Art, History, and Processes of Guilloché Engraving

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Introduction

Many modern day designers benefit by understanding historical processes which have long been forgotten. The guilloché style of pattern engraving is one such process.

There has been a recent re-discovery of the guilloché process by a few jewelry designers and watch makers. This presentation will connect the historical knowledge with the present desire to learn and understand this process. It will show how these rare machines work and how they are used to create the optical effects seen on the surfaces of masterful works of art such as those made by Fabergé, Breguet and others.

Definition and History

The 1911 *Encyclopedia Britannica* defines the term "guilloché" as an architectural element, a French word for an ornament,[1] either painted or carved, which was one of the principal decorative bands employed by the Greeks in their temples or on their vases. The definition continues, "Guillochés are single, double or triple; they consist of a series of circles equidistant one from the other and enclosed in a band which winds round them and interlaces." Figure 1 shows a triple guilloché band on the column base at the Parthenon on the Acropolis.

Figure 1 *Triple guilloché band on the column base at the Parthenon on the Acropolis*

The term guilloché within the jewelry and watchmaking industries is used to identify the engraving made by the trade rose engine, straight line engine, and brocading machines. Guilloché is synonymous with the term "engine turning" and often abbreviated ET. For the sake of this paper, we will use ET and guilloché synonymously and interchangeably.

The ornamental lathe (OT) is the precursor to the rose engine or ET lathe. The OT lathe is used primarily for wood and other soft materials including the historic use on ivory in previous centuries.

Early History and Lineage of the Ornamental Lathe

Evidence exists of the earliest lathe in use by the first millennium BC.[2] These lathes were used for turning wood or similar soft materials. Early lathes were primarily used for simple ornamental work, e.g., spindles as legs for chairs and tables, bowls, and small objects such as cups and boxes.

The simple lathe evolved with the addition of the axial movement of the spindle, which allowed for screw cutting on the lathe. The ornamental turning (OT) lathe as we know it today evolved slowly during the lathe's early history from 600 B.C. to 1500 A.D. The OT lathe then evolved dramatically during the 17th, 18th and 19th centuries.

The earliest evidence of the metal cutting lathe is in the first half of the 15th century, where we also find a crosslide holding a fixed point tool.[2] By 1569 examples of chucks, which allowed for eccentric and elliptical turning, were developed and put to use.[2]

One of the earliest published illustrations of an ornamental lathe is in Besson's *Theatrum instrumentorum et machinarum*.[3] Shown in Figure 2 are several of the ornamental additions to a lathe. A tracing guide is shown above the bed of the lathe, which was used for repeating a shape or pattern. A "swash" plate, which is the slanted cam at either end of the lathe, is set to a prescribed angle and imparts all radial movement with an axial motion and is shown at both ends of the spindle.

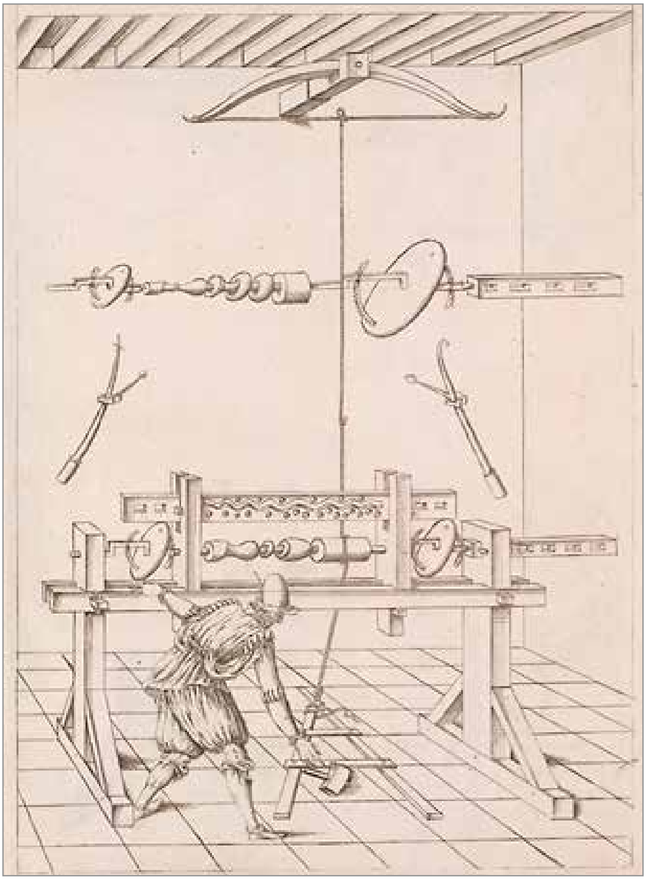

Figure 2 *One of the earliest known illustrations of an ornamental lathe*

The first great treatise on turning was written during the last half of the 17th century by Plumier, *Art Du Tourneur*,[4] published in 1701, although the work was produced between 1653 and 1675. It contains numerous illustrations of ornamental lathes and their accessories such as the elliptical chuck for turning elliptical pieces (Figure 3, lower half); rosettes for rocking radially and/or pumping axially, which produce ornamental *objets d' art* (Figure 3, upper half); along with cams for swash turning (Figure 4, F and P).

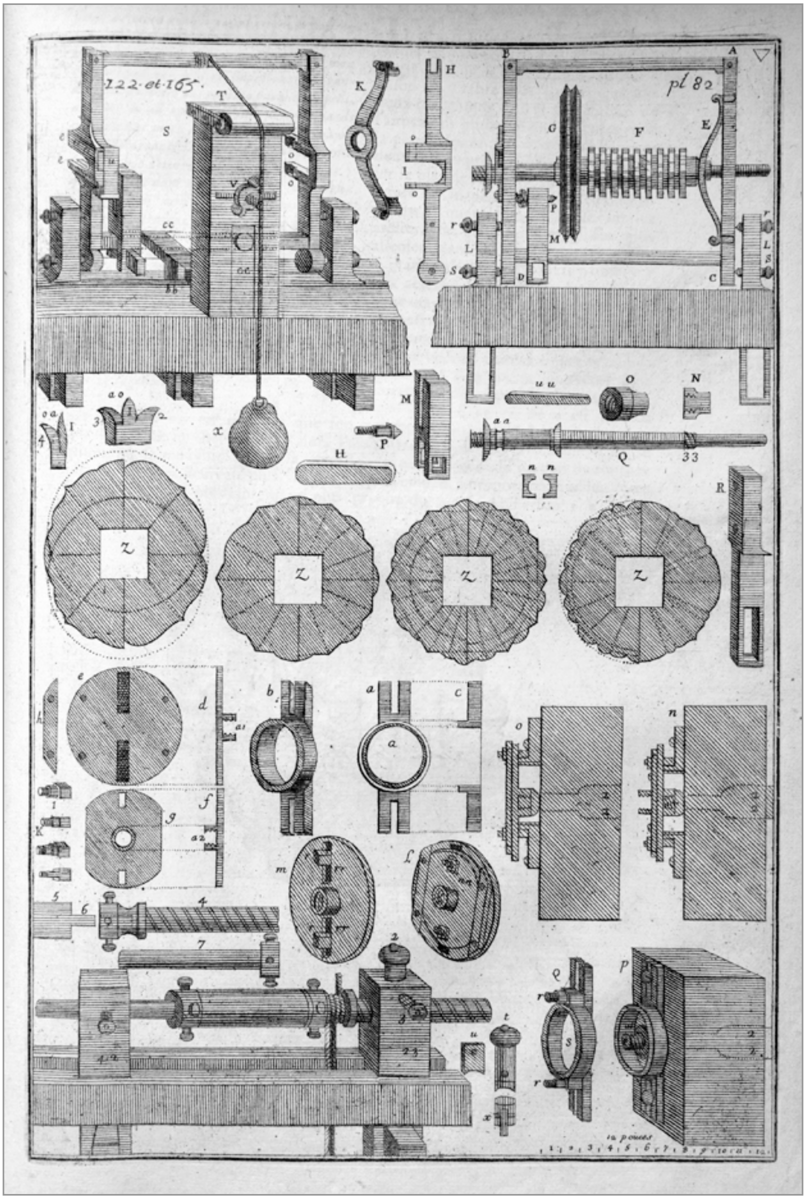

Figure 3 *Illustration of rose engine parts*[4]

