The Straight-Rose Engine Design & Construction

By David Cottrell

When embarking on the creation of my first pocket watch there were naturally many areas of uncertainty as well as new skills to acquire. While I was sure that my time as a tool maker, coupled with experience building race engines and a firm understanding of mechanics would be invaluable, there were still two key aspects of the project with the potential to bring things to a halt. The first was, could I make a working Co-Axial escapement, the second being the manufacture of a high quality dial.

Once the intricacies of the escapement had been understood, and with the movement happily ticking away, there was no avoiding the question of how to make the dial. It had already been decided that it should be engine turned (guilloché) and made from silver, which meant that both a Straight-Line and Rose engine would need to be acquired; however it proved difficult to track down suitable machines. By a timely coincidence a series of related articles appeared in the BHJ written by John Moorhouse. These covered his work on engine turning (Ref.1) together with an outline of the associated equipment. On making contact with John he kindly invited me to his workshop where he had devised an attachment that enabled Rose patterns to be cut on a Plant Straight-Line engine.

Encouraged by what John had achieved the decision was made to design and make a machine based on his general principles that would cut both Straight-Line & Rose patterns (Fig.1). After some thought it became clear that the design could also include the ability to recess sub-dials together with the drilling of index markers or other features without disturbing the dial blank. It was hoped that the combination of these capabilities would provide the flexibility to produce a dial in one piece, as opposed to separate components which are then soldered together.

Fig. 1 – The Completed Straight-Rose Engine

Fig.2 – Work holding compound table located in the jig borer

For the creation of the subdials the machine would be fitted with an electric motor under the main table to drive the spindle and so act as a simple facing lathe. In addition the work-holding head was designed so that it could be unscrewed from the main spindle of the machine and then located in the centre of the rotary table of a jig borer (Fig.2). Index markers or any other holes could then be drilled without disturbing the dial.

Not only was it going to take some considerable time to build the 'Straight-Rose' Engine it also required the acquisition of a decent sized milling machine to make the main structural components. It was my feeling that investing in such a machine would provide further flexibility to make other equipment as the need arose.

Fig. 3 – Delivey of the Milling Machine

Fig. 4 – Fork Lift Truck Negotiating the slope

Delivery of the full-size milling machine was an eventful exercise in its self. Despite informing the company that we lived on the side of a hill the first attempt failed as it was not possible for the small delivery truck to negotiate the slope up to the garage workshop. The solution was to deliver the machine on a much larger low-loader complete with fork-lift-truck to negotiate the slope (Fig.3 & 4).

The overall layout of the machine is that of a small bench-top Straight-Line engine. The difference being that the sliding head is equipped with a spindle that takes rosettes. While a traditional Rose engine rocks radially about a pivot this form of motion is not essential to its operation. It was this particular point that led John Moorhouse to the realisation that the lateral movement of the sliding head on a Straight Line engine could perform the same function.

On a standard Rose Engine the spindle is supported at both ends (similar to that of a lathe) so it can be any reasonable length to accommodate

Fig. 5 – Assembly of part completed sliding head, showing tapered roller bearing

a large number of different patterns. Due to the overhung nature of the design of the Straight-Rose Engine the length is necessarily limited, as is the number of rosettes. This was set to 3 and has proved sufficient for dial making. In any case it is a simple matter to remove the work-head and change the rosettes should others be required; without disturbing the dial blank. In addition the spindle is mounted in tapered needle roller bearings in a massive cast iron sliding block to ensure rigidity (Fig.5).

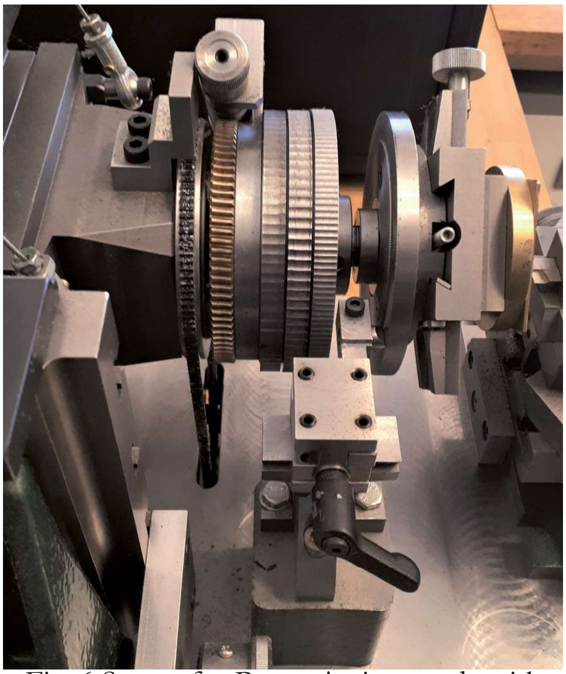
Fig. 6 Set-up for Pump Action mode with touch piece engaged in face rose'

