Moorish Fretwork Revisited

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Abstract

Moorish Fretwork was invented by Moses Y. Ransom in Cleveland, Ohio in the 1880's. It is a unique method of woodworking that weaves milled spiral rods of opposite chirality into many different ornamental patterns and designs. My first paper on Moorish Fretwork [1] was presented at the 2004 Bridges Conference in Wichita. This paper briefly revisits background in the first paper but then explores similar constructions in metal.

Moorish Fretwork Revisited

At the 2004 Bridges Conference in Wichita, I presented a paper [1] entitled *Moorish Fretwork* in which I introduced the marvelous 1885 woodworking invention of Moses Y. Ransom from Cleveland, Ohio. (Figure 1) In the past eight years, I have made some further discoveries on this innovative lattice technique. Ransom's invention involved cross-threading machined wooden spiral moldings. Creating both right and left-handed moldings, he discovered that he could "weave" or interlace them into patterns that resembled the geometries of Islamic design. In fact, they closely adhere to the definition of Moresque or Moorish geometries delineated by Owen Jones in his classic *The Grammar of Ornament* [2]. The silhouette of Ransom's designs reveals negative and positive regions that create a fretwork or lattice structure, hence Ransom's moniker of Moorish Fretwork. Unfortunately, Ransom's work wasn't available until the tail end of the Orientalism design craze in America and only enjoyed about ten years of popularity from 1885-1895. During these ten years though, Moorish Fretwork in both ornamental lattice screens and in furniture graced many of the most stylish homes of the Victorian era in the United States [3].

The geometric structure of Ransom's Moorish Fretwork is relatively straightforward. The vast majority of his patterns involve a field of parallel spiral or helically carved moldings of one chirality intermeshed with a perpendicular field of the opposite chirality. For example, to assemble his basic pattern, Ransom would lay down in parallel a number of right-handed moldings on a flat table and then thread or screw into this a perpendicular left-handed molding, passing alternately above and below the others until it is completely woven into all the right-handed moldings. Repeating this process with more left-handed moldings forms a coplanar mat of these "woven" rods. By adjusting the proportions of the machined wooden rods, these "weavings" can be made very tight so that they interlock to form a very rigid perpendicularly woven screen or loose so that the screen can be "racked" or shifted into a non-perpendicular weave. These looser mats can also be used to form curved surfaces like this section of a hyperboloid that Ransom used in umbrella stands and which Usineviciu modeled in copper wire (Figures 2&7).

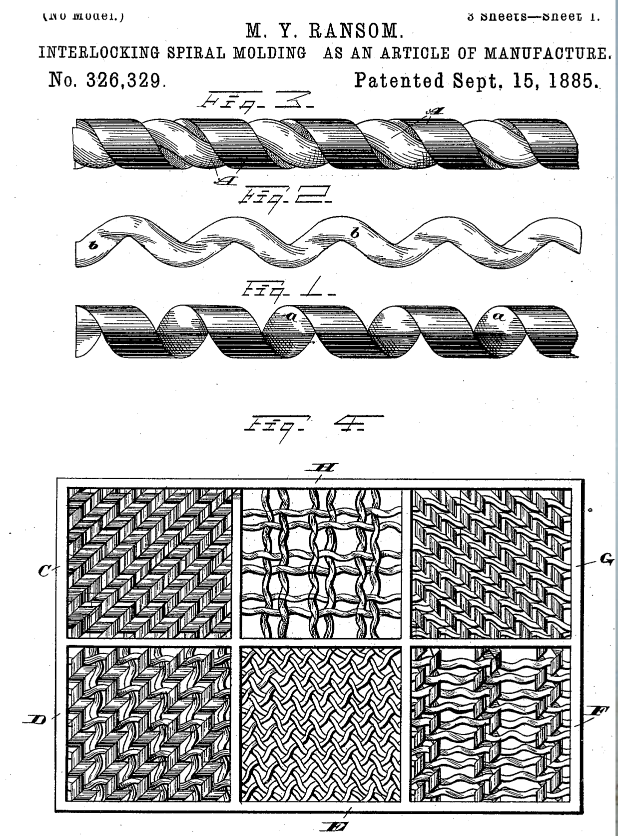

Figure 1: *Ransom's Patent*.