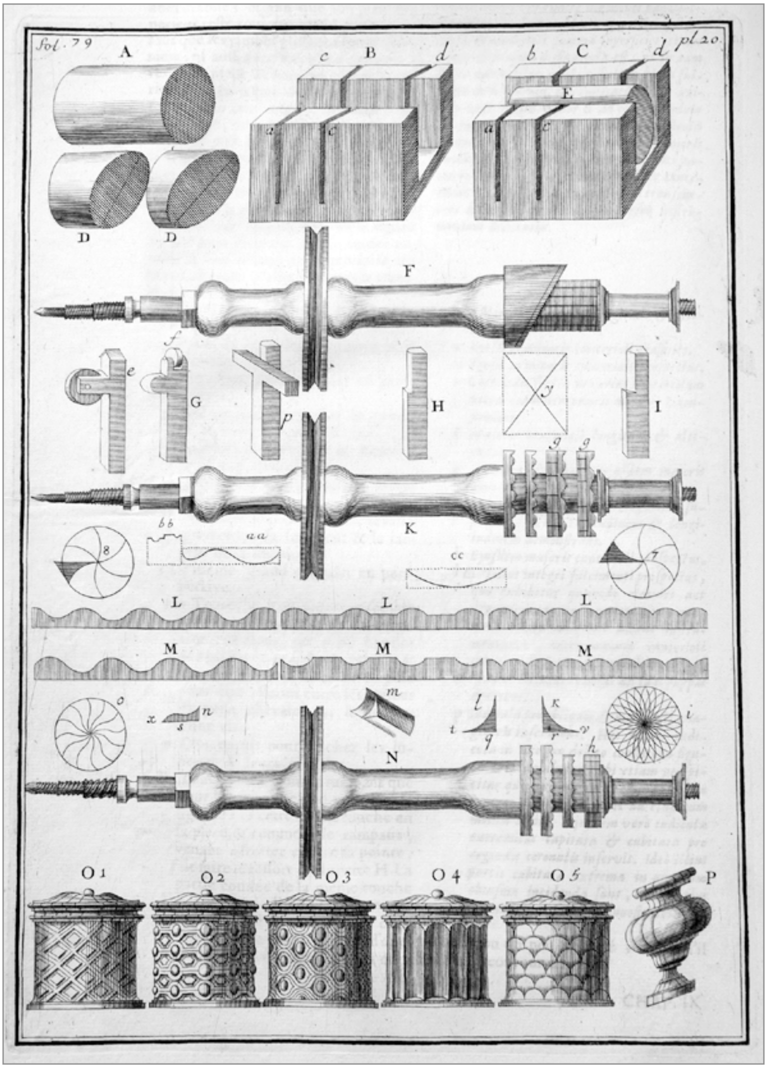

Figure 4 *Early OT lathe spindles and examples*[4]

The encyclopedia of Diderot and D'Alembert[5] included a volume entitled *Art du Tourneur*, 1772. In it are many early examples of rose engines and their accessories, including details showing both axial and radial rosettes used to pump the spindle axially along the long axis of the spindle and rock the spindle radially perpendicular to the long axis of the spindle (Figure 5, B and C). There was a great proliferation of these machines during the Age of Enlightenment due to the rapid spread of knowledge brought about by the new philosophy of shared information and a growing publishing industry. This was the first time a book was published in great numbers which allowed anyone to create the machines shown and described. Up to this time, all of this information was held and kept secret by the guild system.

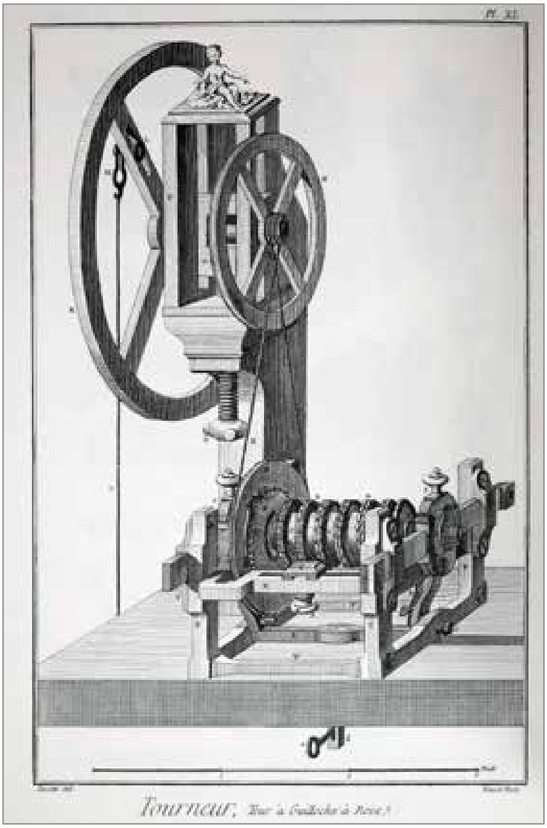

Figure 5 *Rose engine from Diderot's Art du Tourneur*[5]

Ornamental turning became a popular pastime in the homes of European royalty. All of the European courts had a room dedicated for turning, mainly for educational and entertainment purposes. At this time the art of turning had its foundation based in philosophy, the philosophy being that all things mechanical and all things natural were the same. Descartes wrote in 1644, "I know no difference between machines that the craftsman makes and the various bodies that nature makes on its own."[6] Therefore, the wisdom of the day, in order to understand a machine such as an ornamental lathe, was to understand nature's inner workings. This philosophy spread rapidly through the aristocracy and the courts and saw the rapid adoption of the ornamental lathe as an educational device and a mechanical marvel.

The earliest royalty believed to own and use an ornamental lathe was Emperor Maximilian I of Austria in 1500. Tsar Peter I the Great of Russia, the Prussian Kings Frederick III and IV, Louis XV and XVI of France, the kings of Denmark, and King George III and King James I of England all owned and used finely made ornamental turning lathes for their education, their entertainment, and their philosophical studies.[6]

It is speculated that guilloché on metal was first used between 1700 and 1750. Several examples of guilloché on silver and gold are located at the Metropolitan Museum of Art dating from 1743. The majority of guilloché work at this time was performed on snuff boxes.

The French book, *Boites*, states that the earliest guilloché on metal was in the 18th century.

> "Franco-Swiss (guilloché) initially did appear at the XVIII century, and its use has developed heavy around 1750. But it was not until the years 1770-1780 and the invention of a colorless fondant called 'enamel of Geneve' was manufactured for the first boxes with (enamel on) guilloché background."[7]

The first published examples of straight-line and rose engines for guilloché on metal are included in Bergeron's *Manual du Turneur* in 1816[8] (Figures 6 and 7). It was in the printing of these illustrations that the printing plates themselves had guilloché applied to them; then they were inked and pressed.