Pump-action for cutting serrations is also provided for. The work holding spindle slides inside the main rosette mounting spindle and is keyed and sprung. While only one side rose can be used at a time this simply bolts onto the underside of the work holding head, so is easily changed (Fig.6).

Having sketched out the initial design in CAD as a 3D model to establish the overall layout and dimensions it became clear that if everything was made 'from scratch' the build time would be excessive; after all the main objective was to finish the watch. However using too many off-the-shelf components risked compromising the design which was not acceptable.

Other than the base plate the three main structural components are two vertical slides and one compound table. After some searching around it was found that a pair of standard Myford vertical slides were of suitable dimensions and had enough material into which additional features such as dovetails could be machined for the sliding head etc. It is probable that other makes of small vertical slides would be suitable. Minor alterations to the overall dimensions for the machine would then be made to suit what is available locally.

The base-plate is a solid, heavy item. The sides are made out of 1/2 inch steel plate, with ¾ inch plate on the top. Although I do have welding equipment it is not up to this size of material so the base was made by a local steel fabricator.

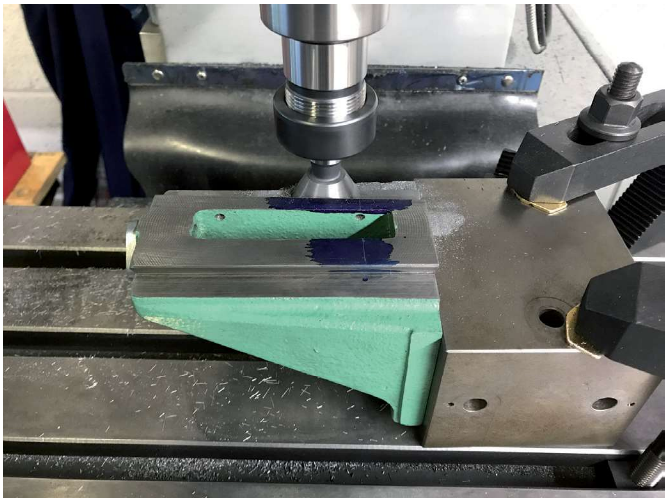
Fig. 7 – Modifying a vertical slide

While the vertical slides were made to a reasonable quality it was decided to change the method of adjustment. Lower cost slides are equipped with a parallel gib strip which is adjusted via a series of screws to obtain the correct sliding clearance. It was felt that something better should be done, so a method of converting the slides to a tapered gib system was devised. (Fig. 7).

