The Ornamental Lathe

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Introduction

Originating from the simple or common lathe, which is known as the mother of all machine tools, the ornamental lathe is arguably the most capable machine tool in the history of mechanization. In the 1981 *Metalsmith Journal*, Kener Bond Jr., professor of art at the Rochester Institute of Technology, wrote, "Contemporary jewelers have been less aware of the rose engine and ornamental lathes and the historical contributions they have made to jewelry design and production."[1] This paper was inspired by Bond's quote and will briefly cover the history of the ornamental lathe and how it works, give an overview of many of its accessories, and share how it can be utilized in the design and creation of new ideas in the jewelry industry.

Evolution of the Lathe into the Ornamental Lathe

The plain or simple lathe dates back over 3000 years. Not until the 15th century did the simple lathe start evolving into something more complex. One of the first of many evolutions included the invention of a traversing spindle, a spindle which could move in and out of its bearings along the lathe's long axis. This would then impart a screw thread into the workpiece which was attached to one end of the spindle and would traverse the lathe bed with the spindle.[2] This meant that the simple lathe could now create the threads needed to make screws.

The earliest published illustrations of an ornamental lathe is in Besson's *Theatrum instrumentorum et machinarum*.[3] The illustration in Figure 1 shows several of the ornamental additions to the simple lathe. In the tool guide bar (A) is a tracing guide, which was used for repeating a shape or pattern to the turned object. The tool guide bar floated in slots between two standards at either end of the lathe bed. The cutting tool was located in one of the round holes in the tool guide bar. The "Circle" plates (B), which are the slanted cams at either end of the lathe and which bear the weight of the tool guide bar, are set to a prescribed angle and impart an elliptical shape to the turned workpiece by way of the tool guide bar being raised and lowered through each revolution.[3] Similar circle plates, called "Swash" plates, are later used to move the spindle axially along the axis of the lathe bed and impart all radial movement with an axial motion.

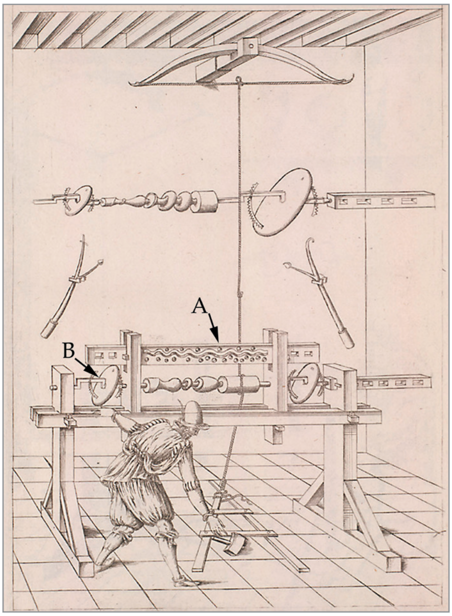


Figure 1 *One of the earliest known illustrations of an ornamental lathe*[3]

During the 16th through 19th centuries, ornamental turning grew exponentially with the distribution of knowledge and with the expansion of mechanical knowledge. Tools for cutting and chucks for holding the workpieces were in a constant state of evolution. Devices were designed and made which could manipulate and expand the motions of a simple lathe into motions of great complexity. Figure 2 shows examples of the extreme manipulation of the lathe upon turned work. The figure on the left shows the use of various rosettes which would move the spindle along the axis of the lathe bed. The figure on the right is an example showing the use of the eccentric chuck. Work from this era often went beyond common modern aesthetics and was, in fact, state-of-the-art at the time, showing off the ingenious mechanical capabilities of machine tools and their operators.

Figure 2 *Ornamentally turned ivories, 1631, Getty Museum (Open Content Program)*

It was an expensive proposition to buy a lathe with a complete set of ornamental lathe tools, chucks and devices, so it was very much left to the aristocracy to afford and acquire. Exquisite work was produced by kings, queens and dukes along with those craftsmen and women that they would sponsor and support. Work was created using exotic woods and ivory. Among the rulers who collected masterpieces of turning and practiced the art themselves were the Holy Roman Emperors Maximilian II (r. 1564–76), Rudolf II (r. 1576–1612) and Ferdinand III (r. 1619–37).[4] Many of the collections of work can be seen in great museums throughout the world including the Museo Degli Argenti of the Pitti Palace (Florence, Italy), the historic Green Vault (Dresden, Germany), Rosenborg Castle (Copenhagen, Denmark), The Getty Museum (Los Angeles, California), and the Metropolitan Museum of Art (New York City, New York).

Ornamental Lathe vs. a Regular Lathe

The ornamental lathe differs from a regular lathe in many ways. Unlike a standard lathe, the ornamental lathe not only uses fixed tools but also uses rotary tools. Ornamental lathes commonly include an overhead drive to power small rotating cutting heads known as cutting frames. The cutting frames allow for the cutting tools to be placed and rotated in unique orientations to the workpiece. The ability to index and lock the spindle on its rotational axis is common in ornamental lathes. It is also designed to utilize many accessories, built specifically for the spindle, which include an elliptical chuck, an eccentric chuck, a straightline chuck, a dome chuck, and many more as shown in Figure 3. Devices are made to fit these lathes, which impart reciprocating and/or spiraling motions to the spindle along with the ability to follow a cam or template. The ornamental lathe also uses many different styles of tool slides, each performing a task unlike a traditional lathe.

Interchangeable slides are available in many configurations. Some can follow or trace a pattern along with the ability to synchronize its movement with the spindle, and others can form spheres and hemispheres.

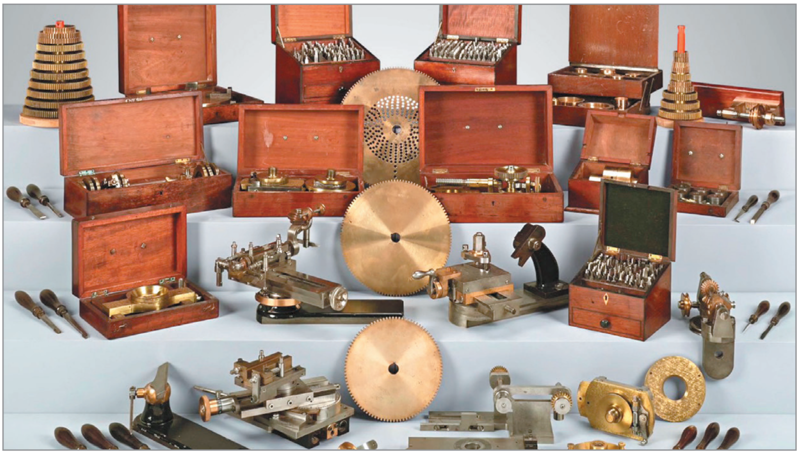


***Figure 3** Vast collection of accessories for an ornamental lathe made by Goyen*

In this paper we will look at several of these accessories, starting with the various cutting tool frames, then proceed to look at the various chucks that hold the workpiece, and on to the devices which are added to the lathe for increased complication of motion. But first, let's look at the lathe itself and see how it works.

A prominent maker of ornamental lathes of the 19th century was a London firm by the name of Holtzapffel (Figure 4). It produced 2,557 lathes between 1795 and 1928;[5] of these, fewer than 16 were built as rose engines. Holtzapffel also produced five volumes entitled *Turning and Mechanical Manipulation*,[6] which are still in use today by mechanical engineers, machinists and ornamental turners. Other past makers of ornamental lathes were Evans, Birch, Goyen, Kennan and Munro. Current makers of modern ornamental lathes include Armbruster, Lindow and MADE.