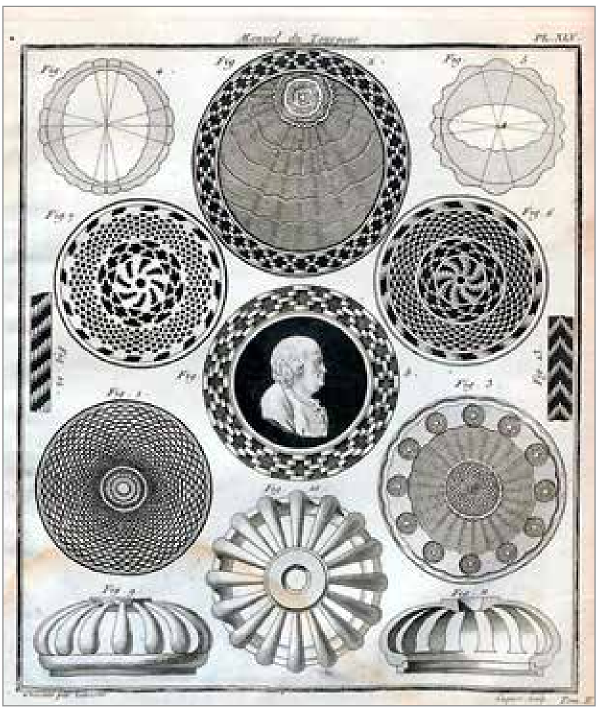

Figure 6 *Earliest illustration of guilloché from Bergeron's* Manuel du Tourneur[8]

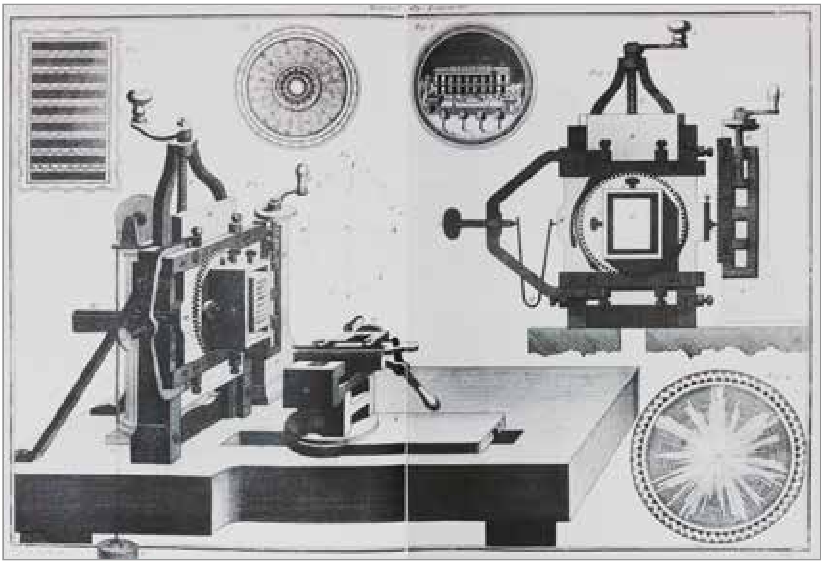

***Figure 7** An early example of a straight-line engine and work created from it (*Manuel du Tourneur[8]*)*

The use of guilloché in watches and watch cases began around 1780. The Swiss-based Abraham-Louis Breguet began to apply guilloché to his watches around 1785. It soon became known as their signature style and today is utilized in the majority of their watches. As recently as 1902, there was an official guilloché class under the school of engraving within the university of industrial and applied arts in La Chaux-de-Fonds, Switzerland, the same place that produced many of the engine turning machines such as Lienhard, Güdel, and Lang.

No discussion of guilloché and ornamental turning would be complete without the mention of the work done by the Holtzapffel Company. The London firm is most famous for its ornamental lathes made between 1794 and 1914. The company was founded by John Jacob Holtzapffel I (1768-1835) and later run by his son Charles Holtzapffel (1806-1847) and then grandson John Jacob Holtzapffel II (1836-1897). It produced over 2000 lathes, of which it is believed that 16 were rose engines (Figure 8).

Figure 8 *One of 16 known Holtzapffel rose engine OT lathes*

Charles and John Jacob also produced five volumes entitled *Turning and Mechanical Manipulation on the Lathe*,[9] which are still referenced by modern-day engineers and designers. The recent publication, *Holtzapffel Volume VI*, has been produced by John Edwards.[10] It is a compendium of rare and previously unpublished material related to OT and includes handwritten notebooks that Holtzapffel wrote for his customers to be used as manuals for their tools.

One notable item shown in the books by Plumier, Diderot, Bergeron and Holtzapffel is the geometric chuck (Figure 9). The geometric chuck creates cycloidal patterns (Figures 10-13) not unlike a rose engine but of a truly different type of line creation. The line drawn by a geometric chuck is a single continuous line whereas rose engine work is a collection of many concentric lines. The geometric chuck was soon put to use in security printing of bank notes, stamps, and legal documents. It produces curves similar to the modern day spirograph. These curves are known as roulettes or cycloids. When the geometric chuck is combined with multiple geometric chucks, the number of possible patterns quickly becomes astronomical, which lends itself to creating engravings that are impossible to counterfeit, the analog form of encryption.

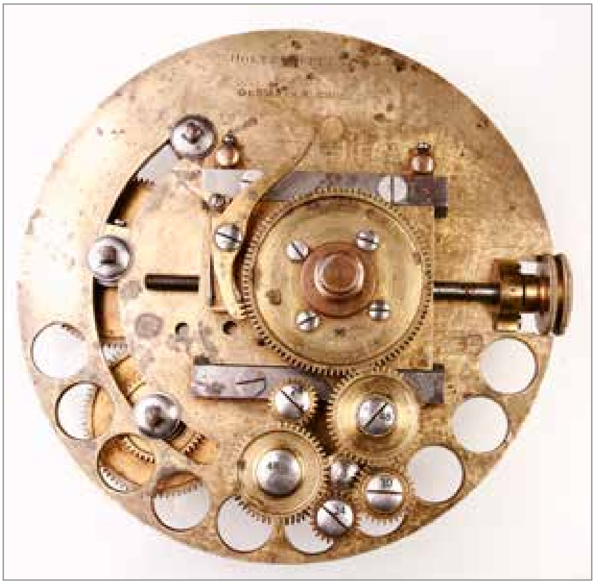

Figure 9 *Holtzapffel geometric chuck used to create Figures 10-13*

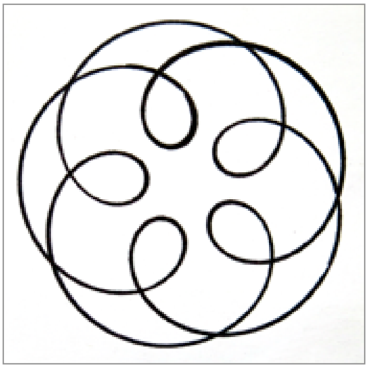

Figure 10 *Cycloidal pattern*

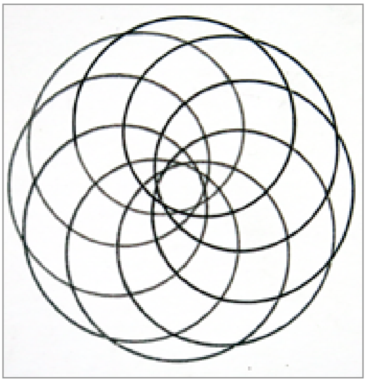

Figure 11 *Cycloidal pattern*

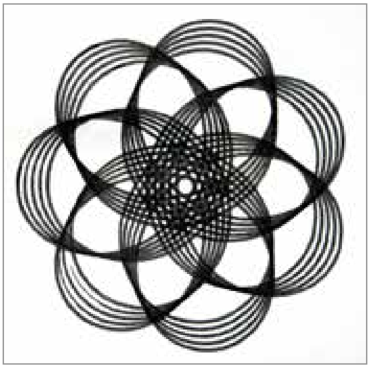

Figure 12 *Cycloidal pattern*

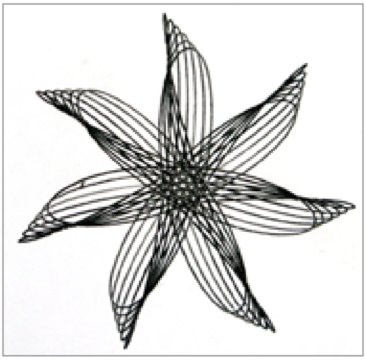

Figure 13 *Cycloidal pattern*

Images of Early Guilloché Examples—Snuffboxes and Watchcase from the Mid-18th Century (Figures 14-17)

