Restoring the Great Clock of Westminster

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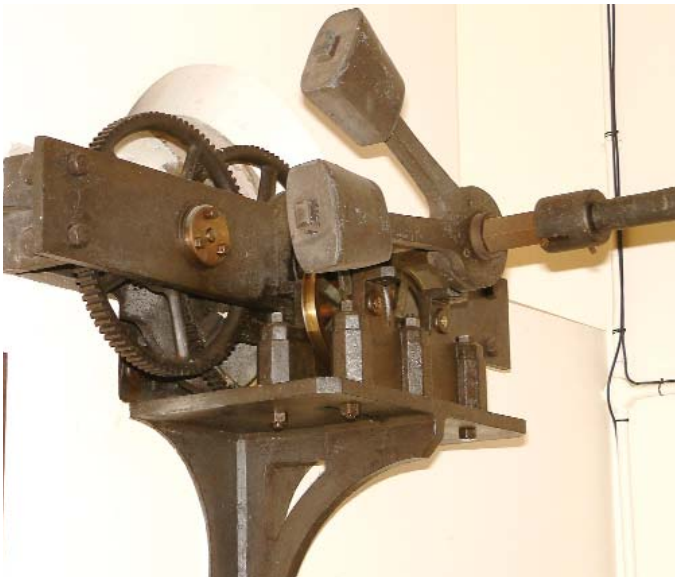
Once all the parts were safely removed the restoration work carried on as three major tasks: the dials and associated motionworks, the escapement and the barrels with their great wheels.

Dials were taken out of action one at a time and set to 12.00. **Photo 18**. Motionworks were serviced with the anti-friction rollers that support the hour tubes. There are two sets of these, one pair inside the clock room next to the motion work **Photo 19** and a second set on an outrigger right behind the dial. In the past some of these rollers had seized up leading to flats on the surfaces of the rollers, so the opportunity was taken to repair these. Since the hour tube is about 12 feet above the floor in the dial chambers, a small scaffold tower **Photo 20** was used to get access to the various set of rollers. One of the shortcomings in the design of the Clock is support of the minute arbor. **Photo 21.** Normally on a turret clock this arbor just rotates inside a bush in the end of hour tube. At Westminster the hour tube has four slots cut out of the hour tube and the minute arbor is supported by four anti-friction rollers that are held by two cages bolted to the outside of the hour tube. Unfortunately the cages are complete rings that can only be removed when the hands have been taken off. Fortunately minimal work was needed on these bearings.

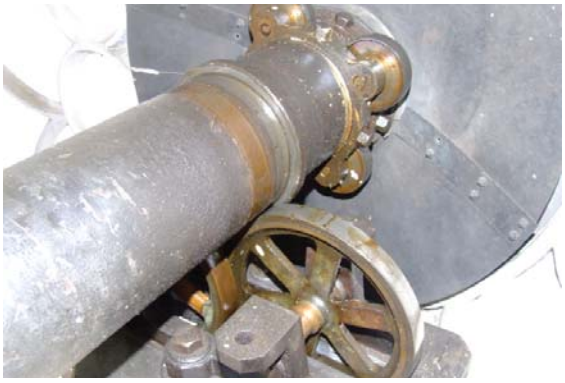
18. Two different times: A rarely-seen sight as one of the dials is being serviced.