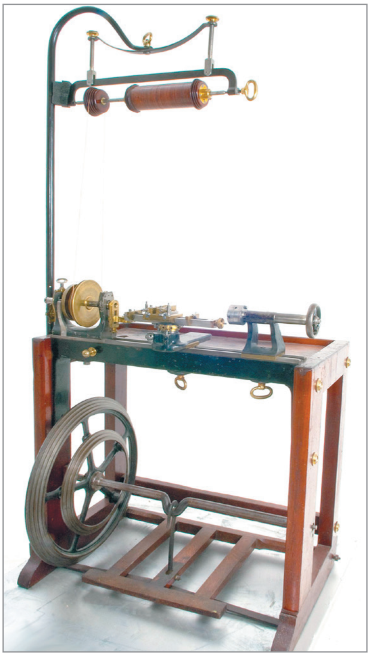


Figure 4 *Ornamental lathe by Holtzapffel*

How the Ornamental Lathe Works

The 17th through 19th century lathes were powered by a foot treadle, which provided power for both the spindle and the rotary cutting tools. Modern lathes now have independent motors for the spindle and the cutting tools. Power is typically transmitted through a large flywheel at the base of the machine (Figure 5). The flywheel, in turn, transmits power to the spindle via the headstock by way of round leather belts. Power to the rotary cutting tools can come from their independent motors or from the main flywheel which powers the overhead drive, again by way of round leather belts or modern urethane belts.

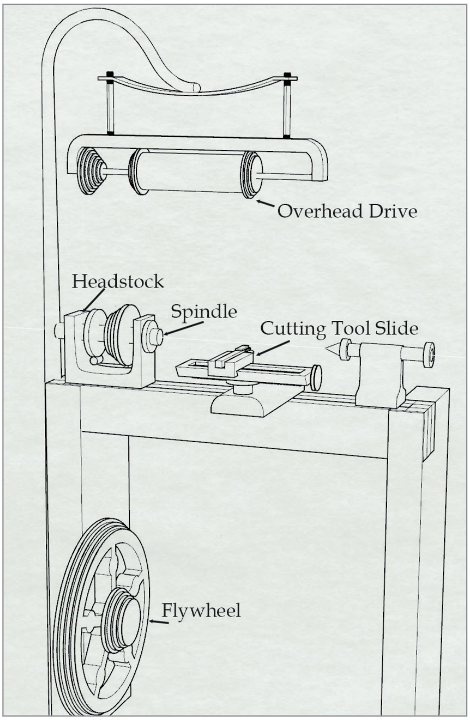


***Figure 5** The parts of an ornamental turning lathe*

The workpiece is attached to the spindle by one of many types of holding chucks (more about these chucks later). The spindle is then set in motion with the workpiece rotating around the lathe's spindle axis (Figure 6). The cutting tool is driven into the workpiece via the cutting tool slide, thereby cutting a shape or profile into either the face or the side of the workpiece. The cutting tool slide can traverse along the spindle's long axis or perpendicular to the spindle axis.

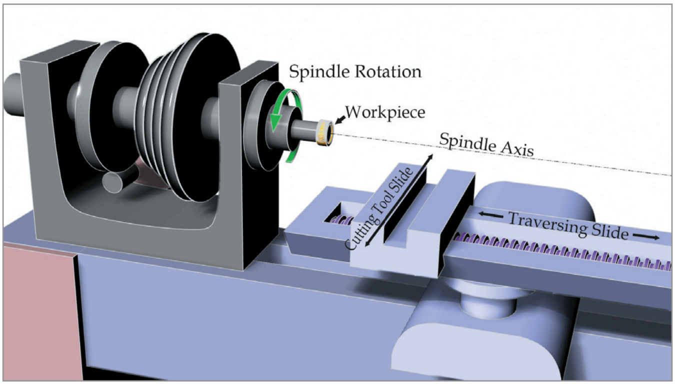


***Figure 6** The motions and axes of a lathe*

The Cutting Tools

Drills

The drills as shown in Figure 7 are similar to the modern wood router. Drills use a rapidly spinning tool oriented along the axis of rotation. Numerous variously shaped cutters are available for the drill, from simple bevels to concave and convex radius cutters to more complex ogee and Gothic arch profile cutters (Figure 8). The drill can be oriented parallel to the spindle axis, perpendicular to the spindle axis or anywhere in between.

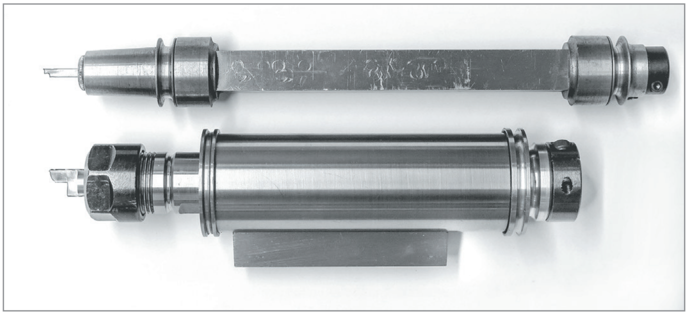


Figure 7 *Drill bodies with ornamental drills*

Figure 8 *Collection of modern drill shapes*

Shown in Figure 9 are examples of the effects of drills upon two ring blanks. These are using only one of countless numbers of drill shapes. The sample on the left was cut with precise overlapping cuts, while the example on the right was cut in the same way but with the drill below the centerline of the lathe. By cutting below the centerline of the lathe, only a portion of the cutter comes into contact with the workpiece, thereby cutting only a portion of a circle.

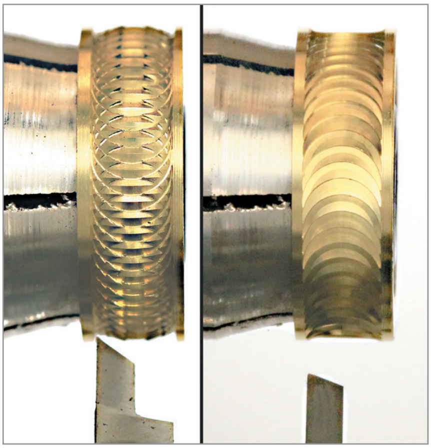


Figure 9 *Effects of simple bevel drills*

Flycutters

Flycutters are another family of rotary cutting tools used with the ornamental lathe. Flycutters use a rapidly spinning tool oriented perpendicular to the axis of rotation. Modern flycutters commonly use triangular carbide inserts or round carbide tools ground to a desired shape. Nineteenth-century flycutters would use both round and rectangular carbon steel tools ground to the desired shape (Figure 10).

Figure 10 *Collection of 19th century flycutting tools and drills*

Modern flycutters come in many different configurations; the most common are horizontal, vertical and universal.

Horizontal flycutters (Figures 11 and 12) are oriented along the long axis of the lathe, vertical flycutters are oriented perpendicular to the long axis of the lathe, and universal flycutters (Figure 13 and 14) are capable of any angle between horizontal and vertical.