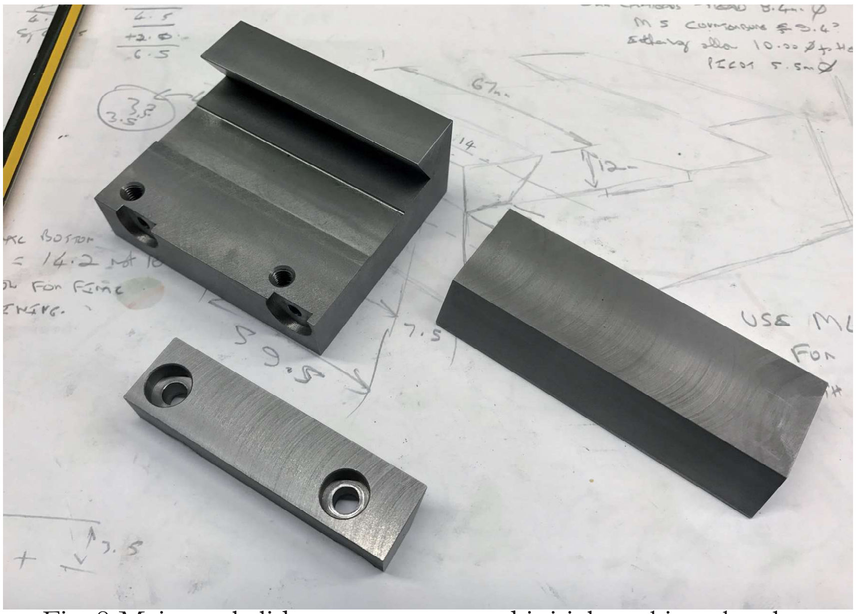

Fig. 8 Main tool slide components and initial working sketches

The manufacture of the compound table and tool holding slide also used a combination of off the shelf and custom-made items (Fig. 8). As with the vertical slides a standard compound table was purchased and then re-machined to suit the design. It was also fitted with a ratchet system for advancing the tool across the work.

Various standard sections of cast iron bar were purchased for the tool holder as well as the quadrant (which is required for patterning around the curve of a case back). The quadrant is moved incrementally with a worm & wheel both of which were machined in the workshop with cutters made to suit (Fig.9).

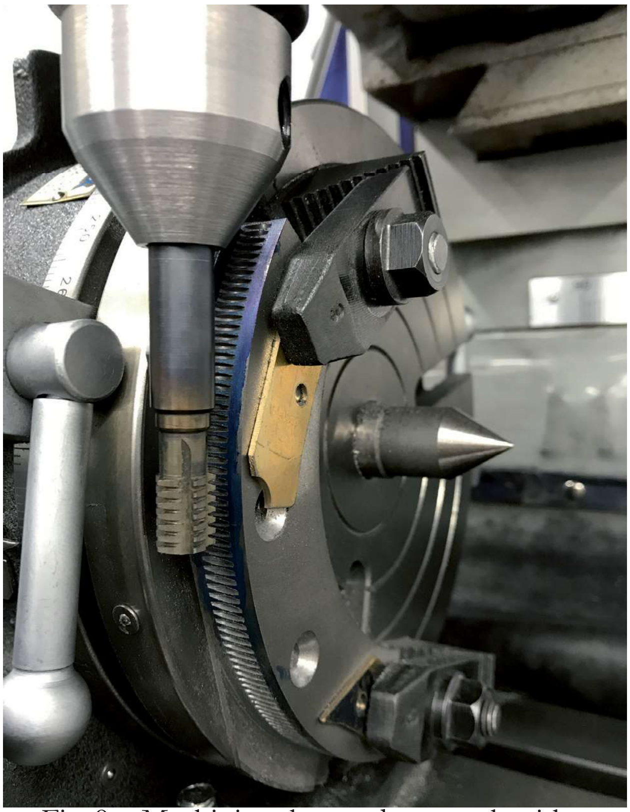

Fig. 9 – Machining the quadrant teeth with a custom made cutter

As expected, the design and making of the machine, together with learning how to use it and the inevitable further refinements took many months (Fig.10). In the final result, the machine proved its value in more ways than one. Not only was it possible to make the dial in one piece, in one setting, but in use it also proved capable of engraving the numerals on the dial. In addition, it was also possible to pattern the curved back of the case Fig. 11.

The completed watch is shown in Figs 12 & 13, together with a close up of the Straight-Rose Engine in Fig. 14