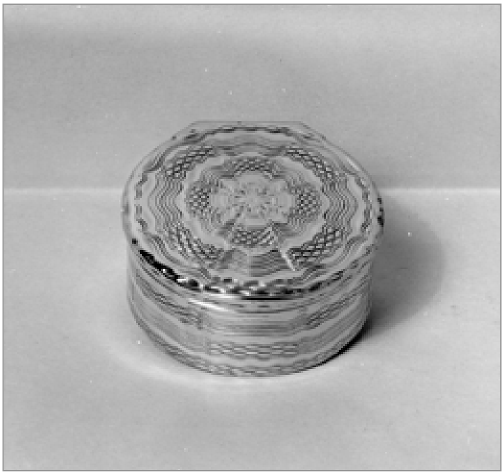

Figure 14 *This item is a candidate for having been made on an OT lathe due to the higher amplitudes of the cut design.*

Unknown artist

Date: 1743–44

Culture: French (Paris)

Medium: Gold

Metropolitan Museum of Art Accession Number: 48.187.478

***Figure 15** Snuffbox*

Charles Le Bastier: apprenticed 1738, master 1754, active 1783
Date: 1773/74
Medium: Gold, enamel
Metropolitan Museum of Art Accession Number: 17.190.1163

***Figure 16** Snuffbox*

Louis Michelin: apprenticed 1736, master 1751, active 1781
Date: 1752–53
Medium: Gold
Metropolitan Museum of Art
Accession Number: 48.187.457

Figure 17 *Watchcase*

Unknown artist
Date: 1791
Walters Art Museum, Baltimore, Maryland
#58.74

From Ornamental Turning to Guilloché

No evidence is found which clearly shows the evolution from the OT lathe to the guilloché rose engine or ET lathe. The earliest forms of guilloché were likely made on ornamental lathes (Figure 14). Although very similar to the ornamental lathe, the guilloché rose engine evolved with several distinctions that differentiate it from the OT lathe. The guilloché rose engine needed to be much more rigid to be able to engrave metal and leave a bright cut without marks made by vibration. The amplitude of the rosettes (difference between the peaks and valleys of the rosette) are also much lower on the guilloché rose engine due to the smaller size of the work pieces and the effects of amplitude on designs. Rose engines produced for the watch trade were made with numerous lobes on each rosette, sometimes upward of 360 lobes with very low amplitudes. The sliderests on guilloché lathes are considerably different. They include the ability to move the slide in repeatable increments and also include a radial movement which is utilized to keep the cutter always tangent to the surface of domed work pieces like watch cases and Fabergé eggs.

Guilloché on gold and silver became very popular during the mid to late 19th century and reached its peak during the years 1880 through 1930. Fabergé

(1846-1920) used guilloché extensively as the background of his transparent enamels. This gave the workpieces a gem-like glow, or optical play-of-light. This optical effect is most notable in Figures 15 and 16.

Guilloché and engine-turning machinery in America began with the Rhode Island firm of Chas. H. Field, which started manufacturing rose engines around 1857. Charles was the son of a watchmaker and had several patents pertaining to watchcase making and engraving machines. The popularity of cuff buttons (cuff links), lockets, pens, and pen knives grew exponentially during the late 19th and early 20th centuries. It is believed that the Chas. H. Field company produced more than 150 rose engines for the jewelry trade in Rhode Island at that time.

Peter DiCristofaro, director and historian of the Providence Jewelry Museum, writes:

> "American Engine Turning exploded in the middle of the 19th century. John Gorham's English silversmiths brought ET knowledge and the vision of building ET machines to Providence, RI. His Gorham Mfg plant in 1862 had a significant ET department on Canal St. The size (of the work room) matched the burnishing room which corrected the defects in the very difficult manufacture of sterling silver/coin silver sheet. It is hypothesized that ET was a relief to the burnishing department as it covered the surface with the optical designs thereby removing the need to burnish.
>
> "The Gorham machinery records suggest that their machines were locally built 'one offs' using local foundries and the skills of Charles Field."[11]

Shops proliferated around Providence and most of the ET machinery built centered on Charles Field, who applied and received many patents for his engine-turning inventions. The last of his patents and machines were built to engrave pen barrels for A.T. Cross. After his death in 1893, his son Charles Field Jr. continued until his death in 1922.

One interesting item to note is that during this time guilloché had become very popular, which created high demand for product. A few new methods were employed to shorten the time needed to produce each piece. One method was to use a diamond point to burnish the lines rather than using a cutter to cut the lines. This saved time by not requiring the use of the *guide*. The depth was controlled by the force required to scratch the surface, which was minimal. This also allowed workers with less training to produce items for market. Another method to speed the process was to guilloché directly into tool steel to create a die, which would then be used to stamp the lines into the metal.

Both of these methods did work to reduce the time needed for each part but the quality of pattern was severely compromised. Present-day attempts using CNC mills to create the same bright cut have been less than successful. This is due to the way a single-point engraving tool is capable of leaving a very bright cut; rotational tools are not capable of the same.

Many pieces were produced with an almost complete covering of the item with guilloché, believed to assist in hiding imperfections in the silver sheet. Figure 18 is a Gorham card case covered with guilloché.

Figure 18 *Example of silver work that is completely covered with guilloché*

The Machines

Rose Engine

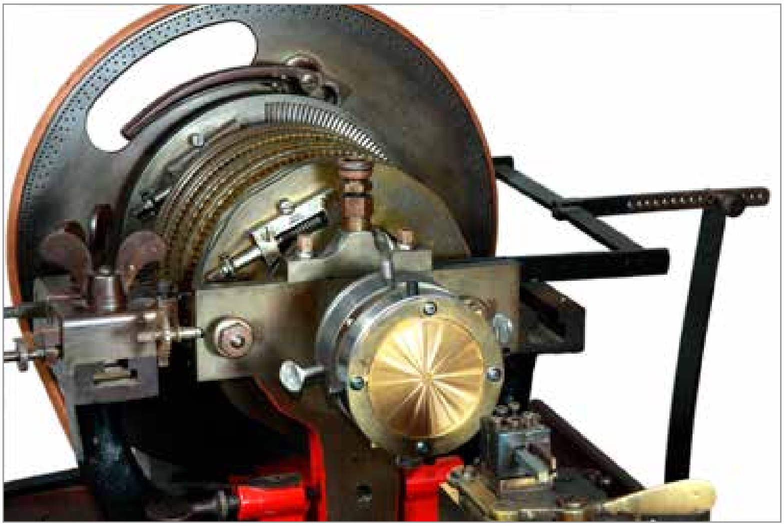

Figure 19 *Rose engine built by the Swiss company Lang, 1880, Geneva, for the watch industry. It is clearly more compact and shows very low amplitude rosettes when compared with ornamental lathes.*

Figure 20 shows a guilloché machine made in 1950 by G. Plant and Sons, established 1857, Birmingham, U.K. Note how this machine is even more compact, with smaller and lower amplitude rosettes (Figure 21), and a more rigid casting for the bulk of the machine. Because of this, this machine can produce very bright engravings suitable for high-end work. Most of these machines also came with an elliptical chuck and a double eccentric chuck to allow for many possible patterns and shapes to be cut.

Figure 20 *G. Plant & Sons trade rose engine*

Figure 21 shows the effect of amplitude on the engraved pattern relative to the center of the work. Note how the line shape changes as the cuts get closer to the center while the amplitude of the rosette, and thereby the cut, remain the same.

Figure 21 *Amplitude and its effect*

Figure 22 shows the recent development of a modern rose engine capable of both ornamental turning and guilloché engraving. It is built by David Lindow, a clockmaker from Lake Ariel, Pennsylvania. These new machines are built after the pattern of the Chas. Field machines but with many modern improvements. The rosettes are easily interchangeable with ones suitable for guilloché or OT work.