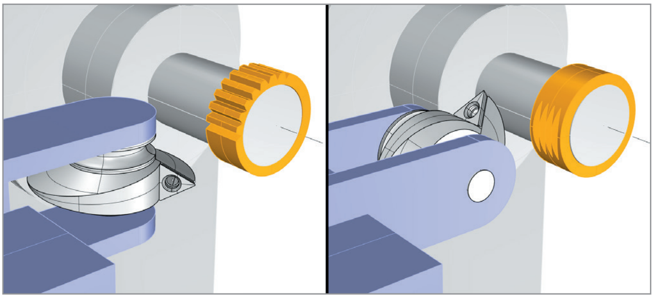


Figure 11 *Horizontal cutting frame (left), vertical cutting frame (right)*

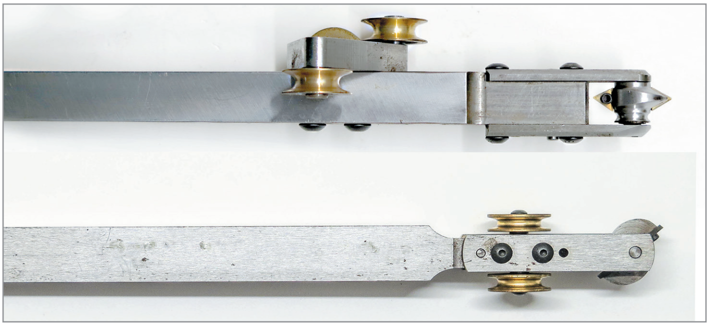


Figure 12 *Cutting frames, vertical and horizontal top view*

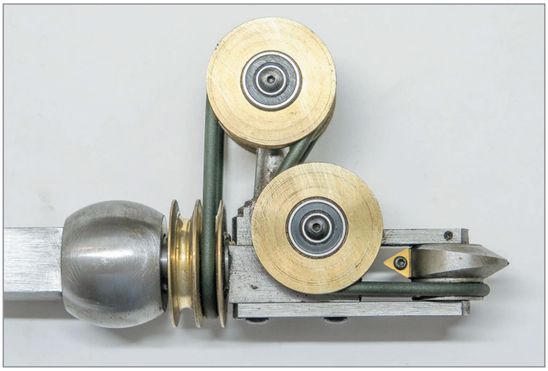


Figure 13 *Modern universal flycutter for triangular carbide inserts, side view*

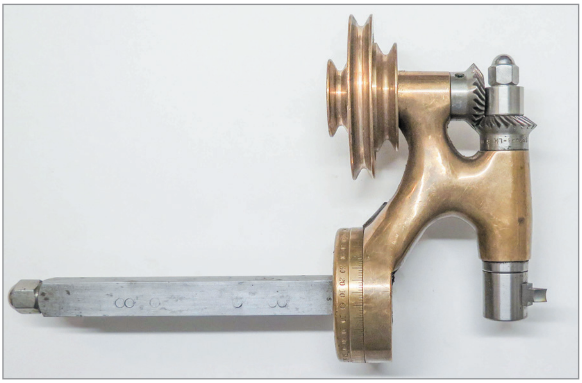


__Figure 14__ Universal flycutter for rectangular ornamental cutting tools, side view

The universal flycutter in Figure 13 uses triangular carbide inserts whereas the flycutter in Figure 14 uses rectangular tool steel cutters ground to a desired shape.

Shown in Figure 15 are several examples of rings after having been cut with a flycutter while indexing the workpiece around the lathe's spindle axis. The two rings to the left were cut with a vertical flycutter, the third from left was cut with a horizontal flycutter, and the far right was cut with the universal flycutter.

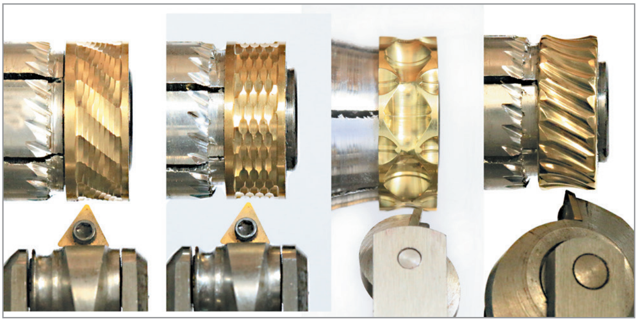


__Figure 15__ Examples of flycutter ring blanks, top view

Cutting tools can also be held eccentric to the axis of rotation, as seen in Figure 16. These are called eccentric flycutters and allow for many more design possibilities. Eccentric flycutters are available to hold either round carbide tools or rectangular cutting tools. The amount of eccentricity is set via a thumbscrew slide as shown.

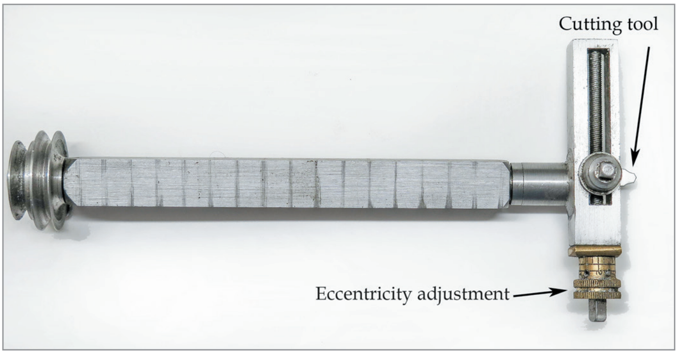


Figure 16 *Eccentric flycutter with ornamental cutting tool*

Shown in Figure 17 is an eccentric flycutter, which was used to cut into the face of a silver disc. The overall pattern was cut by plunging the rotating cutting tool into the surface 48 times around the disc of silver. Each plunge of the tool into the workpiece engraved a circle due to the tool's eccentricity from the rotational axis. After each cut, the silver disc was indexed around the lathe's spindle 7.5 degrees; this was repeated 48 times. This pattern is one of the simplest and most numerous. More complex patterns can be created with an eccentric cutting frame. Ibbetson's book, *Eccentric Circular Turning*,[7] and Holtzappfel's *Volume 5*[6] go into much more detail on the subject of eccentric turning.

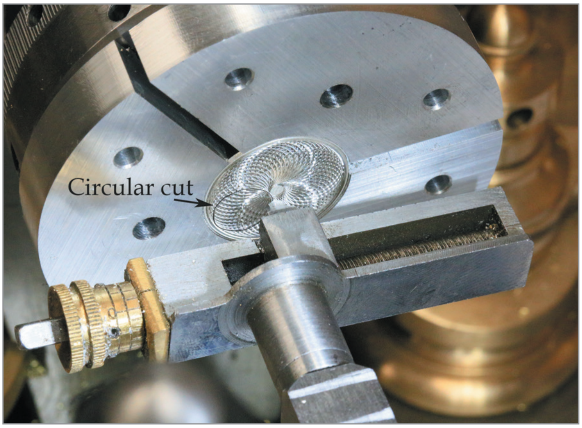


Figure 17 *Examples of the effects of eccentric cutters*

Complex Cutting Frames

Beyond the eccentric cutting frame there are several other complex styles of cutting frames. Some are capable of cutting ellipses, others can cut epicycloidal curves and still others will cut rose shapes.

The Elliptical Cutting Frame

The elliptical cutting frame (Figure 18) does just that; it moves a cutting tool through an elliptical path which cuts an ellipse into the workpiece (Figure 19). The adjustments allow for the size, shape, location and aspect ratio of the cut ellipse. Once cut, the orientation of the ellipse can then be reoriented for an overlapping cut. This reorientation can be performed by either adjusting the cutting frame itself or by indexing the workpiece by way of a rotary axis on the chuck. Multiple combinations of these adjustments can be made to create very complex designs, as shown in Figure 20.