20. Scaffold behind dial to access the hour tube and minute arbor rollers.

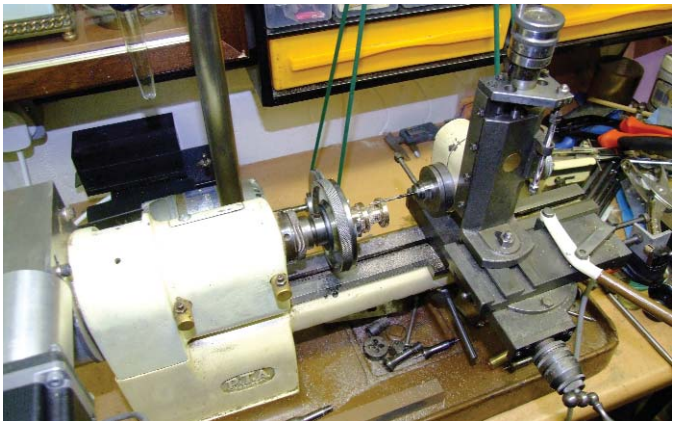
As a complete opposite to the heavy work needed on the barrels and great wheels, the escapement was much more like conventional clock bench-work. Whilst the heavy work was going on at the engineering company the escapement was being rebuilt. A new lantern pinion, **Photos 22 & 23**, was made for the escapement and since its arbor had a whole series of holes, it was decided to make a new one. An examination of the escapement took place at Upton Hall, **Photo 24**, during the turret clock course held in September 2007. The gravity arms looked of a recent construction; there were several fixing holes showing the locking blocks had been moved or replaced at some time. Indeed the whole escapement did not have the look and feel of the rest of the clock suggesting it was a 20th century replacement. New blocks and lifting pins were fitted and flats on



19. Motionworks inside the clock room. The Y-shaped arrangement of weights allows for precise balancing of the minute hand. Hour hand counterbalance cannot be seen here. Note one of the pair of friction wheels that take the weight of the assembly.



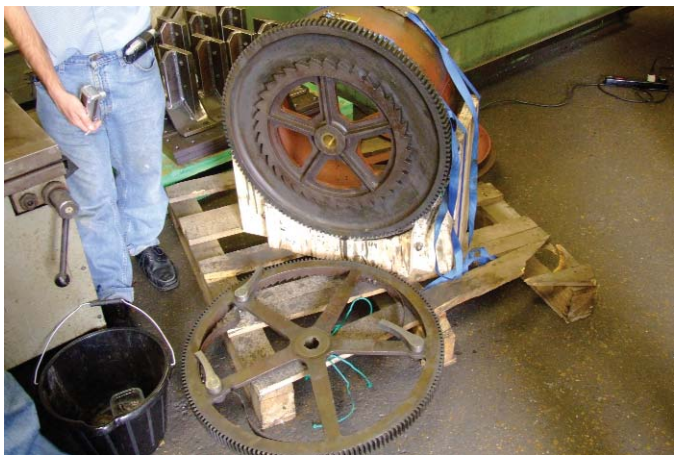
21. Friction rollers behind dial. The bottom par of rollers take the weight of the hour tube, the cluster of four rollers mounted on the hour tube support the minute arbor.



22. Drilling the lantern pinion.

23. The finished lantern pinion and arbor made for the 'scape wheel.

24. Edmund Beckett Denison's double three legged gravity escapement. The assembly was brought to Upton Hall for the turret clock course and inspection, discussion and advice was invited.



25. Going barrel and great wheel with its arbor removed. Note that three clicks are used, and the bronze bush in the barrel end.

26. Cracks in going great wheel boss.

27. Repairs using cold stitches can be clearly seen looking like a row of filled holes.

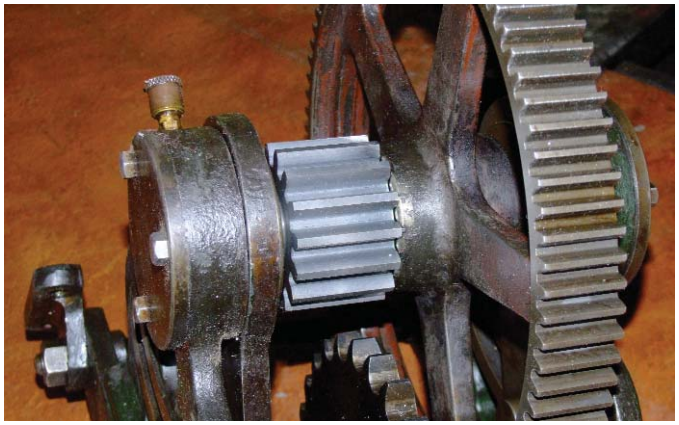
28. Striking barrel and great wheel at the engineering works.

