

Cutting metal into perfect 100-300 nm strips in the 16-17th centuries

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Metal threads are strips of metal used either as an independent thread, or twisted around a silk core. They have been used to decorate textiles since ancient times. Typical sizes of threads of 16-17th centuries were 130-420 μm width and 3-15 μm thickness. A base metal was copper or silver. Some of threads were gilded on two or only one side.

All known publications [1, 2, 3, etc.] agree that before the invention of the wire drawing the threads were simply cut off from the foil sheet (with scissors or something else) and they became a product of rolling the wire after the invention. There is only one point of view about the method of gilding: it was diffusion gilding. About 40 samples of threads (5 mm each) were examined in a scanning electron microscope with an EDS detector. The specific defects of the gold layer, as well as the absence of Hg, confirmed diffusion gilding. But our measurements (plus some calculations and a search in the history of technology) disprove the version about the wire and rollers. It is impossible to explain perfectly parallel edges and a rectangular thread cross-section (Fig. 1) and gilding on only one side of some threads as well.

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We suggested that the threads were made by cutting from a sheet of foil as before (i.e. without a wire drawing), but not with a hand tool. The fact is that rollers were already known to jewelers in the 14th century, two centuries before first roller mill [4]. A pair of precisely arranged rollers can move the foil sheet in a straight line. If you add a blade, you can make a straight cut. But since there are no tool marks or deformation marks on the edges of the thread, the blade had to be placed almost parallel to the sheet and be very sharp, about 1 μm at the tip [5]. The sheet (unlike the rod) can be gilded only on one side by heating to 600-900 $^{\circ}\text{C}$ and pressing [6].

Of the 40 threads studied, even from one textile, there were not two of the same width. According to our assumption, this can be explained as follows: the thread each time was simply cut into two, equal or not. It would be interesting to study a long thread ($\gg 5$ mm) to find the point (and method) of joining together. If two threads of different widths are joined, our assumption can be considered proven. And therefore, the main invention that changed the technology of manufacturing metal threads was not wire drawing, but rollers and a method of parallel and non-deformation cutting into strips.

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