

A man with a beard and safety glasses is working in a glassblowing workshop. He is holding a large, clear glass vessel that is being shaped on a lathe. A bright lamp is focused on his work. The background shows the industrial setting of the workshop with various tools and equipment.

Cut and Engraved Glass

Richard Edlund

Kalmar läns museum
2018



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Engravers at work at Orrefors. Pay special attention to the staircase shaped storage of different types of copper wheels on the workbench. The photograph was taken during the 1920s, before 1928. Photo: Winell, KLM archive.



Introduction

Cut and engraved glass was once the cornerstone amongst the items that were packed with wood and straw, with pride and a gentle hand, and left the Småland Kingdom of Crystal. This type of glass was also a reliable source of income. Large, magnificent cut crystal pieces or crystal tableware with countless glasses, all designed for their particular drink, reached buyers in Sweden or abroad. Behind these products, hides a range of professionals such as engravers, grinders and designers. The grinder's tool is the grinding wheel and the engraver's is historically the copper wheel, and later the engraving pen. This report highlights these two craft processes related to glass production in the Kingdom of Crystal.

At the turn of the 1900s, each of the major glassworks employed over a hundred grinders and engravers. What was once a large professional group is today, in 2018, a handful of people at a few glassworks. The future may seem dark for this area of expertise and one may wonder if cut glass has a future. An answer to that question may be found in an ongoing exhibition in the Kingdom of Glass. During the fall of 2018, The Glass Factory in Boda opened the exhibition "Cutting edge" with cut glass from the collections. The exhibition shows samples of cut glass with advanced techniques such as star cutting from the 1800s, cut glass from the 1950s and contemporary glass with experimental grinding.

Today, The Glass Factory claims, cold-worked glass is experiencing a renaissance and a number of young artists and craftspeople have started experimenting with new ways to grind glass.

Kalmar County Museum has over the years worked with various kinds of cultural heritage and cultural environments in The Kingdom of Crystal. In this report, we focus on engraved and decorative glass.

This report does not concern other types of cold glass processing, such as removal of punty marks, etching, sandblasting or flat grinding of bottoms. In other words, when the report states ground, it is to be understood as ground in the decorative sense.

The report is fact-checked by glass antiquarian Björn Arfvidsson, head of collections at the Culture Park Småland in Växjö. The section on the grinding building and the energy supply is written by antiquarian Susann Johannisson. Special thanks to Anders Nylander of Kosta Glassworks, Mats Jonasson Målerås glass factory and Björn Arfvidsson at the Kulturparken Småland.

The copper engraving was done with smooth rotating copper wheels. Since copper is relatively soft and glass hard, some form of abrasive substance, emery paste, is used between the copper surface and the glass surface. Engraving can be described as wearing down the glass surface. The copper engraving enabled irregular figurative artistic motifs with great depth and high artistic quality. The smallest and finest copper wheels could, for example, create small, sparkling stars or reproduce fireworks. To achieve this, many years of experience were required of those who did the work. The copper wheels had a diameter of between 1 mm and 100 mm.

Grinding of glass used to be done with a rough or fine grinding wheel of, for example, stone. Today, a diamond-coated artificial grinding wheel is used. A grinding wheel is always harder than the glass. Grinding was and is most often associated with cuts that create refractions. Grinding of glass objects can, in various combinations, exhibit a very large variety of motifs when it comes to decorative expressions. In principle, the decorative grinding consists of four types of grinding stones; olive stone, facet stone, groove stone and V cutting stone. One or more grinding stones are used according to the needs and scope of the pattern. Grinding is carried out with grinding wheels with a diameter between 100 mm and 600 mm. A type of grinding called "flower-cutting" can sometimes be mistaken for copper engraving.





The glass artist Leif Swahn engraves a vase, Orrefors glassworks 1985.
Photo: Ola Leijonborn, KLM archive.



Before the Paris Exhibition in 1925, Gustav Abels was commissioned to engrave Simon Gate's Bacchus' Train. In front of the window is Gate's cardboard, the model Gustav had to copy from. In the foreground are containers with emery paste. The engraving took about 300 hours to perform and afterwards Gustav said that it was his most demanding job as an engraver. Photo: Winell, KLM archive.

Engraving – the historical development

Copper engraving has been called the most refined and expressive form of glass decoration. The work behind the copper wheel was time-consuming and had limitations, the engraved object needed to be held within the hands. Glass engraving was done by an engraver with the aid of an apparatus, that since the middle of the 1800s was often called, simply, the engraving machine.