29.Barrel showing groves to guide the line.

30. Bush in endplate of winding wheel. Note the oiling holes.

31. Ratchet wheel on hour striking barrel. At two o'clock the peg sealing an oiling hole can be seen.

32. Great wheel on lathe 2.



33. The new spur gear on motor-powered winding mechanism.

the gravity arms and the pendulum rod were all polished out.

On the going barrel, there are two end plates each with bronze bushes, **Photo 25**, and the arbor is fixed to the great wheel. In this case the arbor had three slots that corresponded with three slots on the great wheel and tapered wedges were hammered into the mating slots to secure the great wheel on its arbor. When it came to examine the great wheel, cracks were noticed, **Photo 26**, and a further examination was carried out with dye penetrants and magnetic techniques. The force of the wedges had caused the great wheel boss to crack, these cracks propagated from the sharp roots of the slots. Repairs were made using cold stitches, **Photo 27**, a technique commonly used in industry to repair cracked castings. Here a series of holes are drilled using a custom jig, the line of holes being at right angles to the direction of the crack. A specially-shaped lock insert is put into the hole and secured with a resin. The lock is made of a high-nickel steel alloy and is much stronger than the parent cast iron. Accurate drawings were made of the going great wheel, so in the unfortunate event of the wheel having to be replaced, the necessary information would be at hand. All the bushes were all repaired with new bronzes, but it was decided to make a new arbor, the great wheel being secured to the arbor with a single conventional Woodruff key, and the key retained with a collar.

The hour striking barrel, **Photo 28**, is a cast-iron hollow drum, **Photo 29**, with cast-iron endplates, one is the winding wheel **Photo 30**, and the other the ratchet wheel, **Photo 31**. Both of these have bronze bushes that were found to be worn. Also worn was a thrust washer that had allowed the ratchet wheel securing bolts to rub on the great wheel. First the main arbor was skimmed down, **Photo 32**, to remove wear. It was then decided to re-bush all the barrel bearings and to reline the split plumber blocks that act as the main bearings. One original bush had turned over time so the oil hole in the bush no longer lined up with the oil hole in the great wheel. New bushes were pinned to prevent this happening again. It looks like this was the first time in the clock's history that this bushing work has been needed; indeed it is a great tribute to its maker E J Dent. Clickwork and ratchet teeth were built up with weld and re-profiled where necessary.

Dent installed a winding mechanism in 1913. This comprises a motor-driven centre shaft with three in-line clutch units each of which carries a chain sprocket. Roller chain connects from the sprocket to a reduction mechanism of spur gears that in turn meshes with the winding wheel on the striking or quarter trains. One spur gear on the hour striking had become badly worn so a new one was made, **Photo 33.**

When the weights were on the ground the giant pulleys were all checked and serviced. Lines were inspected and one of the

34. Empty clock frame.

tie-offs was re-made. Whilst the work on the clock was going on, other tasks of a non-horological nature that needed doing were completed: the stair well and handrail were painted once all the parts were back up the tower. A new phone was installed and there are plans to have a hard-wired link from the clock to a clock timer situated in the workshop. All the bulbs that illuminate the dials were changed during the maintenance interval.

With the flat bed frame empty, **Photo 34,** frame members and other parts were cleaned and all the necessary odd jobs completed. As the major parts came back from the engineering works they were hoisted up the tower and installed; the going train first, then the striking. First the going train was run without the gravity arms to identify any possible tight spots in the train. Speed of running was regulated by the fly on the reconstructed scape wheel. After several fault-free runs the gravity arms were installed and the clock set going. After a short series of adjustments the clock was brought to time and remained on test for a week before the official restarting.

Once the strike barrel had been returned it was hoisted up the tower and the great wheel and arbor tested for true and smooth running in the frame. **Photo 35.** With all well, the huge barrel was installed **Photo 36** and again tested. Train and winding wheels were re-installed along with all the release and locking levers. The scaffolding was then struck and the striking fly and winding wheels re-instated. After a period of testing the Great Clock was deemed fit to resume normal duty.