***Figure* 22** *Modern rose engine*

The Double Eccentric and Elliptical Chucks

Common with the rose engine is an accessory known as the double eccentric chuck, which allows for off-center work so a work piece could have the engraving done off-center rather than centered on the piece. The adjusting slides are shown in Figure 23, #1 and #3. The same chuck also has rotational adjustment shown at #2. The elliptical chuck allows for ellipses to be made of varying short- to long-axis ratios. Long, narrow ellipses or short and wide ellipses could be achieved by simply adjusting a slide (Figure 23, #4).

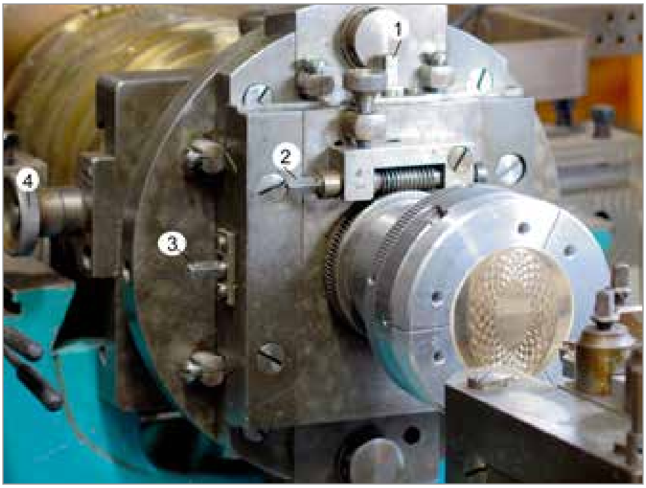

Figure 23 *Various adjustments to the double eccentric and elliptical chucks*

Figure 24 shows the effect of off-center turning and rotational adjustment. In this example the rotational adjustment was indexed four times each at 90 degrees.

Figure 24 *This example shows the effect of off-center turning and rotational adjustment. The rotational adjustment was indexed four times each at 90 degrees.*

Figure 25 is a graphic illustration of a rose engine in rocking mode, front view. In this illustration the headstock is spring loaded towards the left using the *rocking spring*, forcing the *rosette* against the *touch*, which is fixed, causing the entire *spindle* assembly, which includes the *rosettes*, *crossing plate*, *worm* and *index lever*, to rock gently left to right. As the spindle is rotated, the *rosette* will *pivot* to the right when the *touch* reaches a *rosette* peak and conversely, the *spindle* will pivot back to the left when the *touch* reaches a valley in the *rosette*. The work piece is held in a chuck which attaches to the *spindle nose*.

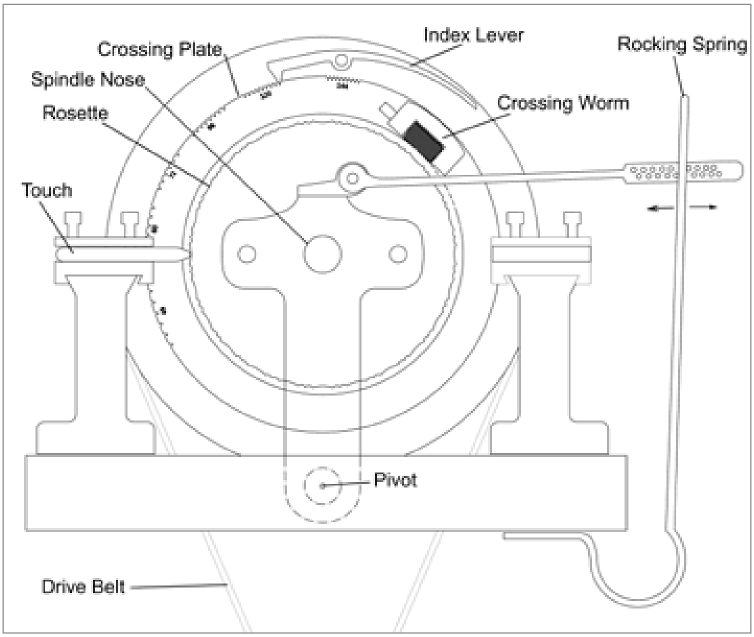

Figure 25 *Front view of a rose engine*

The Straight-Line Engine

Figure 26 shows a modern straight-line machine also made by G. Plant and Sons about 1950. Note the leather cords used for counterbalancing the weight of the cross slide.

Figure 26 *G. Plant & Sons straight-line machine*

Figure 27 is a graphic illustration of the straight-line engine, front view. Its motion is as follows: As the *handwheel* is turned, the *main motion screw* drives the *cross slide* up and down upon the *main slide*. This action coupled with the *leafspring*, which keeps the touch sprung against the *pattern bar*, makes the *cross slide* move left and right. The work is held by a chuck coupled to the *spindle nose*.

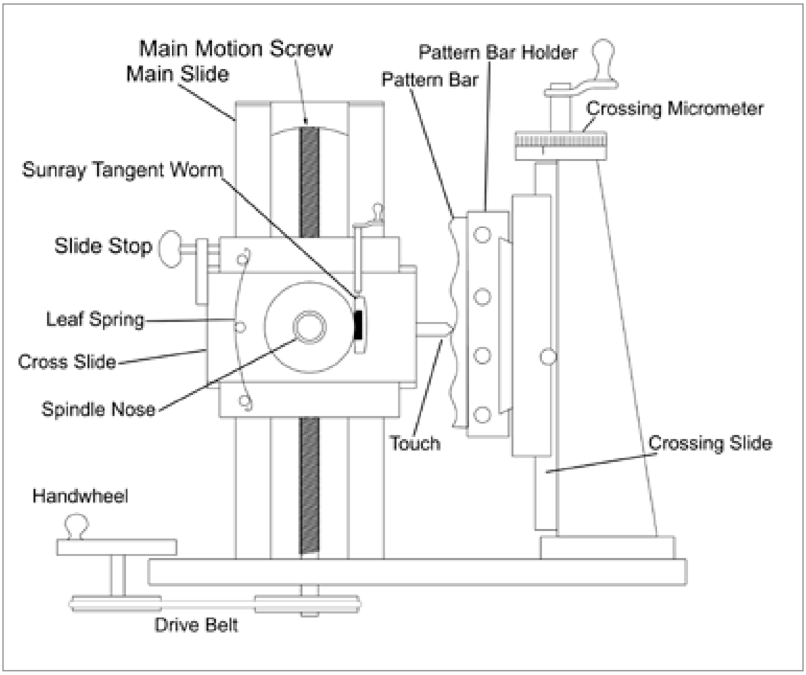

Figure 27 *Front view of staight-line machine*

The Cutting Tool

The cutting forces acting upon the cutter are quite high when cutting gold or silver. Cutters must be hardened and tempered to avoid chipping of the tool edge. If the tool becomes chipped, worn, or damaged during cutting, the work piece is usually discarded due to the difficulties involved with re-indexing the tool to the cut. Some guillochers prefer high-speed steel for deep cuts because of its toughness; others prefer using carbide cutters because of their ability to keep a sharp edge and when making shallow cuts.

The geometry of the cutter varies according to the work and the desired outcome. A *cutting tool* for general use will typically have a 150 to 160 degree included angle with a 20-degree front rake as shown in Figure 28. The top edge of the cutter is given a slight deburring polish at its tip to prevent chipping. The *guide* is used to control depth and to impart a burnished area ahead of the next cut. It is adjusted in relation to the cutter to achieve the correct depth of cut, which also affects the width of the cut (Figures 29 and 30). Cutting starts on the outside of the design and works toward the center of the design. While cutting, the operator is using hand-eye coordination while pushing on the tool carriage and observing the curl of removed metal and the quality of the cut to achieve the best optical reflection and the best quality of pattern. Figure 31 shows the curl coming out of a cut while cutting a circular border without the use of a rosette.