Figure 2: *Ransom's Umbrella Stand.*

Curiously, a perpendicular cross section of one of Ransom's spiral rods is not a circle. It is instead half of the curve known as a nephroid [4], (Figure 3). The name nephroid means kidney shaped and was first used for the two-cusped epicycloid by R.A. Proctor in his *The Geometry of Cycloid* [5]. The nephroid curve can be described as an envelope of circles whose centers are on a base circle and are tangent to a line that bisects the base circle. This indicates that the shape of Ransom's wooden spiral is best described by a sphere rotating tangentially around an axis that it is concurrently travelling along. The cross section of one of Ransom's spiral rods not only contains the center circle of the sphere tangent at that point but all the smaller sections of the spheres that have entered and are exiting that plane. Gaspard Monge (1746-1818), a French mathematician and the father of descriptive geometry, referred to this special kind of sweep surface as a helical canal surface. Monge is one of 72 French scientists and engineers honored by having their name inscribed on the Eiffel Tower.

While researching Ransom's invention for a better understanding of both its ornamental uses and its manufacturing processes, I discovered many other similar lattice structures made of metallic wire or strips produced for much the same purpose around the same time period. I was interested in these metallic ornamental screens because of their close aesthetic ties to Ransom's woodwork. There were many metal screens that used the simple twisting of flat strips or bars of metal like Einbigler's and Adler's 1887 patent (Figure 4). But I only found one instance of formed metal rods that relied on their helical shape to form a lattice structure similar to Ransom's Moorish Fretwork.

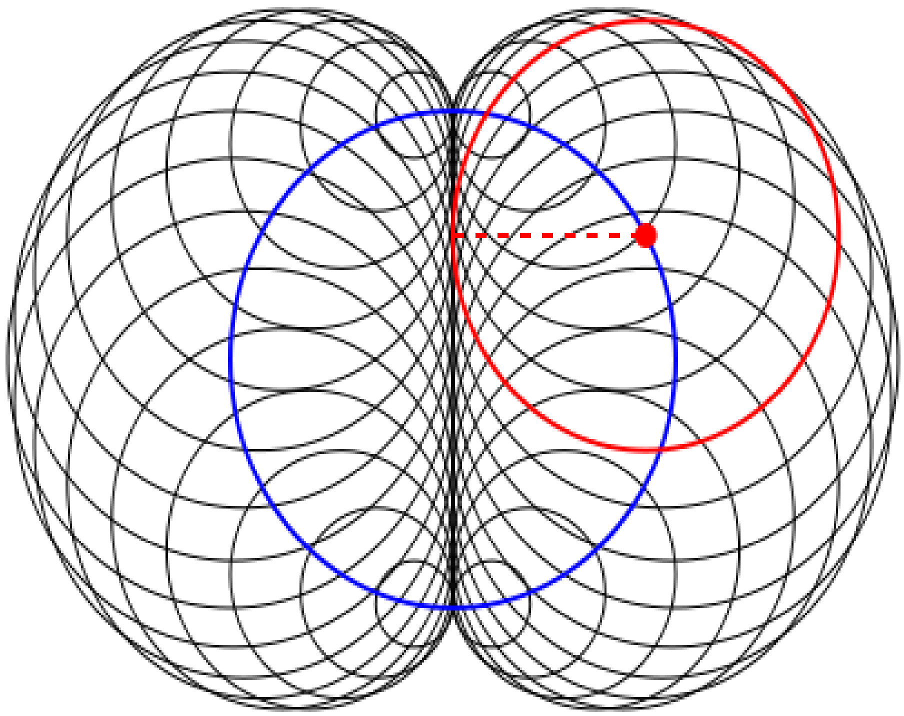

Figure 3: *Nephroid as an envelope of circles.*

I found it in the 1908 patent of Malcolm Scougale (Figure 5) from Fort Worth, Texas that looked very similar to Ransom's Moorish Fretwork, only made out of metallic wire. The main difference, beside the material used, was that Scougale's design for "Intermeshing Wire Fabric" used only same-handed spiral wires. So these screens can be made without switching chirality. The result is a self-locking wire mesh suitable for fencing. I've been unable to determine if the invention was ever realized.