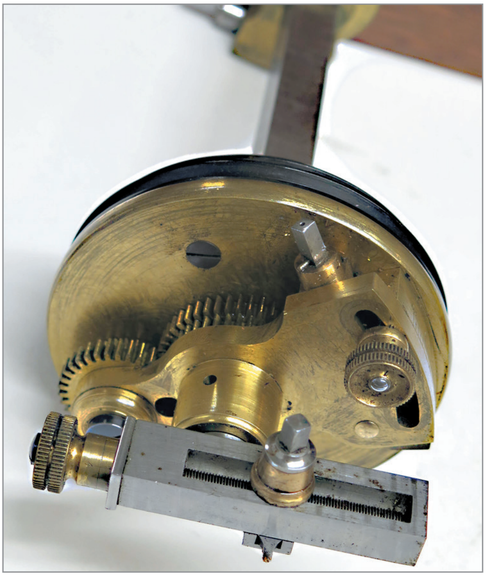


Figure 18 *Elliptical cutting frame*

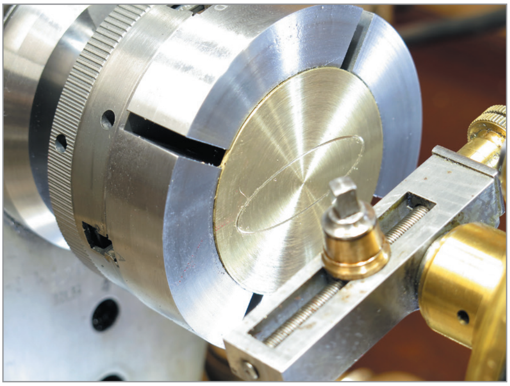


Figure 19 *An elliptical cut using the elliptical cutting frame*

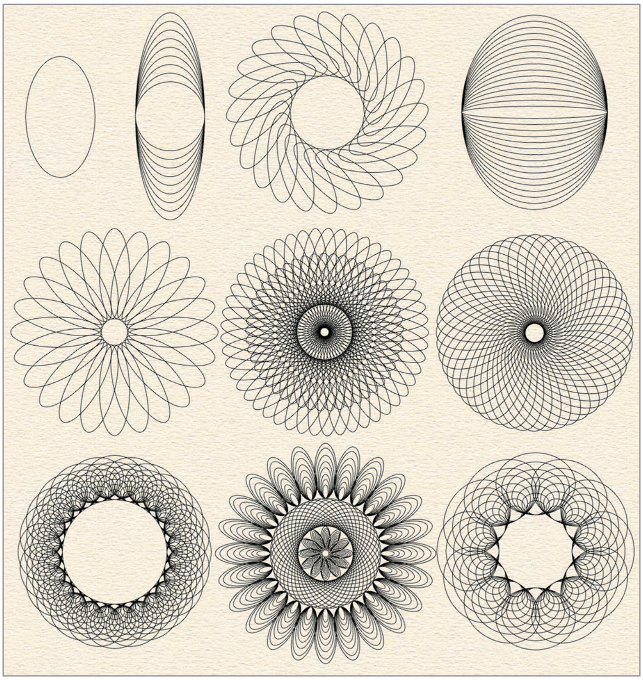


Figure 20 *A few of the infinite possibilities of the elliptical cutting frame*

The Rose Cutting Frame

The rose cutting frame (Figure 21) is used to cut or engrave a shape which is dictated by the cam, or rose, that is installed onto this cutting frame. Original kits would have included several different rosettes. The size of the cut or engraved rose is adjusted by way of the eccentric cutting tool slide at the working end of this cutting frame. Once the pattern is cut, the cutting frame can then be reoriented into a new position via the worm and wormwheel located behind the rosette, or the eccentricity of the cutter can be adjusted to cut a larger or smaller shape (Figure 22). This allows for more complex designs of overlapping ellipses. This flycutter was originally designed for cutting wood and ivory. When used for cutting metal, the rigidity of the tool holder and tool rest is of utmost importance.

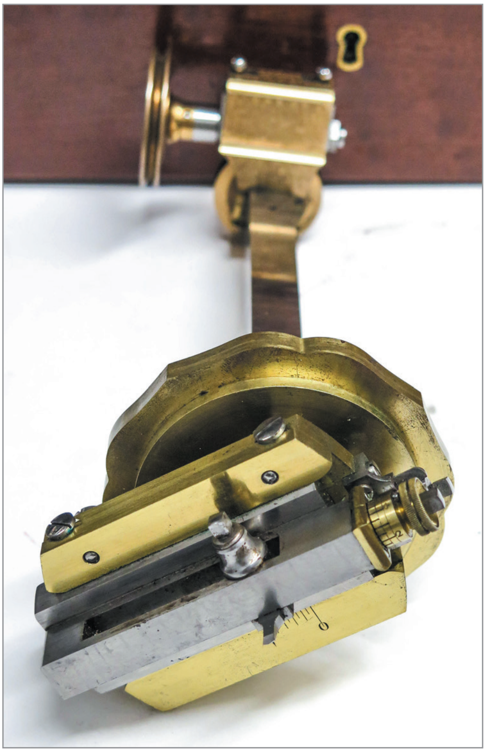


Figure 21 *The rose cutting frame*

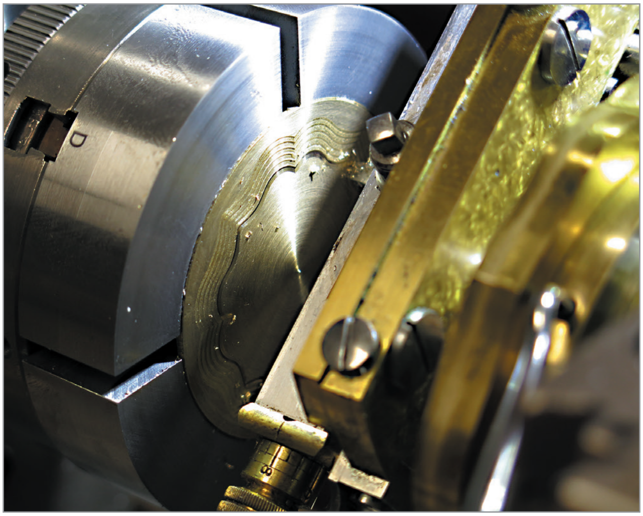


Figure 22 *Cutting with the rose cutting frame*

The Epicycloidal Cutting Frame

The epicycloidal cutting frame, also known as a geometric cutting frame, shown in Figure 23, was made by Holtzapffel early in the 19th century. An epicycloid is a roulette curve traced by a point attached to a circle rolling around the outside of a fixed circle (Figure 24). Think Spirograph.

Figure 23 *Epicycloidal cutting frame*

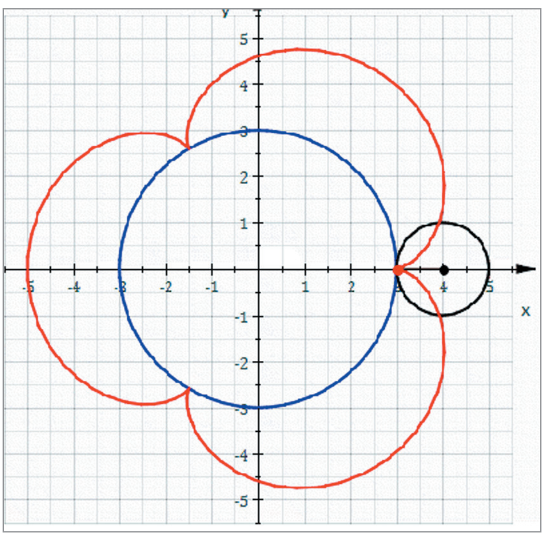
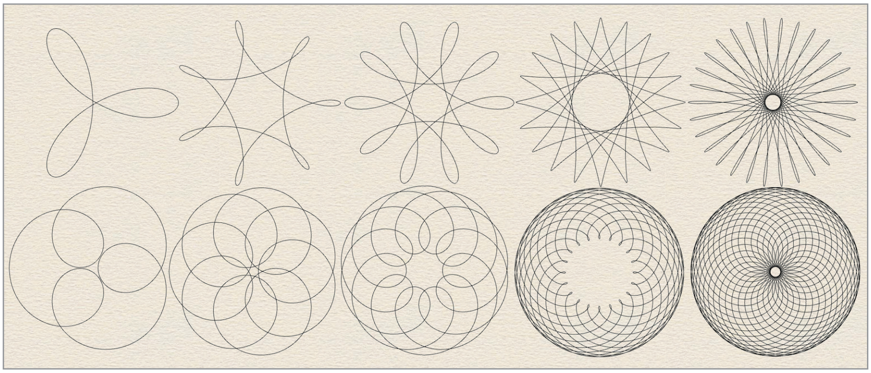


Figure 24 *An epicycloid curve (red)*

The epicycloidal cutting frame includes interchangeable gears (Figure 25) to move the cutting tool through a single continuous curve with loops numbering from 1 through 90.

Figure 25 *Epicycloidal cutting frame*

Figure 26 shows examples of cutting with the epicycloidal cutting frame. The top row was cut with gear trains set to cut 3, 7, 10, 20, and 30 outward loops; the bottom row was cut using the same respective gear trains but in the opposite direction. The gear train direction dictates which way the loops form.



Figures 26 *The curves of cutting with the epicycloidal cutting frame*

This epicycloidal cutting frame was also originally designed primarily for wood and ivory. When cutting metal it must be supported for maximum rigidity, and only light cuts should be made. Shown in Figure 27 on the left is sterling silver and on the right a piece of African blackwood.

Figure 27 *Two examples of cutting with the epicycloidal cutting frame: sterling silver (left), African blackwood (right)*

Chucks

There are numerous ways of connecting the workpiece to the spindle. The simplest and most common are 2, 3, 4, and 6 jaw scroll chucks (Figure 28). The ornamental lathe differs from the common lathe in its ability to utilize complex and compound chucks to hold the workpiece. Some of these complex chucks can change the rotary motion of the lathe spindle into an elliptical motion, a linear motion, and a complex geometric motion.

