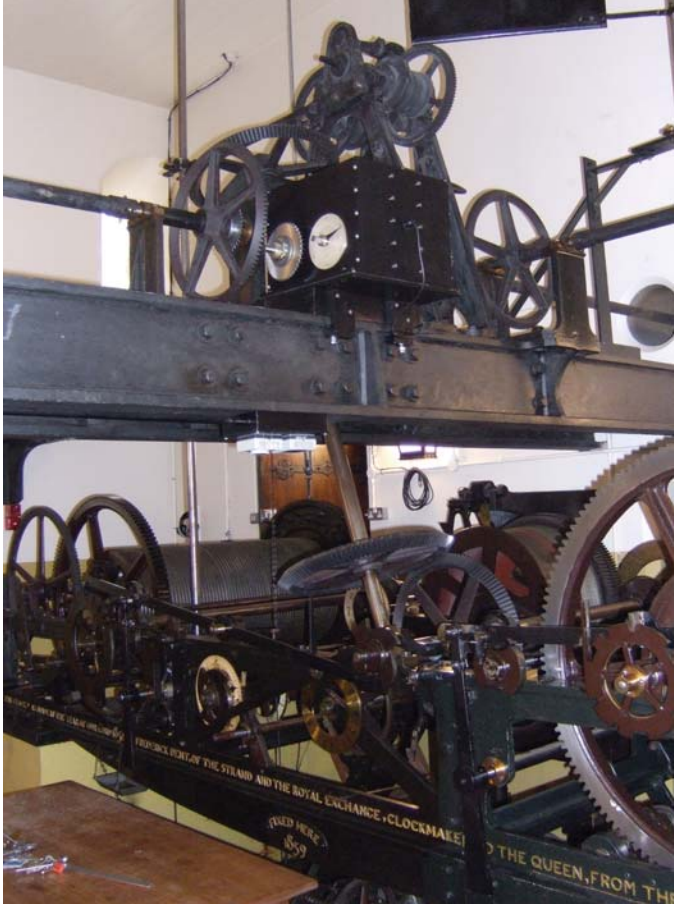


6. On test and lifting two weights totalling 2cwt.

directions so a contra-rotating drive was needed.

A solid aluminium base and case were built for the drive unit, **Photo 3**. The case held the various arbors which run in commercially available flanged sealed ball races. A heavy duty synchronous motor provided a 1 RPM output. This was connected to a hardened steel worm giving a 60:1 reduction in conjunction with a bronze worm wheel. One drive was taken from the worm wheel arbor, the other drive was reversed by employing a pair of spur gears. Chain sprockets were mounted on the appropriate output arbors. In order to engage and disengage the drive, the worm and motor were mounted on a swinging frame **Photo 4**, the position of which could be selected to drive or not to drive. A pre-settable slipping clutch was incorporated to prevent damage in the unlikely event of something jamming.

A nice finishing touch reflecting Cumbria's connection with traditional clockmaking was a hand-engraved silvered setting dial, **Photo 5**.



7.The drive unit fully installed.

Testing was an important part of the manufacturing process. The drive unit was securely clamped and turret clock weights added to both arbors to simulate the worst-case situation, **Photo 6**. Problems were experienced with insufficient output torque. All design calculations were checked but no error was found so the synchronous motor unit was suspected. Eventually a faulty phasing capacitor was identified. A replacement was swiftly supplied by the manufacturer, fitted and the drive unit just purred away and easily coped with the full-load test situation.

With the unit completed, it was installed on the Great Clock, **Photo 7**, the week before the major work commenced. Installation was watched by Derek Youngs, Keith's father who despite some rather senior years, very much enjoys his retirement getting his hands dirty up clock towers.

On Saturday 11th August the drive engaged and carried on with faultless operation for the following 7 weeks. Whilst out dog walking, Keith received a phone call the morning the unit was started. 'Listen to this' said the Palace Clock team. A strange humming noise with a regular clunk came down the phone. Keith froze with horror, and thought of all the failure possibilities that could cause such a sound. 'Don't worry' they said, 'it's the oscillating fan in the workshop. Relax; the drive unit's working really fine'.

Chris McKay

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