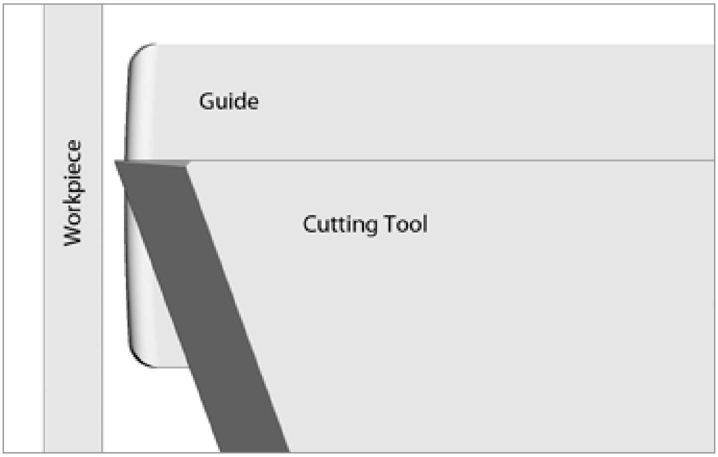

Figure 28 *Graphic of left side view of cutting tool and guide*

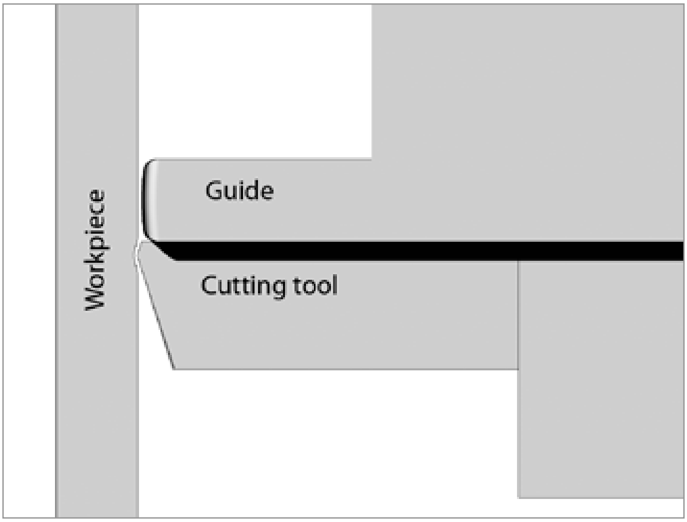

Figure 29 *Graphic of top view of cutting tool and guide*

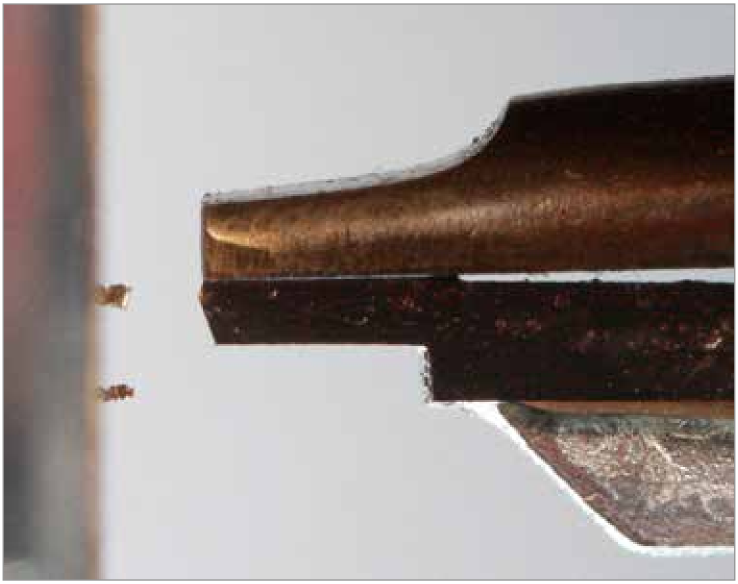

Figure 30 *Photo of top view of cutting tool and guide*

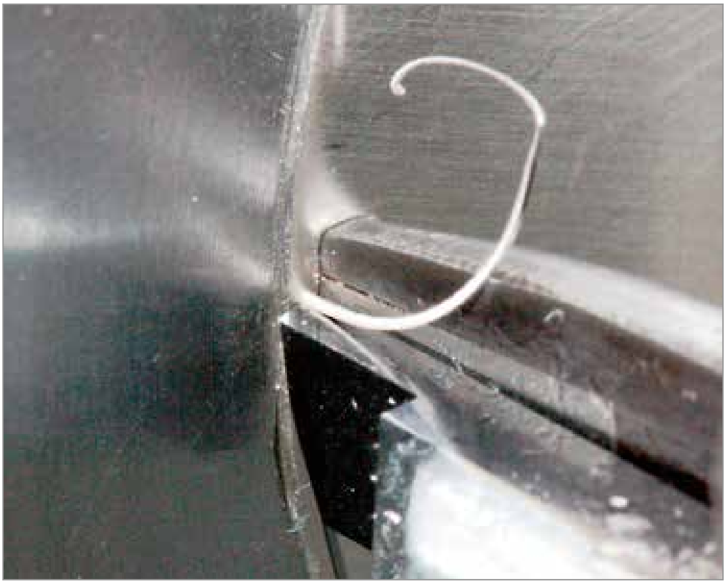

Figure 31 *Photo of left side view of cutting tool and guide*

Figure 32 shows the start of a cut during the first revolution of the part where the swarf (material produced by the cutting action) is primarily welded material, rather thick, with signs of orange peel on its surface. Note the burnished area under the guide. Figure 33 shows the swarf after the first revolution and well into the second revolution of the part. It has a foil-like quality and the cut itself is now showing a bright, highly reflective surface.

***Figure* 32** *Initial cut*

***Figure* 33** *Secondary cut*

Figure 34 Shows the finished part fully engraved with guilloché from the outside perimeter to the center. Note that the center is cut with a circular cut without the rocking of the rosettes. Near the very center of rose machine work, the side-to-side motion of the part creates a very muddy pattern due to the amplitude of the pattern at center. Most guillochers will turn simple circular cuts at the center for this reason. It is less of a concern with watches as they have a hole for the hands of the watch at center.

Figure 34 *Work completed from outside towards center*

Pattern Development

Rose Engine

Using only one rosette or one pattern bar, hundreds or even thousands of patterns can be developed by using one or more adjustments on the machines. The simplest of the rose engine patterns is the concentric pattern. A rosette is selected, and the cutting proceeds from the outside diameter to the center of the work. The first cut engraves a circular border. The cutter slide is then moved over one increment, the rosette is engaged, and the second cut is made. This continues to the center of the work and creates the pattern shown in Figure 35.

One form of pattern development is when the relationship between the spindle and the rosette is adjusted radially with each cut. This can be achieved by either using the *worm* or the *crossing plate* (Figure 25). Figures 35-39 all use the same 24-lobe rosette. Figure 36 shows the effect of adjusting the spindle/rosette relationship by half of the pitch of rosette. In this case, the 24-lobe rosette is rotated 1/48 of a circle, or 7.5 degrees. This is a common pattern referred to as "barleycorn." Similarly, if a 96-lobe rosette is being used, it would be rotated 1/192 of a circle or 1.875 degrees to create a barleycorn pattern (Figure 40).