In the 1600s, the craftsman was called “glass carver”, and in the 1700s he was called “draftsman”. The first glass engravers came to Sweden in the middle of the 1600s. They were named Anthony Seifferd and Elias Horn. An engraver who came to have a great impact on the development of engraved glass was Christoffer Elstermann (–1721) who worked at Kungsholm’s glassworks. The engraving machine was called in the 1700s a “machine for drawing glass” or merely the “drawing chair”. These older terms regarding the craft and the craftsman must in some places have remained in use until as late as the 1900s, according to factory owner Edvard Strömberg at Strömbergshyttan. Kosta glassworks was built in 1742. As early as 1747, the first glass engraver, Hans Wenzel Gerner (c. 1720–1772), was employed. He originally came from Germany and had his own equipment, which was the custom. Copper wheels were already used during the 1700s. The engraving machine was pedal-driven at this time. Hydropower had not yet begun to be used to power the machines (see opposite page). From the 1820s and for several generations onwards, members of a Kjellander family worked as engravers at Kosta. The profession was passed on from father to son.

In 1913, Orrefors’ glassworks ownership changed to Gothenburg industrialist Johan Ekman’s and in the same year, crystal glass was melted for the

first time. The year 1916 Simon Gate was employed and in 1917, Edward Hald. During the late 1910s and throughout the 1920s, engraved glass dominated Orrefors’s range. Typically, thin glass is covered with skilfully engraved motifs that follow a strict design language. Gate and Hald were backed by several skilled engravers such as Elis Rydh (1881–1964) and Gustav Abels (1893–1974), the German Wilhelm Eisert and the Bohemian A Diessner. Perhaps the most well-known of these was Gustaf Abels, born Gustaf Abelson in Ekeberga parish. He started in Kosta but was lured to Orrefors glassworks in 1915 where he worked as an engraver until 1959. Before the 1925 Paris exhibition, Gustav was commissioned to engrave Simon Gate’s “Bacchus’ Train”. It took about 300 hours and afterwards, Gustav Abels said that it was his most demanding job as an engraver. All in all, 13 bowls had been made, but he did not engrave all of them. Abels was rewarded at the Paris Exhibition in 1925. At the Paris Exhibition in 1925, Orrefors glass received its international breakthrough. Orrefors, alone amongst all the glassworks, received the Grand Prix medal, as did the artists Simon Gate and Edward Hald. Later, the glass for the Stockholm exhibition in 1930 was not designed prior to manufacture as was normal, but rather, experiments in shape and form happened in the glass workshop, directly with the glassblowing masters. The glass style now became thick and solid and was often accompanied by a black foot that came to be typical throughout the 1930s. The engraved decor was more limited. The glass was not allowed to disappear behind a motif but was able to express its own qualities. Vicke Lindstrand came to the factory in 1928 and debuted at the Stockholm exhibition with engraved pieces that added something new. Gate’s women in baroque attitude were now supplemented by Lindstrand’s

diving men underwater in the form of pearl fishermen or shark hunters.

During the late 1920s and 1930s, interest in glass increased in the interior design field. Practicalities of scale then became a problem. In the book "Glass of the Past and Present" of 1933, one of the authors, Kurt Vogel, writes: "Recently, however, experiments have been made with a device, reminiscent of the dentist's drilling instrument, i.e. a flexible shaft, which makes it possible to move the nozzle with the wheel towards any sized object. When engraving large windows or tabletops, this is, of course, the only way forward and it must be acknowledged that the results so far have been promising. However, it is still uncertain whether the old machines can be deprived of their domicile within this conservative art form". Vogel got it right, it would take almost 20 years, until the late