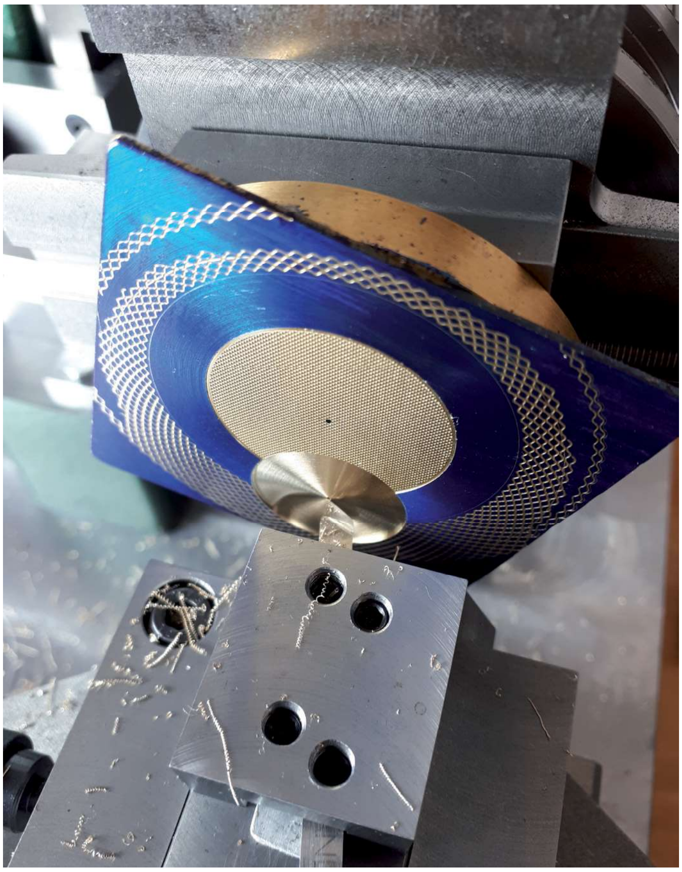

Fig. 10 – Initial trials in brass, recessing for the seconds sub-dial

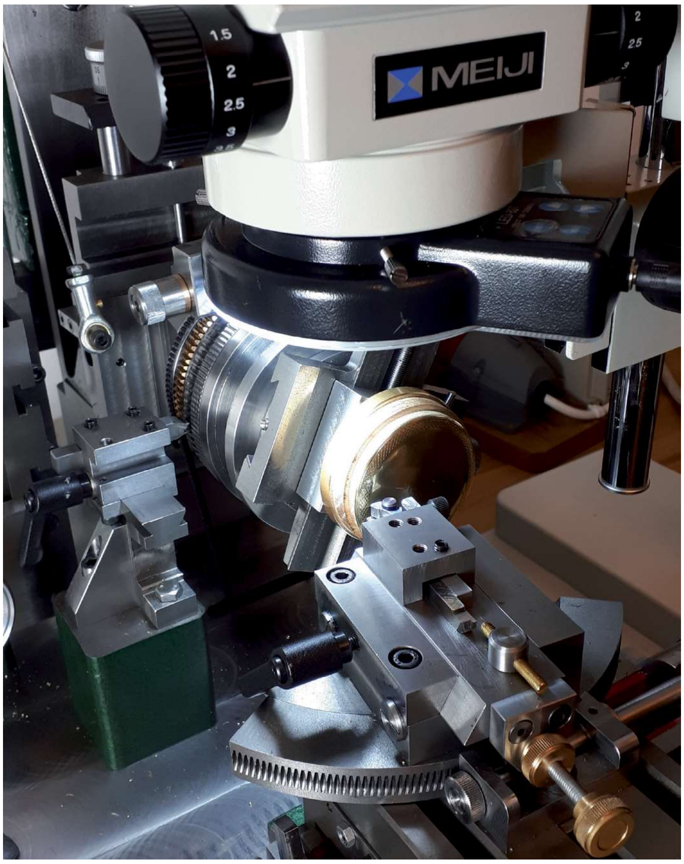

Fig. 11 – Patterning a case back, using the quadrant to keep the tool normal to the curved surface