On the evening of Saturday 29th September the bolts on the main hand setting clutch were tightened and the synchronous motor disengaged. The Great Clock was again running as its maker and designer had intended. Over the next day the timekeeping performance was spot on.

Monday 1st October was the official re-starting of the clock: Just before midday the tied up quarter and hour trains were released and shortly afterwards the Great Clock sounded the Westminster quarters and struck twelve blows after a silence of 7 weeks. Project completion finished with putting the rails and barrier back and tidying up all the loose ends. A few weeks later the official tower guides were back in business taking their tours up the tower every morning.

The reality is that a thorough job has been done on the Great Clock due to the skills and hard work of the Palace clockmakers and their leader Mike, **Photo 37**.

Ian, who has worked on many turret clocks in the past said: "It's the biggest and most prestigious job I have ever done, I am pleased with the outcome". Paul in his methodical manner commented: "Rebuilding the escapement was a pleasure, it was an honour to work on such an important escapement in such an important clock". Huw was added: "I think I know every pane of glass in those dials having been through all the motionworks and supporting anti-friction rollers". Mike McCann as Keeper of the Great Clock had the last comment: "It has been a good project, the Great Clock has had its 150th birthday present a year early". **Photo 38.**

Next month we see how the drive unit was designed and constructed.

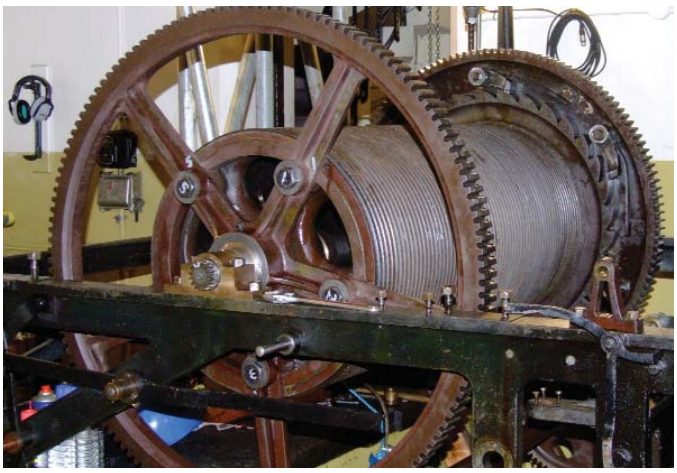
Acknowledgements

The Palace of Westminster for permission to publish the pictures.

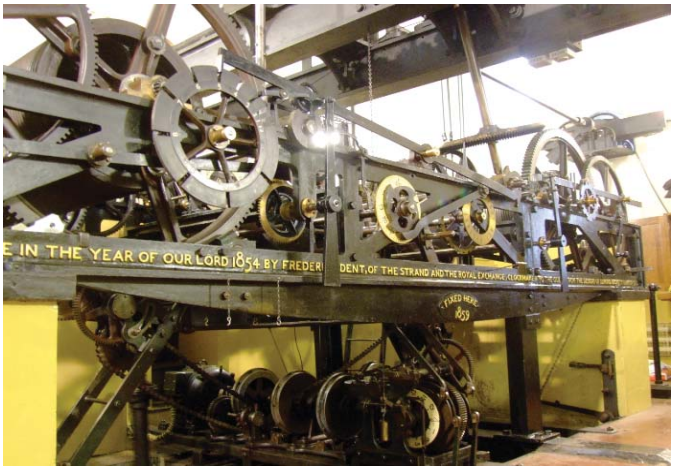
Mike McCann for making this article possible.

Ian, Paul and Huw for their cooperation and assistance in supplying information.

35. Great wheel and arbor being installed.



36. Fully restored, the striking barrel is back in place



37. The Great Clock

38. Just a year to go now for the Great Clock's 150th anniversary.