In 2011, I received a phone call from Alexandru Usineviciu, a Romanian sculptor and jewelry maker in Yonkers, NY. Alex was very enthusiastic because he had just found some of my Moorish Fretwork images on the internet and he realized that the interweaving of spirals that he had discovered independently had in fact been discovered about a century earlier by Moses Ransom. Alex sent me some images while still on the phone and I couldn't believe my eyes when I saw some of Ransom's exact patterns miniaturized…and in gold! (Figures 6&7).

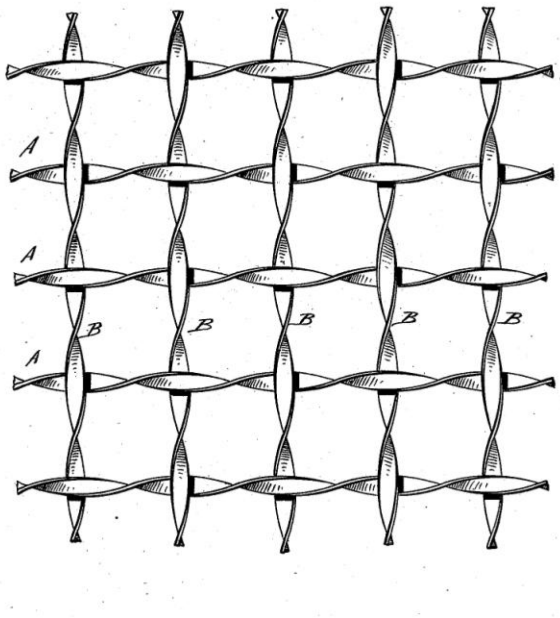

Figure 4: *Helical Metal Strip Patent 1887.*

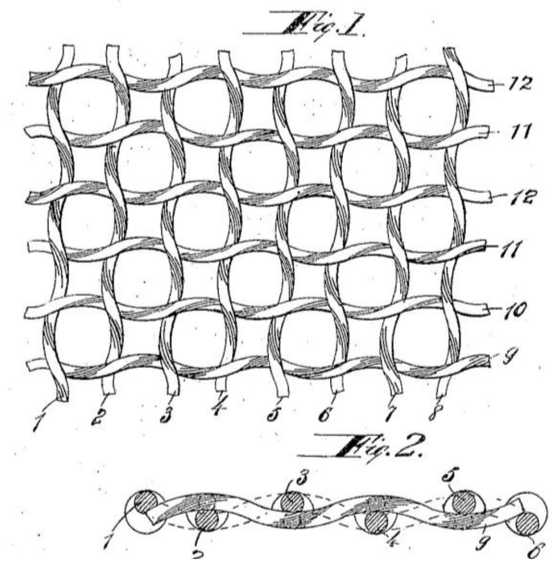

Figure 5: *Scougale's Same Chirality Patent 1904.*

Figure 6: *Usineviciu's Moorish Fretwork in Gold*.

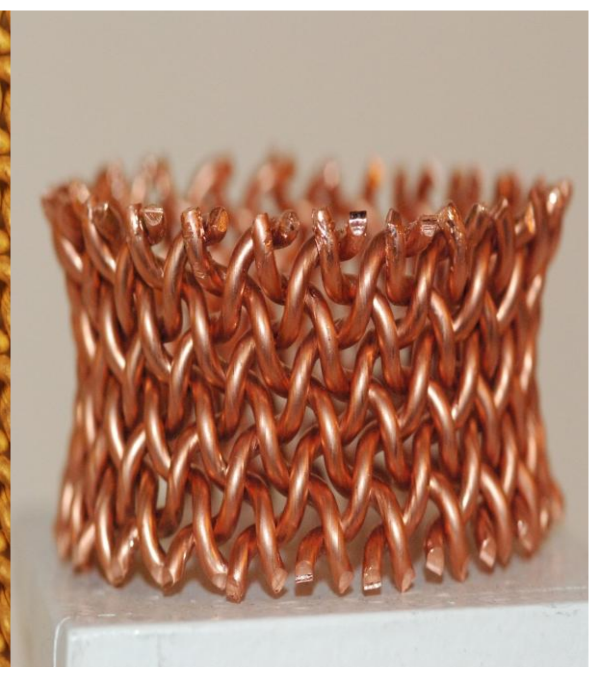

Figure 7: *Usineviciu's Hyperboloid in Copper*.