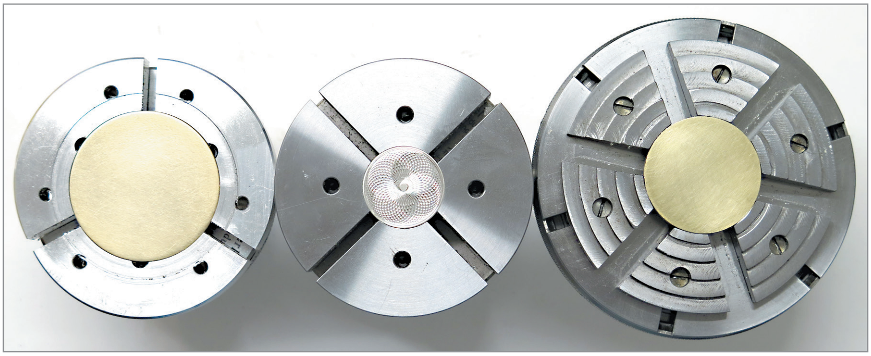


Figure 28 *3, 4 and 6 jaw chucks*

Eccentric Chuck

The eccentric chuck allows the workpiece to be mounted to the spindle eccentric to the spindle axis (Figure 29). It uses a calibrated slide(s) to move the workpiece incrementally away from the spindle's center of rotation. The eccentric slide also can have a rotary axis mounted to it, which allows the workpiece to be rotated and indexed around the eccentric axis. In use, this would typically entail setting the eccentric slide off center, then making a cut, then indexing around the eccentric center and repeating the cut, working all the way around the circle.

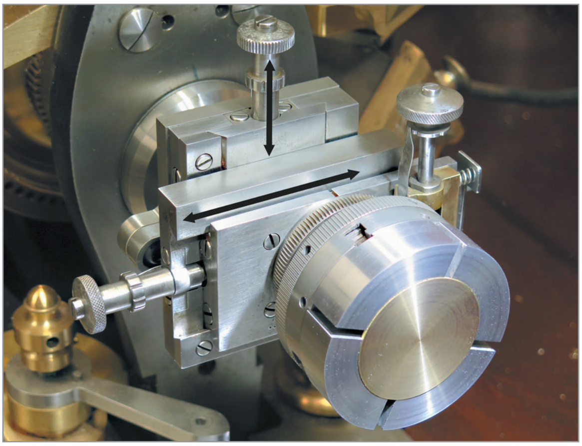


Figure 29 *A double eccentric chuck with rotational worm wheel*

Ellipse Chuck

The ellipse chuck transforms the spindle's circular rotation into an elliptical motion. It is similar to the elliptical cutting frame but, instead of moving the cutter through an elliptical motion, this chuck moves the workpiece through an elliptical motion. Figure 30 shows the effect of an elliptical chuck while cutting a piece of carving wax.

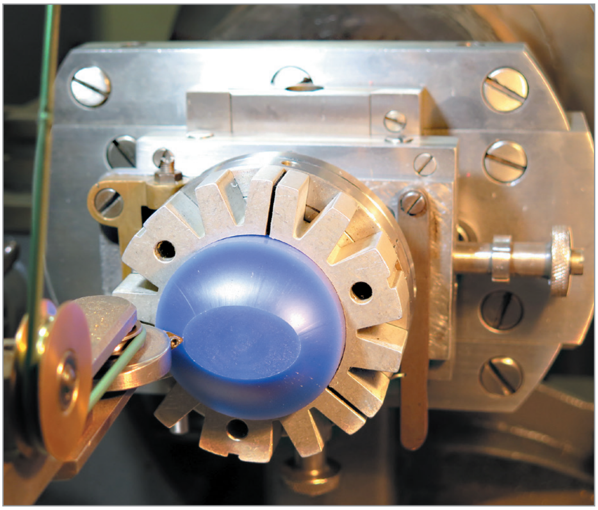


Figure 30 *Elliptical chuck with double eccentric chuck*

Geometric Chuck

The geometric chuck is also known as the epicycloidal chuck (Figure 31). This chuck is similar, though different, to the epicycloidal cutting frame. Much like the epicycloidal cutting frame, this chuck moves the workpiece through an epicyclic motion while the cutter remains fixed. The important aspect of the geometric chuck is that it produces a pattern that is a single complex curve, whereas other chucks and motion manipulators, such as the elliptical chuck and the eccentric chuck, rely upon multiple overlapping curves to create a complex pattern. The geometric chuck produces a complex pattern with a single complex curve.

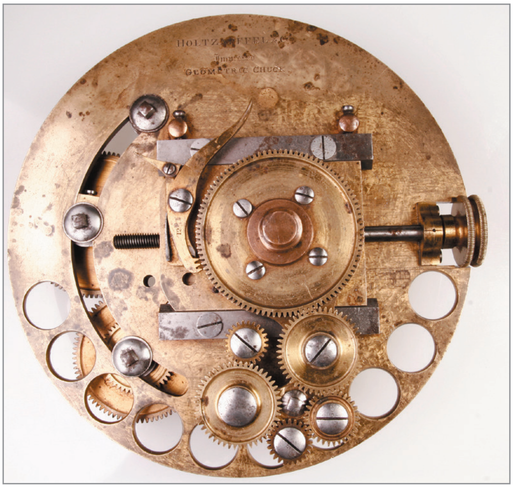


Figure 31 *Geometric chuck, single stage*

Geometric chucks can have multiple stages, e.g., placing one geometric chuck on top of another, thereby increasing the complexity of the motion by several magnitudes. This idea, carried to an extreme, can yield an infinite number of patterns. A seven-stage geometric chuck was assembled by Norman Tweddle of the UK. It was calculated that a seven-stage geometric chuck was capable of at least 8×10^{24} variations.[8]

Because of this, the geometric chuck soon evolved into a machine dedicated to the security printing industry (Figure 32). These complex motions provided currency printing a form of analog security, similar to today's digital encryption. This was possible by the vast quantity of gears that would be entered into the gear train along with a number of eccentricities of the stages relative to each other to create a unique pattern, with only the operator able to replicate that combination of gears, eccentricities and movements.

Figure 32 *Currency and security printing*

Edwin Alabone explored the extremes of the geometric chuck and published his findings in 1910.[9] His book illustrates the multitudinous patterns possible with this chuck. Figure 33 has two examples by Alabone, which show the diversity of patterns possible. Remember that these images were created with a single line.

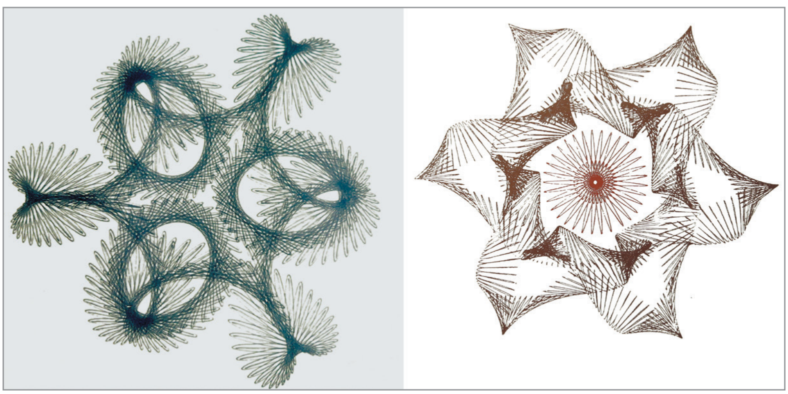


Figure 33 *Alabone's epicyclic patterns*

Dome Chuck

The dome chuck allows for the workpiece to be mounted perpendicular to the spindle's axis. This adds an additional two axes of rotation or movement to the workpiece. Figure 34 shows a ring mounted to the dome chuck perpendicular to the spindle axis and capable of being indexed around its new axis. This new axis can also be tilted to any angle from 0-90°, as shown.