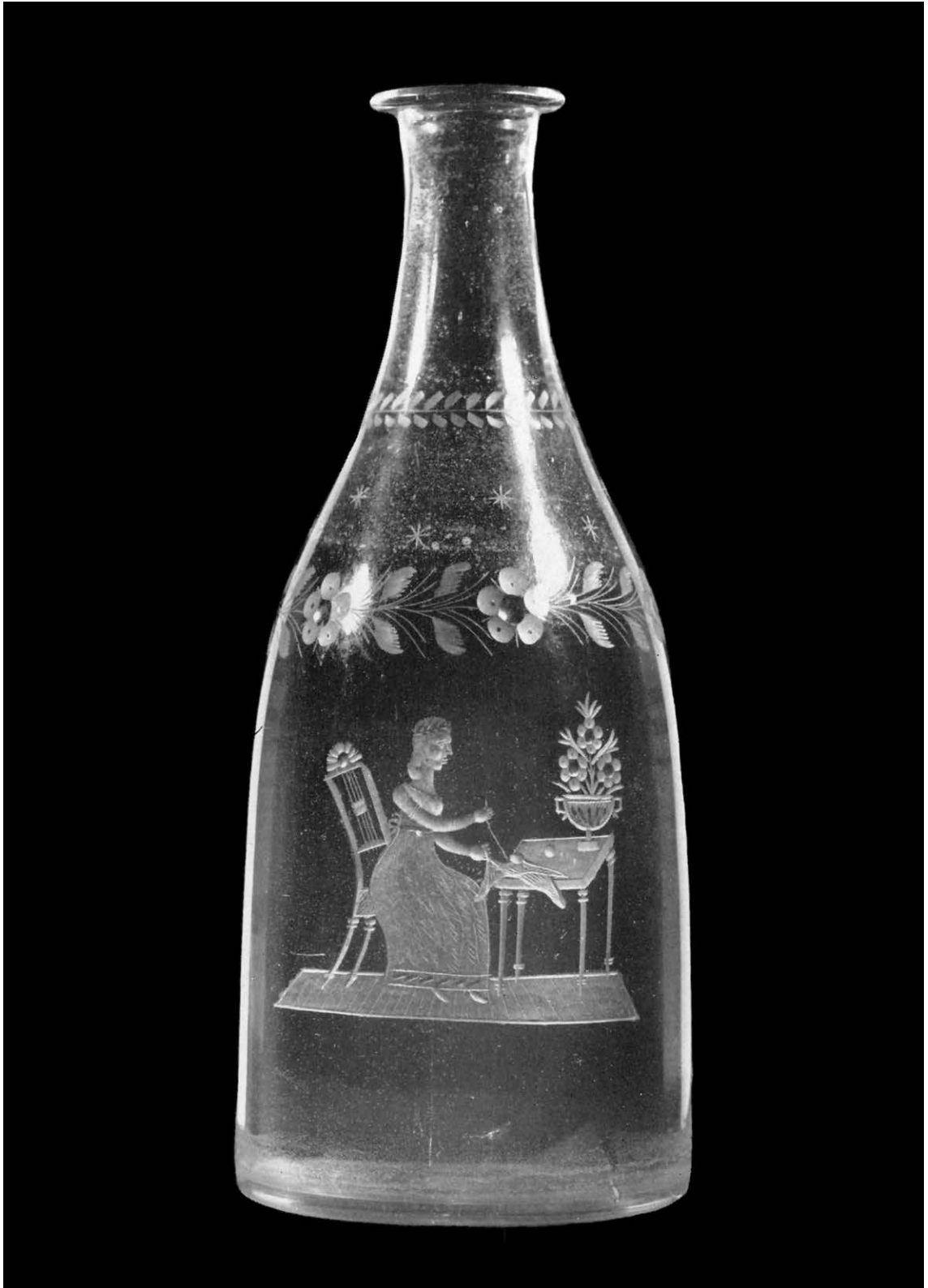
1950s, before this technology shift began in earnest. This modernised engraving technology was not considered to give the same depth or lustre as its predecessor copper engraving but was easier to work with in practical terms. One person who made interior design with decorated glass was Nils Landberg (1907–1991) who trained in the graphics department at the craft school in Gothenburg. Following recommendations from there, he started at the engraving workshop in Orrefors. Landberg was active at Orrefors glassworks between 1925–1972, initially as an engraver, and from 1936 as a designer. Among other things, he designed glass interiors in banks and other public premises in Sweden and abroad. An example from 1947 still preserved today is the entrance to the then County Administrative Board's premises in Kalmar, which consists of an etched decorative background pattern combined with a large engraved county coat of arms.



Edward Hald's masterpiece and one of the highlights of his career was the Celestial Globe. The 53 cm high glass globe with engraved constellations, the zodiac, was manufactured at Orrefors for the Stockholm exhibition in 1930. Photo from 1963, KLM archive.



The entrance to the then County Administrative Board from 1947, detail of the engraved county coat of arms.