Fig. 12 – Completed watch

Fig. 13 – Movement side of completed watch

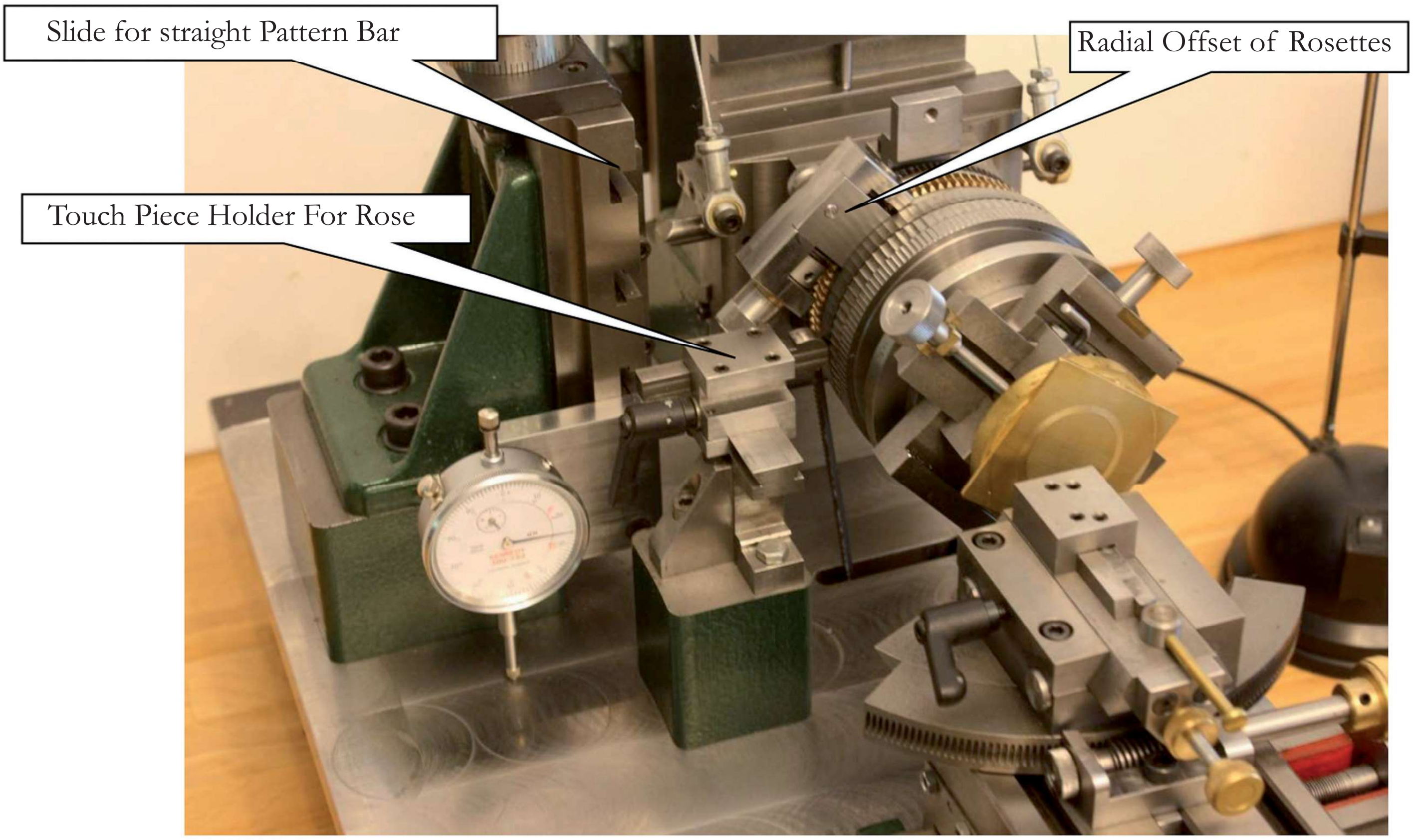

Fig. 14 – Close up of the completed Straight-Rose Engine

Work is now well advanced on the creation of a second pocket watch to my own design, this time with a four-minute tourbillion and keyless winding. Further pictures can be found on Instagram at...

www.instagram.com/djcottrellwatches

References

Ref. 1 BHI Horological Journal, October 2017, Engine Turned Watch & Clock Dials, P454, John Moorhouse MBHI

<u>About the Author</u>

David Cottrell started his working life as an apprentice toolmaker at Borg Warner, though even before that he had a small workshop in a spare room complete with Unimat 3 lathe. Cottrell admits he is still not sure to this day how his mother tolerated this use of the room, but he suspects that the quiet support from his father, a car mechanic, with a natural ability to fix just about anything probably helped.

Following the apprenticeship, he studied Mechanical Engineering at Kingston University (Surrey, England) before embarking on a career in Information Technology with various software companies focused on manufacturing management, planning & optimisation.

There has always been a workshop in the home garage, which has facilitated building race cars and engines. However, it was an article about a certain Dr. George Daniels some 8 years ago that sparked his desire to make a watch which naturally led to an ongoing interest in engine turning.