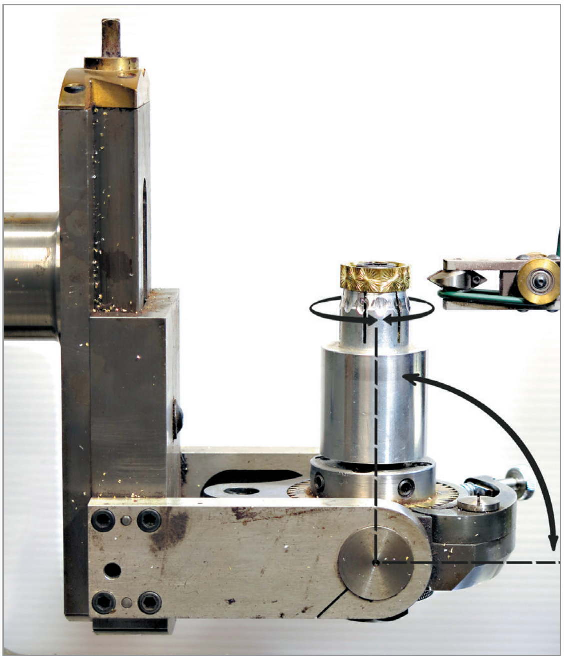


Figure 34 Dome chuck with ring mounted

Straightline Attachment

The straightline chuck (Figure 35) allows the operator to cut straight lines on a lathe. This chuck transforms the spindle's rotary axis into a linear motion. When coupled with any of the many cutting frames or drills. the design possibilities are boundless. Similar to the straightline chuck is the rectilinear chuck, which resembles the straightline chuck and allows for both linear and rotational movements of the workpiece.

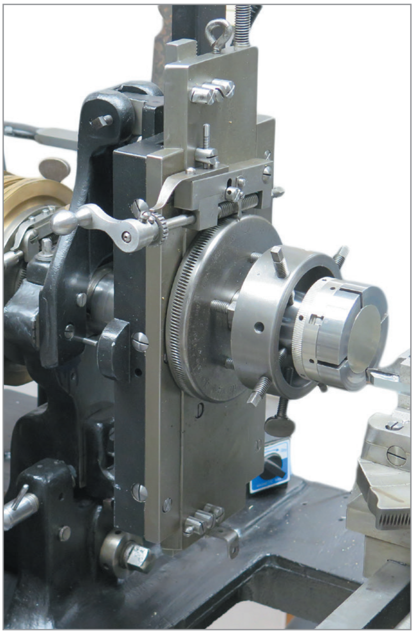


Figure 35 *The straightline chuck*

A very small percentage of ornamental lathes include cams, known as rosettes, which can move the spindle in a rocking and/or an axial motion. These are called ornamental turning rose engines after the appearance of the cams, which resembles the outline of a rose. When either of these motions are combined with any or all of the previously described motions, very complex cuts and patterns are achievable. Much more information and details on the rose engine can be found in previous Santa Fe Symposium® papers.[10,11]

Driving Devices

Beyond the many chucks and flycutters available to the ornamental lathe are several devices which can add additional axes of motion and synchronization for both the lathe spindle and the cutting tool. It should be understood that the devices written about and shown here are just a small fraction of those available that were designed for use with the ornamental lathe.

The *reciprocator* synchronizes the slide rest and cutting tool travel, which produces an undulating motion to the spindle and workpiece. In Figure 36 the small brass gear is connected to the sliderest. As the sliderest is traversed, this small gear drives the lower large gear, which in turn rocks the upper large gear by way of the crank arm. This action causes the spindle to undulate, allowing the cutting tool to cut a sinewave-like pattern into the cylindrical surface of the workpiece. This undulating pattern can also be applied to the face surface of a workpiece. Examples of workpieces cut with the reciprocating device are shown in Figure 55.

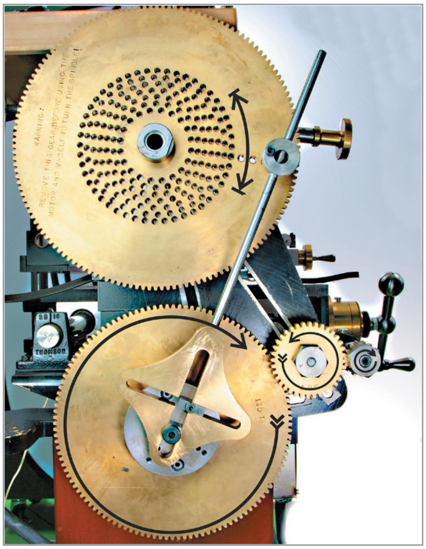


Figure 36 The reciprocating device on a Lawler lathe (photo courtesy Celia Kudro)

The *curvilinear* sliderest allows the cutting tool to follow a template, which in turn creates a profile cut along the long axis of the lathe (Figure 37). This can be used for fluting along the curve or in conjunction with a rosette for a profile with a rosette cross-section. The curvilinear slide works like this: the template (A) is traced by the wheel (B), which is attached to the cutting tool (C) and is kept in contact with the template by way of a spring or weight with force in the direction of the arrow. The slide traverses from right to left by turning the hand crank (D). The slide can also be made to traverse by way of the pulley (E), or it can be synchronized with the spindle via a gear train connected to the spindle at one end and the drive key (F) at the other end.

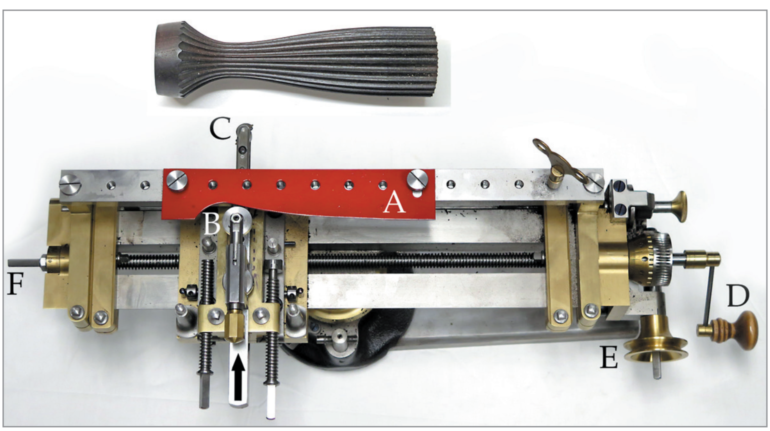


Figure 37 *The curvilinear slide—template shown in red; result is at the top.*

The *spiral* apparatus synchronizes the sliderest with the spindle, causing a spiral to form on either surface of a turned object, face or cylinder. This motion is very similar to screw-and-thread cutting on the common lathe but designed for slow spirals rather than the fast spiral of a machine screw. Most modern common lathes include a gear train that produces spirals for threads, most of which have a minimum thread count of four or six threads per inch. For ornamental work, spirals tend to be much "slower" in twist, in the range of one to ten turns per foot.

Spiral devices differ dependent upon the lathe. Some lathes have lead screws such as the Goyen shown in Figure 38. Other lathes need to use a gear train to connect the spindle to the sliderest. Spiral movements can also be applied to the face surface of the part.

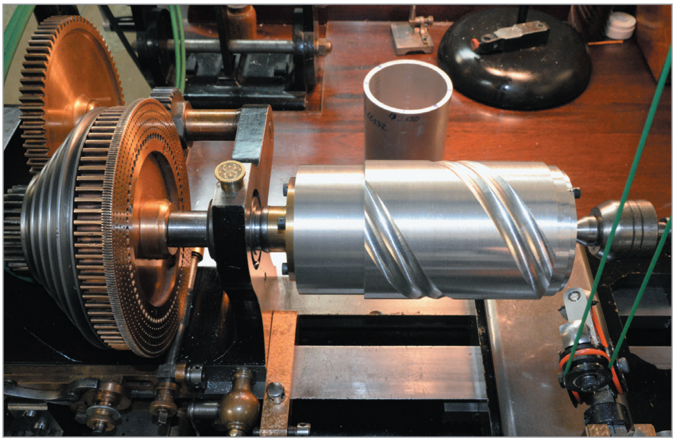


Figure 38 *A Goyen ornamental lathe cutting slow spirals*

The *Pudsey-Dawson* device adds a rose-engine effect to the cut. Most common lathes can be adapted to add the cam action of a rosette. In this case the rosette articulates the tool slide rather than articulating the headstock as in a standard rose engine. (See the 2015[10] and 2016[11] Santa Fe Symposium® papers for more information on rose engines.) Figure 39 shows a simplified graphic of a Pudsey-Dawson device. The parts shown in green are the drive train of a Pudsey-Dawson device. It works as follows: It starts with rotation of the spindle, which drives the gears, which turns the driveshaft, which rotates the cam. The cam pushes the cutting tool slide against a spring which moves the slide fore and aft following the cam shape. Here we see a triangular cam creating a hexagon shape (gold); this is the result when using a 2:1 gear ratio as shown. If we changed the gearing to 3:1, then the result would be a nine-lobed cut.