Engraved carafe from Cedersberg glassworks in Östergötland, the 1820s. This high quality copper engraving shows examples of ornamentation and detail that later came to inspire and be recreated by grinders and engravers, mainly during the 1900s. Pay special attention to the flower border as well as the flower arrangement set in the urn, which echo decorative details in 1900s flower cutting. Illustration from *Äldre Svenska glas*, Seitz, 1936.

Classic copper engraving

Copper engraving

Hand engraving was carried out using copper wheel engravers. Engraving wheels of varying sizes, thickness and profile were used in combination with abrasives, such as emery paste. The engraving wheels were made of copper plate, hence the name copper engraving. The grinding or engraving wheel was inserted at one end of the rotating spindle shaft. The engraver held the object and pressed it against the copper wheel which was firmly mounted to the shaft. To copper engrave, a large number of wheels of different sizes and designs were needed, which were quickly alternated by the engraver, depending on what the design required.

In older times, the engraving machines were driven by the engraver's peddling force or by a water wheel. In the late 1800s, they were usually driven by a steam engine or by a turbine whose power

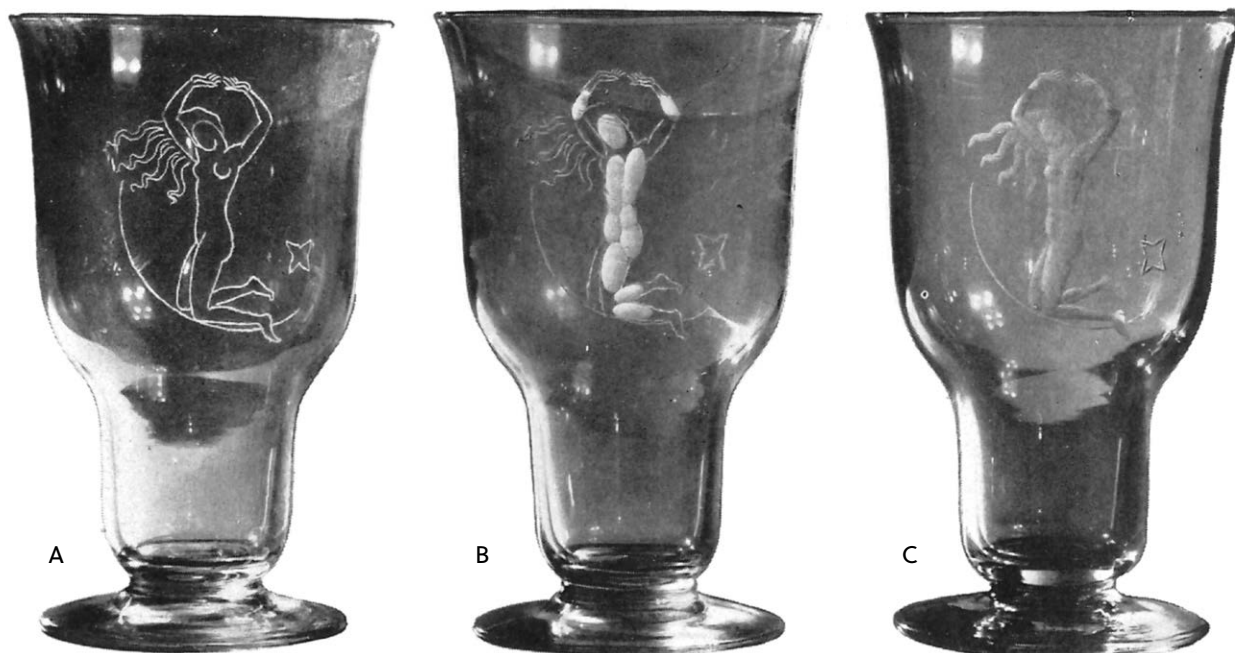
was conveyed to the machines via a single transmission shaft. Since electricity was introduced in the early 1900s, the opportunity arose to connect a central electric motor to the machines via the transmission shaft, but towards the middle of the 1900s, the individual engraving machines were instead equipped with their own motors.