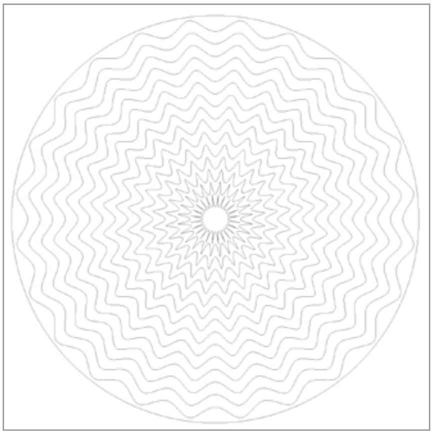

Figure 35 *Concentric pattern*

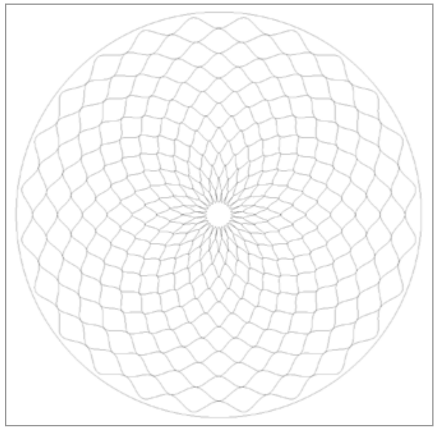

Figure 36 *Barleycorn pattern*

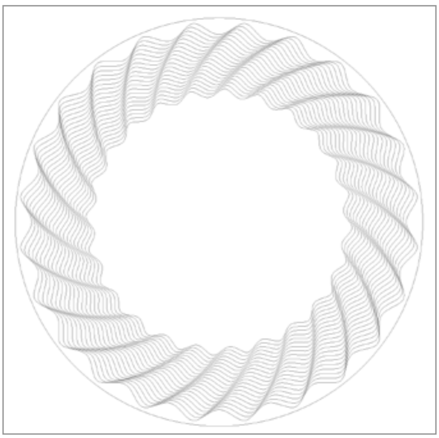

Figure 37 *Pinwheel pattern*

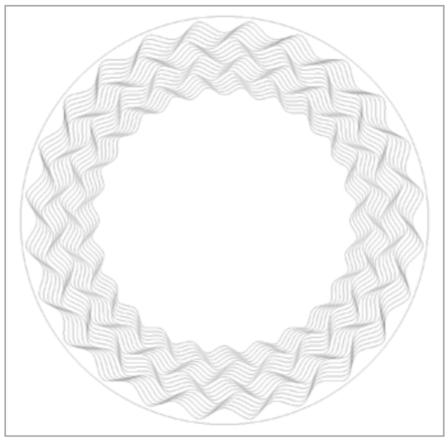

Figure 38 *Lightning pattern*

Figure 37 shows the effect of changing the spindle/rosette relationship by one degree before each successive cut using the worm. Figure 38 shows a one-degree change after the initial cut for 5 successive cuts, then a one-degree change in the opposite direction for another 5 cuts, continuing this way to the center. Figure 39 uses the worm to change the spindle/rosette relationship to create the pattern where a "sinewave" appears radiating from the outside towards the inside of the work. This pattern is sometimes referred to as "moire."

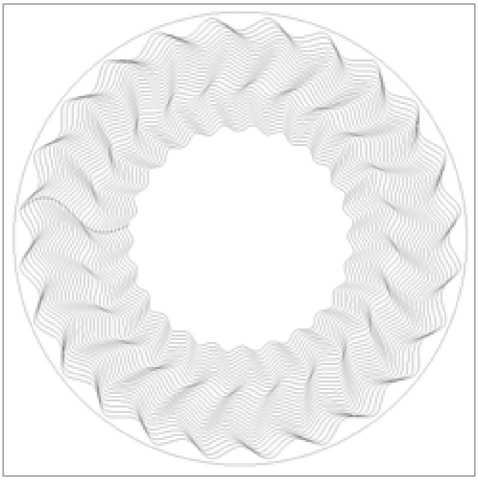

Figure 39 *Sinewave pattern (sometimes referred to as "moire")*

Shown below are examples of guilloché on metal. Figure 40 is a barleycorn pattern. Figure 41 uses a rosette with 12 lobes consisting of a long lobe followed by three short lobes. The spindle/rosette relationship was altered by turning the worm approximately 1 degree between each cut.

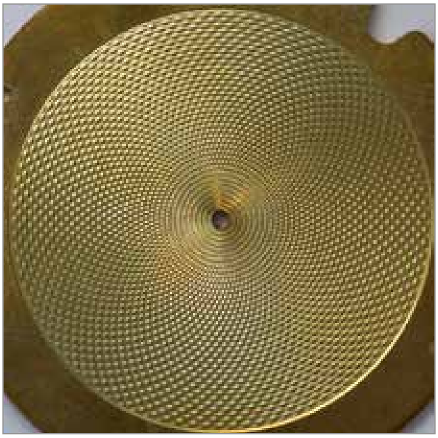

Figure 40 *Barleycorn pattern*

Figure 41 *Pinwheel pattern*

Figure 42 shows a typical lightning pattern, also known as "escargot" or "zigzag." The worm is adjusted by a set increment for each of 10 cuts. It is then reversed and the worm is adjusted in the opposite direction for each of the next 10 cuts and so on, continuing towards the center of the piece.

Figure 43 is a moire pattern, which exhibits the classic sinewave effect that radiates from the center outward. The worm adjustments that are made between each cut resemble the Fibonacci sequence—1,2,3,5,8,13,8,5,3,2,1—and then they are repeated in the opposite direction.

Figure 42 *Lightning pattern*

Figure 43 *Sinewave pattern*

Straight-Line Engine

Straight-line patterns are developed in a similar way as rose patterns, the simplest being consecutive cuts at a given distance with no change to the adjustments of the machine (Figure 44). By moving the crossing slide by one-half of the pitch (distance between the peaks of the rosette) of the pattern bar, the barleycorn pattern is produced (Figure 45).

By adjusting the crossing slide by a small increment before each cut, the diagonal pattern in Figure 46 is produced. Figure 47 shows the effect of moving the crossing slide a small increment and repeating nine times, then moving the crossing slide by the same increment but in the opposite direction and repeating nine times, creating the lightning pattern.

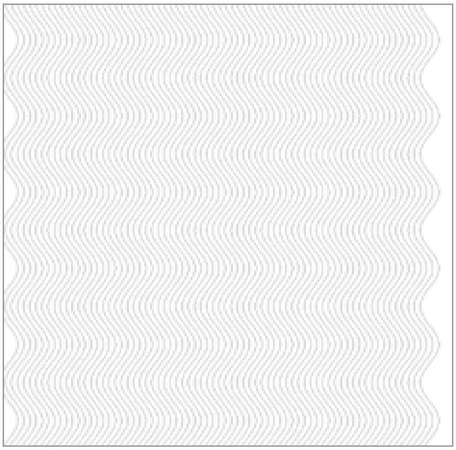

Figure 44 *Consecutive cut pattern*

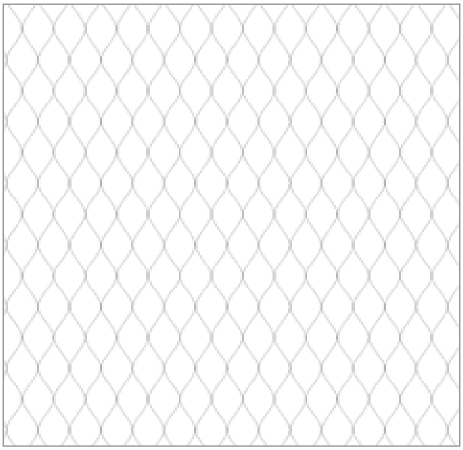

Figure 45 *Barleycorn pattern*

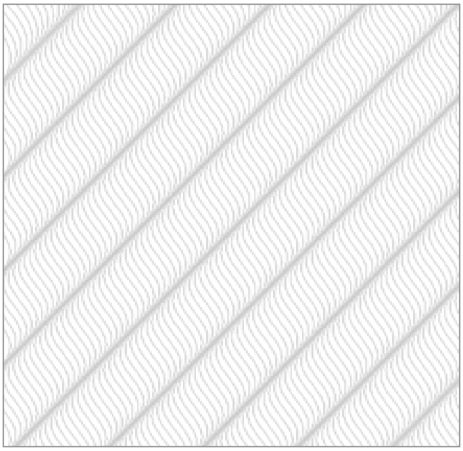

Figure 46 *Diagonal pattern*

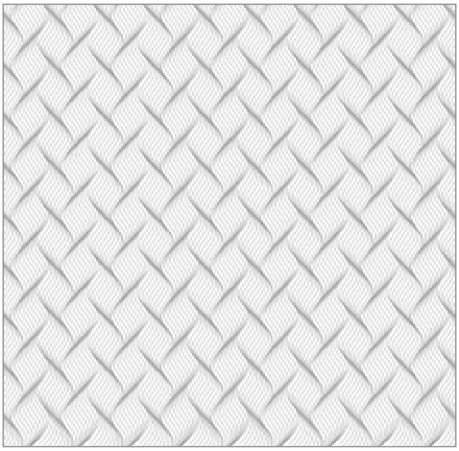

Figure 47 *Lightning pattern*

Many other adjustments to the machines are available to multiply the number of patterns that any given rosette can make. One of the many variables is the radius of the *touch* in relation to the radius of the lobe on the rosette. Most rosettes consist of a series of shallow concave scallops around the periphery of the rosette. If the radius of the *touch* is half of the radius of the rosette lobe, then the resulting cut is in the form of a sinewave (Figure 48). If the radius of the touch is less than half the radius of the lobe, the result will be a series of concave scallops similar to the rosette itself. Whereas, if the radius of the *touch* is greater than half of the radius of the lobe, the result will be a series of convex shapes, in effect opposite the shape of the rosette or mirror image of the rosette (Figure 49).