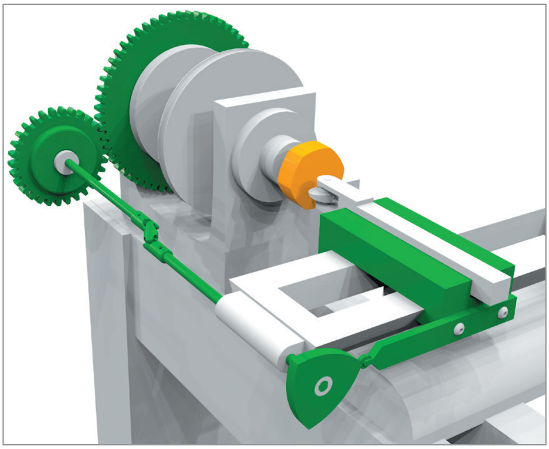


Figure 39 *Simplified graphic of the Pudsey-Dawson device*

The *spherical* sliderest does just that: It produces a spherical surface upon the workpiece (Figure 40). This sliderest can be driven by hand, motor or a gear train linking it to the headstock, which would produce a spiral cut over the sphere's surface. The example in Figure 40 shows the result of using the spherical sliderest with the rosettes engaged, producing a low-dome ring with ridges.

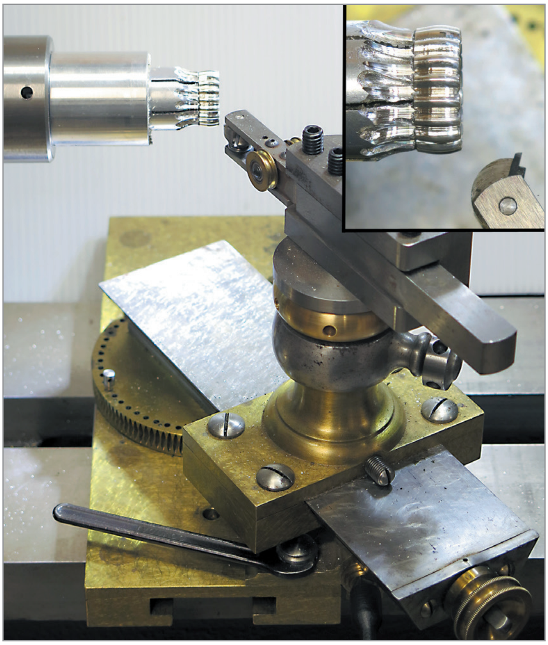


Figure 40 *The spherical slide rest with inset close-up of low-dome ring*

An Overview of Recently Produced Ornamental Lathes

Several modern ornamental lathes have been produced in the last 35 years. Of these, the Armbruster (Figure 41) is probably the most well-known. The Armbruster ornamental lathes were built by Dr. Fred Armbruster of Maine, USA, with 30 lathes in total being made between 1995 and 2018. When asked about his inspiration and fascination for building these lathes, Dr. Armbruster answered, "The original tools were built with a quality that has become rare; they were ends in themselves, not just the means to an end like most tools today. They are sculptural, functional, beautiful, and built so well they are still working after 200 years of use. Building new tools to these standards has been an engaging challenge. Using these tools opens the door to fascinating mechanical processes and endless decorative possibilities."[12]

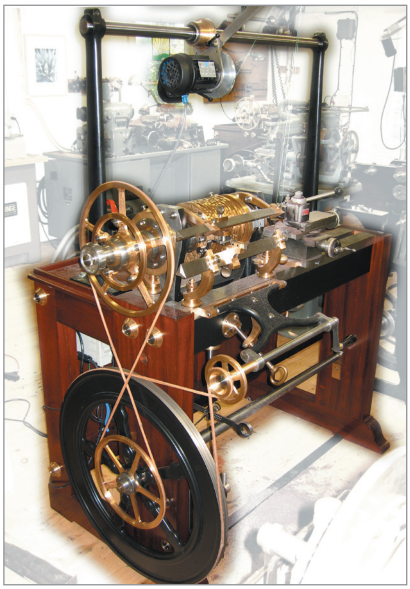


Figure 41 *Armbruster ornamental turning lathe*

The Armbruster ornamental rose-engine lathe was inspired by and designed as a modern version of the 19th century Holtzapffel ornamental rose-engine lathe. The modern updates include variable-speed electric motors on the spindle drive and overhead drives for the rotary tools. It also has a variable amplitude device so the motion induced by the rosettes can be adjusted from 100% all the way down to 20%. The spindle interface uses an industry-standard 5C collet for holding any chuck or object.

The MADE lathe (Figure 42) is in current production and, so far, eight have been ordered and delivered. The MADE lathe fills the void left after the Armbruster ceased production in 2018. It is also of similar design to the original Holtzapffel rose-engine ornamental lathe but with modern updates. It is built by a group of craftsmen whose names makie the acronym MADE, namely Mike Stacey, Al Collins, David Lindow and Eris Spatt, all of whom are ornamental turners.

The Cler lathe (Figure 43) was in limited production between 2000 and 2006 and it is believed that ten were made. The Cler included Pudsey-Dawson devices for both the cylinder surface and the face surface of the workpiece along with a reciprocator and spherical sliderest.

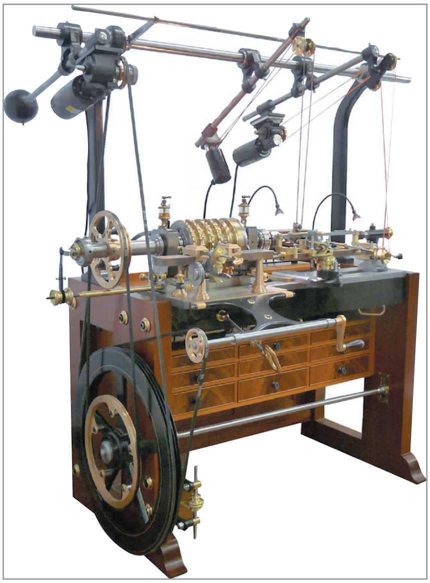


Figure 42 *The MADE lathe*

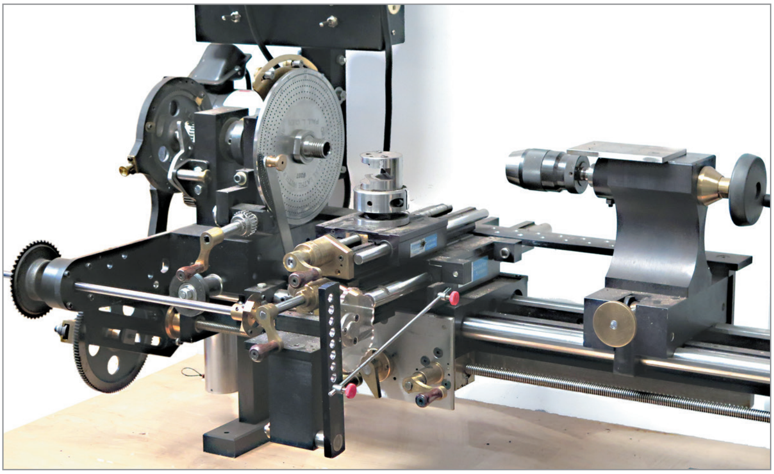


Figure 43 *Cler ornamental lathe*

The Lawler lathe (Figure 44) was produced between the years 1985 and 1996 and it is believed about 36 were made. Modern linear ways were introduced in the Lawler which included both reciprocating and spiral driving devices.