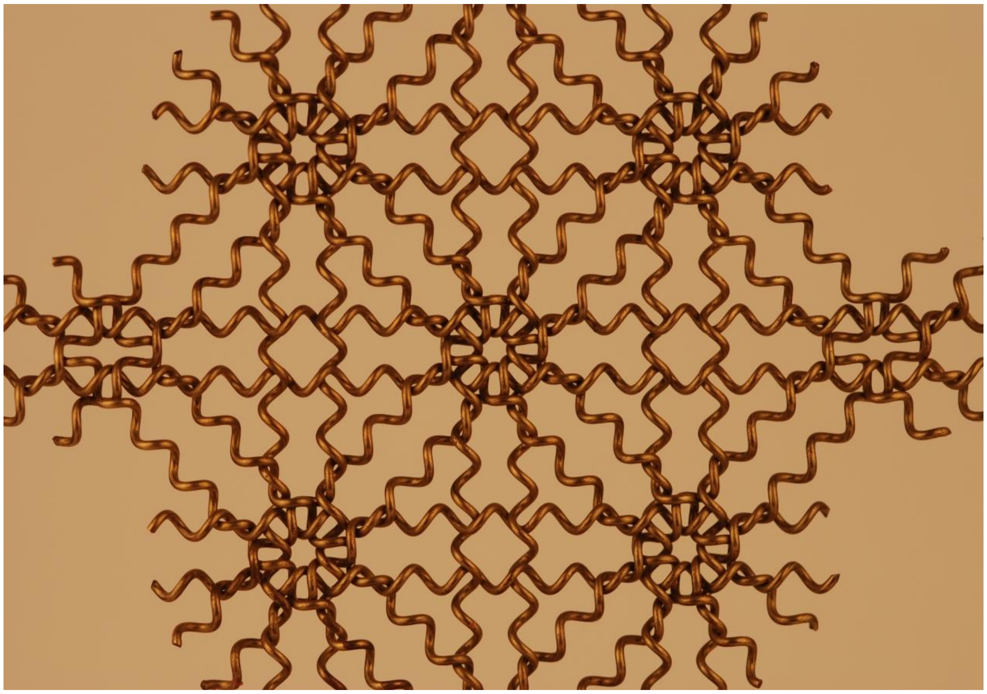

Figure 8: *Usineviciu's Woven Springs*.