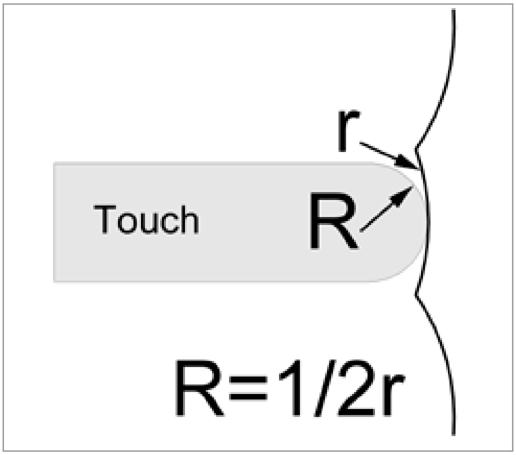

Figure 48 *Relationship of touch radius to rosette radius*

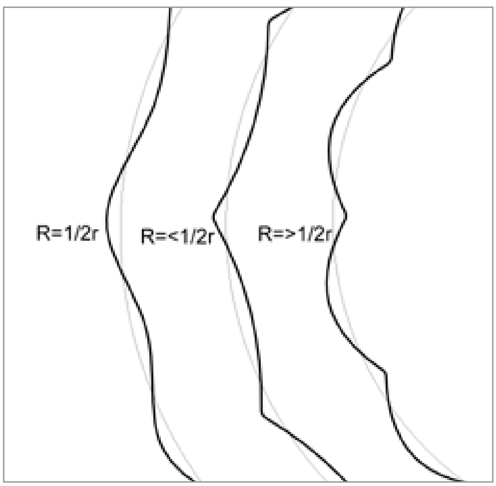

Figure 49 *Different touch/rosette relationships yield different results.*

Another variable which again multiplies the number of patterns per rosette is the location of the *touch*. Most machines have *touch* tool mounts on either side of the spindle. By placing the *touch* in the opposite tool mount, the mirror image of the rosette is created in the cut.

Cutting typically proceeds on the left side of the spindle axis, starting the circular cuts from the outside of a round piece and working with progressive cuts towards the center of the work. By cutting on the right side of the spindle, the cut will be a mirror image of the rosette. In other words, when using a standard rosette with concave scallops and a *touch* with a radius less than half the radius of the lobe, cutting on the left of center creates convex scallops, whereas cutting on the right side of center creates concave scallops.

Modern Work Examples

Guilloché is realizing a new rebirth in its use in modern jewelry and sculpture. Figures 50 and 51 show modern and innovative work by German designer Frieda Doerfer. Her work is unique and shows a textile-like quality in the metal.

Figure 50 *Frieda Doerfer pendant and chain*

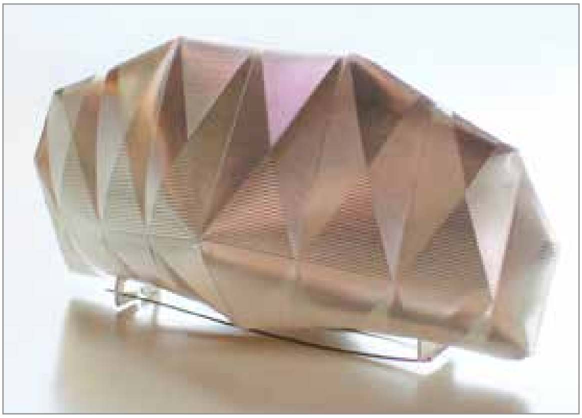

Figure 51 *Frieda Doerfer brooch*

Figure 52 shows straight-line work on the inside of a locket in 18K. The work was first engine turned and then formed using polyurethane and an acrylic die. By using polyurethane as a die material, the engraving is left unmarred when formed.

Figure 52 *"Timeless Locket Watch," 18K (by the author)*

Figure 53 also shows straight-line ET use along with ornamental turning on titanium. Guilloché on titanium, niobium, and stainless steel is a new direction in the art, made available by new materials.

Figure 53 *Titanium buckle using both OT and ET (by the author)*

Rich Littlestone of Colorado engraves his hand-made fountain pens using a straight-line machine. He has invented many new patterns and tools for use with his designs (Figures 54 and 55).

Figure 54 *Sterling silver pen by Rich Littlestone*

Figure 55 *Sterling silver pen by Rich Littlestone*

Roland G. Murphy of Lancaster, Pennsylvania, uses guilloché on many of his watches. Figure 56 shows one of his watch faceplates chucked on his rose engine. Note the multiple patterns which differentiate the "seconds" and label areas of the watch. The periphery of the "seconds" area and the dial both show the results of pumping the spindle of the rose engine. Figure 57 shows a beautifully finished watch demonstrating multiple patterns on its face.

Figure 56 *Roland G. Murphy watch on rose engine*

Figure 57 *Watch by Roland G. Murphy*

Celia Kudro of Colorado uses both ornamental turning and guilloché on her rings (Figure 58). In Figure 59 you can see the effects of guilloché underneath the transparent stone, also a new direction in the use of guilloché.

Figure 58 *Sterling silver rings by Celia Kudro using both OT and ET*

Figure 59 *Necklace by Celia Kudro with guilloché under transparent stone*

Conclusion

The possibilities are endless when it comes to patterning metal for jewelry purposes. There is a growing renewed interest in guilloché, engine turning, and ornamental turning, which is finding ready buyers for produced works. Big-name fashion designers are utilizing the art of guilloché in their new designs as can be seen in a recent promotion featuring a new watch line. In it is showcased a rose engine from the mid-19th century. Unfortunately, in an effort to create a sense of rarity, their claim of only four guillochers practicing the art of guilloché in Switzerland is far from true. It is well known that many watchmakers in Switzerland have complete guilloché workshops with many employees practicing the art. Cartier, Tag Heuer, Patek Phillippe, Oris, and Vacheron Constantin are just a few of the watch companies currently reintroducing guilloché. Of these, Vacheron Constantin has led the way by innovating many new ways to use guilloché coupled with enameling. Apart from the watchmakers, many up and coming young designers are rediscovering the art and utilizing it in new, innovative ways for their jewelry.

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- I'm also very grateful and quite proud of my protégé, Calina Shevlin, who, through lots of hard work and perseverance, became an accomplished guillocheuse and went on to guilloché for the Breguet watch company, Switzerland. Her samples can be seen in Figures 40-43.
- And last, but certainly not least, is a big thank you to Eddie Bell, Rio Grande, and all of the Santa Fe Symposium® sponsors.

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Poirier

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David Lindow's rose engines can be found at http://www.roseengine1.com.

RGM watches can be seen at http://www.rgmwatches.com.

Rich Littlestone's work can be seen at http://www.argentblue.com.

Frieda Doerfer's work can be seen at http://frieda-doerfer.de/.