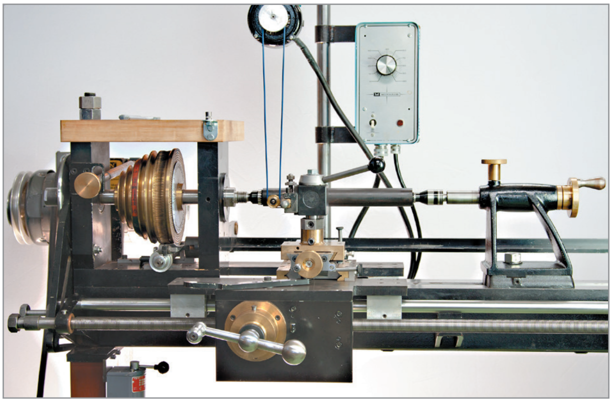


Figure 44 *Lawler ornamental lathe*

The Lindow rose engine (Figure 45) is in current production with 104 lathes being produced between 2006 and today and are represented in the USA, Belgium, England, France, Canada, and Australia. They are made by David Lindow of Gravity, Pennsylvania. When asked about his inspiration and reason for building ornamental lathes, he responded, "I found the old machines incredibly beautiful, the work they did exquisite, and believed that the world would be a better place if there were more rose engines in it."[13]

Figure 45 *The Lindow rose engine ornamental lathe*

Modern Uses in the Jewelry Design Studio

How can these ornamental lathes be used in the modern jewelry studio or in the modern production shop? At the very least they can be used to explore new design possibilities by understanding the mechanical motions of the ornamental lathe and its accessories. Prototyping individual designs in metal or in wax will yield an unlimited number of designs for one-offs or for production runs. Cutting directly into tool steel will yield high-quality hobs and dies for stamping, coining and forming. One benefit of cutting directly into the work metal is that the piece comes off the machine in the finished state, not needing further finishing.

Some of the motions of an ornamental lathe can be translated to a modern CNC lathe for production work. This requires a CNC lathe capable of spindle indexing (C-axis), along with radial and axial live tools.

Many of the ornamental lathe motions are not easily translatable to a modern CNC lathe without major refitting of the machine due to the compound motions and cutting axes available on the ornamental lathe. That said, a modern computer-controlled ornamental lathe can be built from the ground up, or an existing ornamental lathe can be retrofitted with automation to be run via CNC controls.

This would be beneficial in speeding up production when directly cutting workpieces on the ornamental lathe. The quality of cut and sharpness of detail is finer than any other technique available and requires no further work to finish the engraved area. Diamond-tipped cutting tools can also be used for exceptionally bright cuts.

Figure 46 shows a compound slide fitted with CNC drive motors on an ornamental lathe. There are two more motors on this retrofitted lathe, one on the spindle (C axis) and one on a dome chuck (W axis) for a total of four CNC-operated axes.

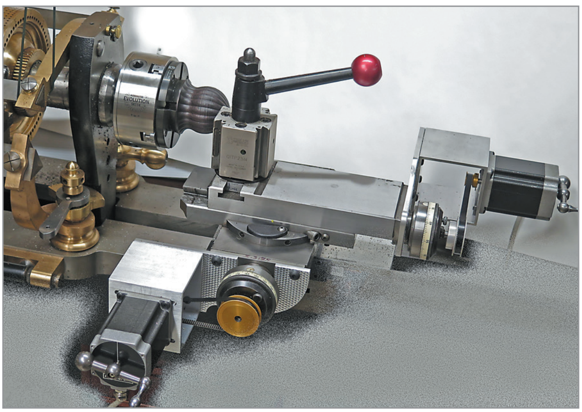


Figure 46 *An ornamental lathe retrofitted with CNC drives and controls*

Figure 47 shows the rings that were produced while writing this paper. They show a broad range of patterning, which represent a very small fraction of the number of possibilities. Most of these were produced with 3-axis control while the remaining samples were produced with 4-axis control.

Figure 47 *Examples produced during the writing of this paper.*

A few examples from craftsmen currently employing an ornamental lathe are shown in Figures 48–59.

Figure 48 *Rings in sterling silver, 18K gold bezels, amethyst and African blackwood by Celia Kudro*

Figure 49 *Bracelet in sterling silver, using the straightline chuck, by Becky Lindow*

Figure 50 *Pendant of vitreous-enameled fine silver and African blackwood by David Lindow*

Figure 51 *Bracelet and ring box, closed, by Jon Sauer*

Figure 52 *Bracelet and ring box of African blackwood, boxwood and betal nut, opened, by Jon Sauer (5 inches tall x 3-1/2 inches wide)*

Figure 53 *Vessel/urn of aluminum, vitreous enamel and sterling silver by Bill Brinker (4 inches diameter x 6-1/2 inches tall)*

Figure 54 *Ring box of African blackwood, vitreous-enameled fine silver and sterling silver by the author (2-1/4 inches diameter x 3-1/2 inches tall)*

Figure 55 *Containers in aluminum by the author: note the use of a reciprocating device on the first, second, and fifth containers (from the left) in the back row*

Figure 56 *Sterling silver bracelet, cut in-the-round on the OT lathe, then formed into a cuff by the author*

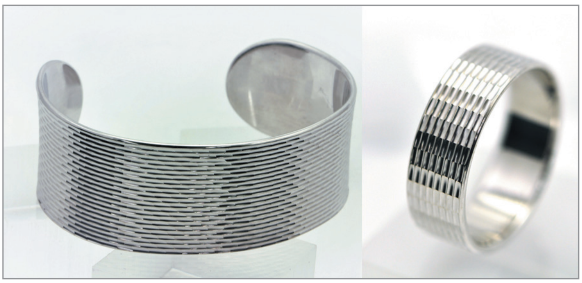


Figure 57 *Bracelet and ring in sterling silver using the straightline apparatus by Eric Spatt*

Figure 58 *Tassle caps by Brooke Barlow showing three different OT lathe patterns*

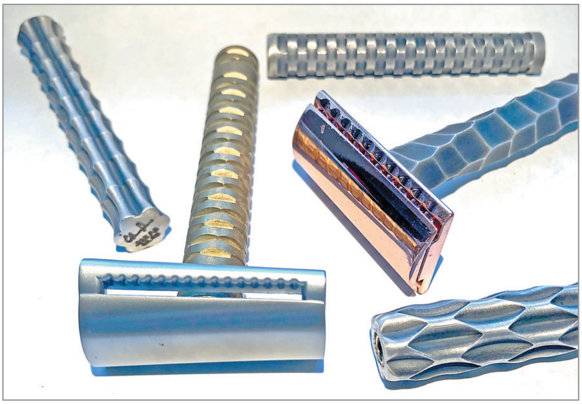


Figure 59 *Razor handles in sterling silver and bronze by Chris Ploof*

As can be seen in these examples, the design and creation of new and unusual jewelry is virtually unlimited with the use of an ornamental lathe. By looking into our jewelry industry's past and using modern knowledge, we can redeploy machines and ideas to create 21st century interpretations. Many of these artists have innovated new designs with the use of the ornamental lathe with modern tools and materials. One of these new approaches, innovated by Chris Ploof, uses the ornamental lathe to precisely cut designs that are then inlayed with a dissimilar metal, the details of which will be discussed in another 2019 Santa Fe Symposium® paper entitled "Practical Application of the Rose Engine in the Modern Shop."[14]

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11. G. Phil Poirier, “The Parts and Processes of a Rose Engine in the Modern Shop,” *The Santa Fe Symposium on Jewelry Manufacturing Technology 2016*, ed. E. Bell et al. (Albuquerque: Met-Chem Research, 2016): 459–493.
12. Dr. Fred Armbruster, personal interview with the author.
13. David Lindow, personal interview with the author.
14. Chris Ploof, "Practical Application of the Rose Engine in the Modern Shop," *The Santa Fe Symposium on Jewelry Manufacturing Technology 2019*, ed. E. Bell et al. (Albuquerque: Met-Chem Research, 2019).

Additional Resources

L’Abbe Plumier, *L’Art de Tourner en Perfection* (1701).

Diderot and D’Alembert, *Art du Tourneur* (1772).

H. Bergeron, *Manuel du Tourneur* (1816).

John Edwards, *Holtzapffel Volume VI* (Kent: John Edwards Publisher, 2012); available directly from the author at ornamental.turning@talktalk.net and his website, http://www.ornamentalturning.co.uk/.