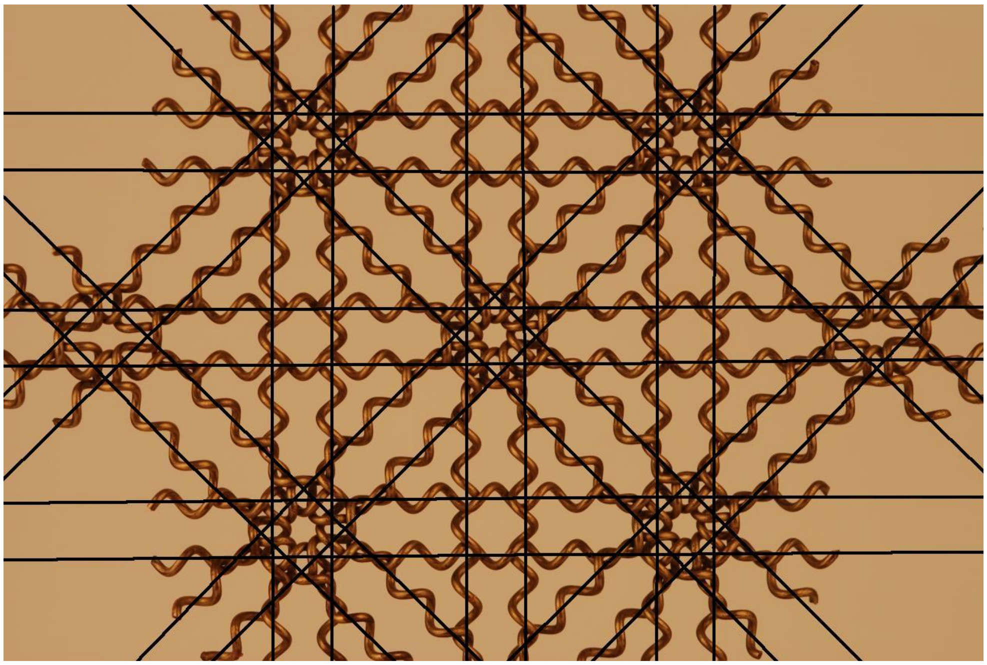

Figure 9: *Woven Springs with Spring Axes Indicated.*

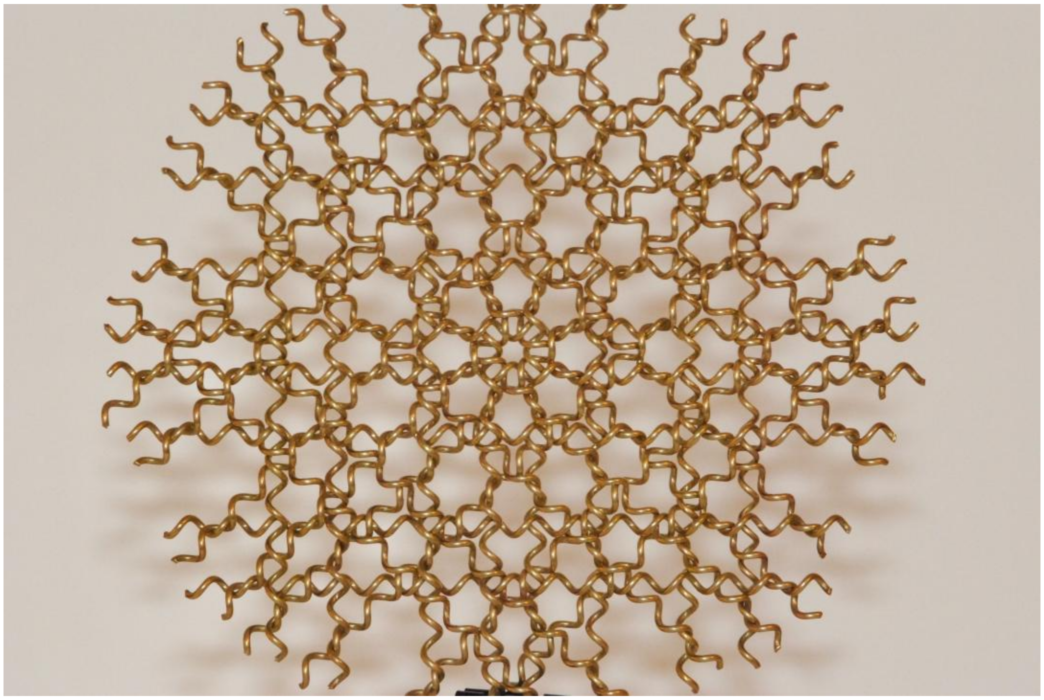

Figure 10: *Usineviciu's Jewelry Composed Entirely of Straight Springs*.

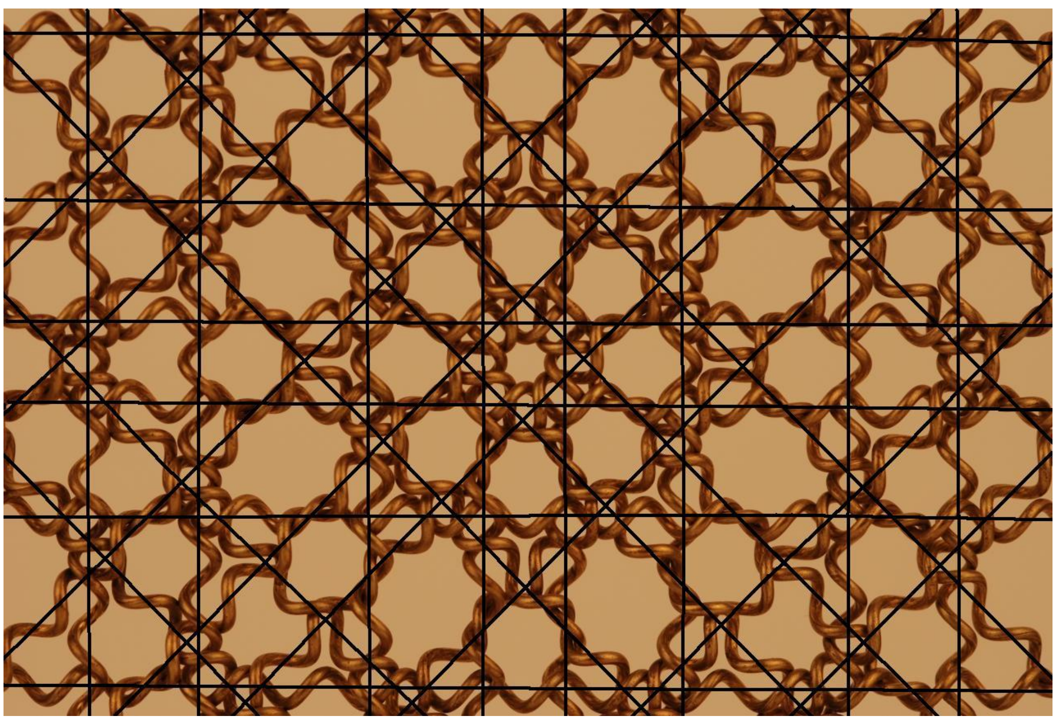

Figure 11: *Usineviciu's Jewelry* with Axes Iindicated.

Alex and I have since spent many hours exploring this system of interlocking spirals, or what Alex refers to as "woven springs". In addition to his Moorish Fretwork style lattices, Alex expanded on the system by literally expanding the spirals. Ransom's wooden spirals have an internal radius of zero so that the pieces would necessarily lock together by friction. Alex opened up the internal radius of the spirals so that they were more or less stretched springs. In fact, Alex ingeniously and thriftily found inexpensive springs in the form of plumbing snakes in the hardware store and talked his neighbor into using the bumper of his car and a tree in his back yard to stretch these into very long spiral wires that he could cut up to create his art. Alex has found many other creative ways to make these "springs" that he weaves into wonderful patterns and designs. He discovered that the more open springs freed him from the limited rectilinear patterns of Ransom. None of these patterns require the springs to bend. Just as Ransom's spiral rods in his hyperboloid sculptures, the axes of the Usineviciu's springs are in a straight line. Alex Usineviciu has invented freestyle Moorish Fretwork [4]! (Figures 8,9,10,11).

The design in Figure 8 consists of twenty-four individual left-handed springs on an octagonal grid. Figure 9 shows the same picture as Figure 8 with the longitudinal axes of each spring indicated. Springs are simply screwed together. Patterns such as this one have enough intermeshing that soldering or other mechanical connections are unnecessary to hold the work together. This pattern is stable once it is completed yet it is still possible to easily unscrew an individual spring and to replace it. Usineviciu's jewelry in Figure 10 is based on the same octagonal grid as that in Figure 8. The dramatic difference in the two patterns that share the same base grid illustrates the variety of patterns that are available just by strategic placement and /or skipping of springs. Just as Islamic patterns make use of the repetition of a basic shape, Usineviciu's ingenious patterns use just this one shape. His jewelry patterns, however, literally add a whole new dimension to these symmetries by substituting a three-dimension helical spring for a two-dimensional zigzag line.

In 2011, I also was made aware of a patent [7] that had been secured in 2004 by a Japanese inventor named Nobuhiko Katsura. Dr. Katsura, a professor of biochemistry at The School of Dentistry at the University of Nagasaki, Japan, was studying the structure of tendon collagen when electron microscopy revealed an unexplained surface pattern. Exploring these patterns, Katsura has proposed that the underlying structure is formed by sheets of helical rods of tropocollagenic material measured in nanometers [8]. And I thought that Alex's wire art was miniature! Dr. Katsura had some helical metal wires made so that he could manipulate them for his studies. He then saw that these helical wires could be woven both in the Ransom (opposing chirality) and Scougale (same chirality) methods.

Katsura's patent, *Net Body Using Helical Wire Members* [6], describes a method for constructing fencelike wire fabric of various thicknesses and flexibility. Dr. Katsura also has explored structural uses for this woven wire system. One example of structural use is made by wrapping helical wires around a cylindrical form and then cross-threading same chirality members transversely (Figure 10). This can make a very strong structural tower that relies solely on the woven design with no need for mechanical reinforcement of joints.

There has yet to be written a descriptive mathematical language for this field of weaving spirals. A study is also needed to determine what is possible in this unexplored territory. Recently I have seen that a number of companies are weaving three-dimensional woven spring structures with three or more axial directions. One company in Germany, Kieselstein Wire Solutions, makes Strucwire. The company describes Strucwire as a three-dimensional lattice structure that excels in applications where high strength to weight ratios and impact absorption are critical.

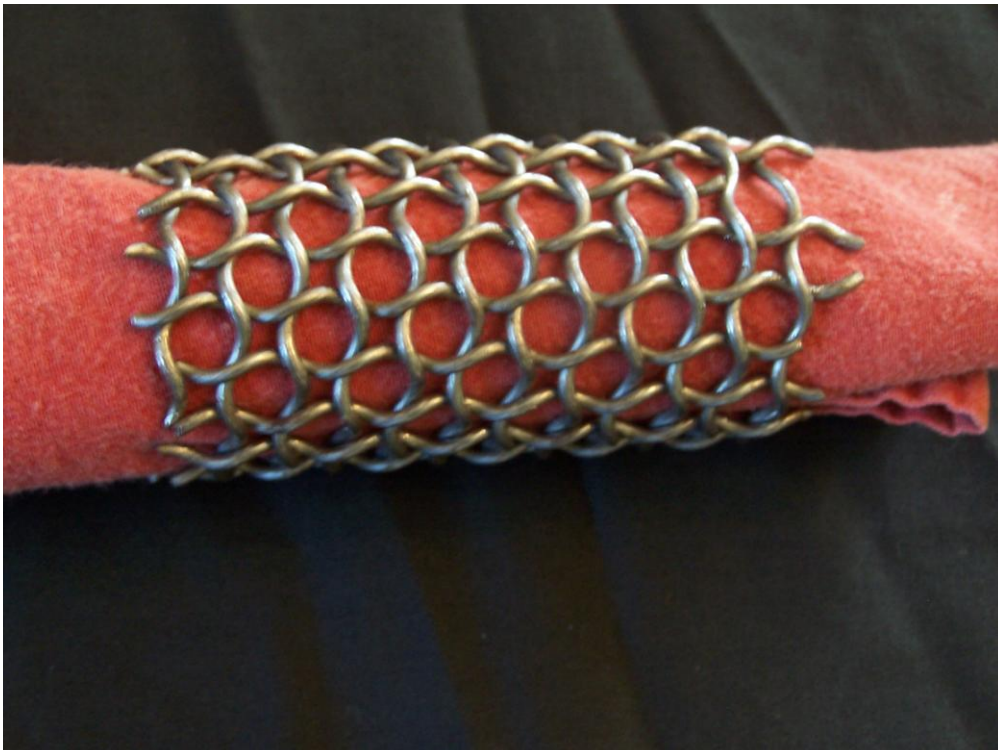

Figure 10: *Dr. Nobuhiko Katsura's woven spiral cylinder.*

[1] Paul Tucker, *Moorish Fretwork, Bridges: Mathematical Connections in Art, Music, and Science*: Conference Proceedings 2004, ed. Reza Sarhangi and Carlo Sequin, pp. 181-188.

[2] Owen Jones, *The Grammar of Ornament*, London, 1856.

[3] Paul Tucker, *Moorish Fretwork Furniture*, The Magazine Antiques, pp. 115-123, May 2005.

[4] E.H. Lockwood, *A Book of Curves*, Cambridge University Press, pp.62-71, 1961.

[5] R. A. Proctor, *The Geometry of Cycloids*, London, 1878.

[6] Alexandru Usineviciu, *Alexandru Usineviciu Sculpture/Jewelry*, http://www.oossy.com/.

[7] Nobuhiko Katsura, *Net Body Using Helical Wire Members*, US Patent 6,684,912, February 3, 2004.

[8] Nobuhiko Katsura and Toshio Ono, *A Novel Helical Filament Model of Hen Tendon Collagen Fibril*, Extracellular Matrix-Cellular Interaction: Molecules to Diseases, pp. 185-202. 1998.