Marking

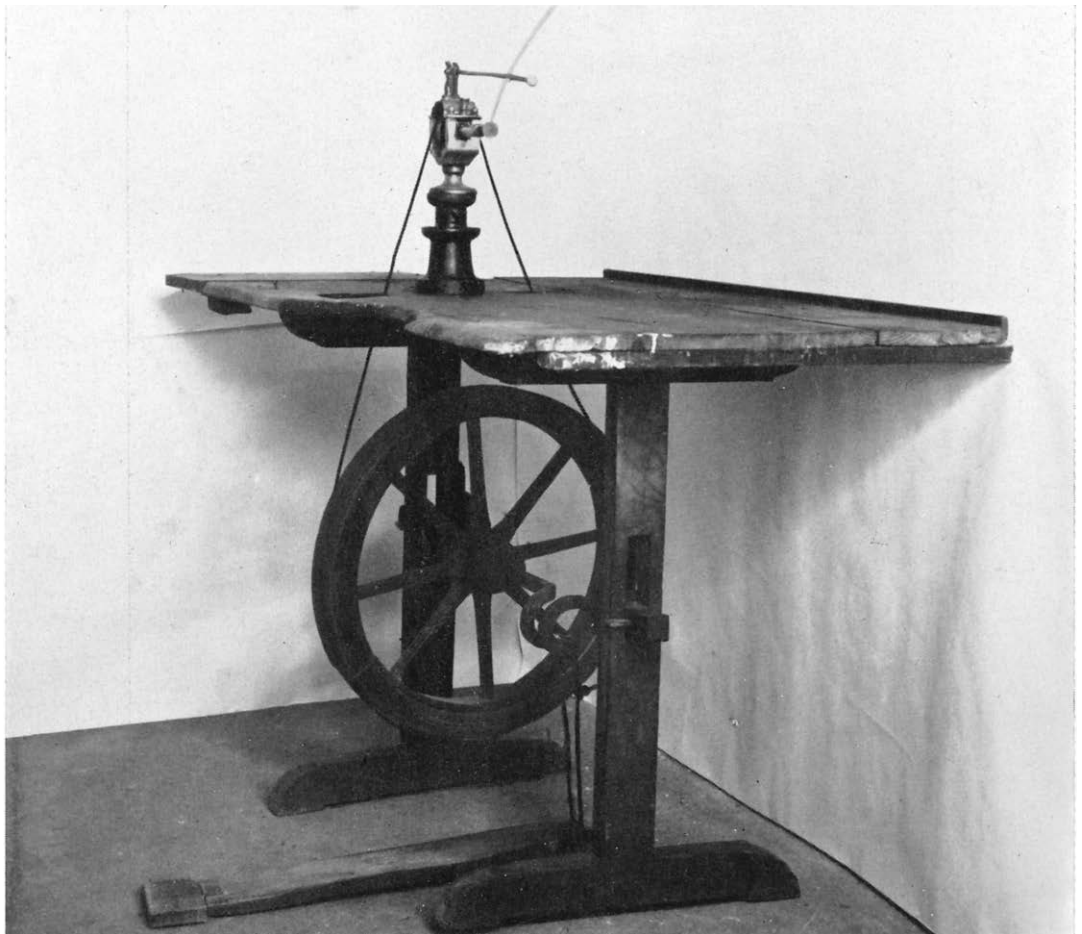
The motif was drawn on the glass with a white water-based paint containing gum arabic.

Protecting the surface

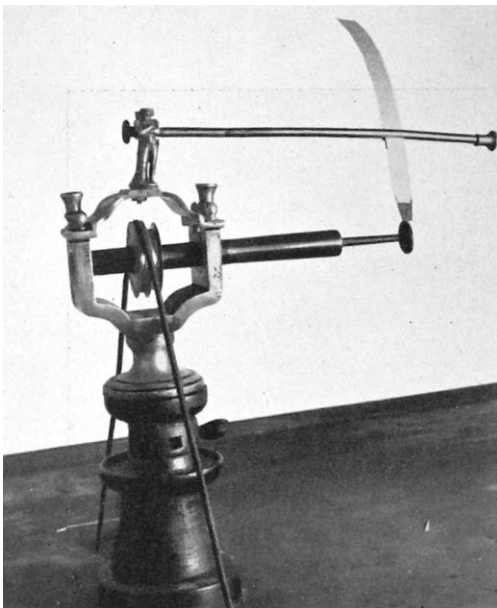
When the marking dried, it was protected with a thin varnish, which was usually a zapon lacquer. The varnish was there to fix the drawing and protect the glass from scratches that otherwise may occur during the work.



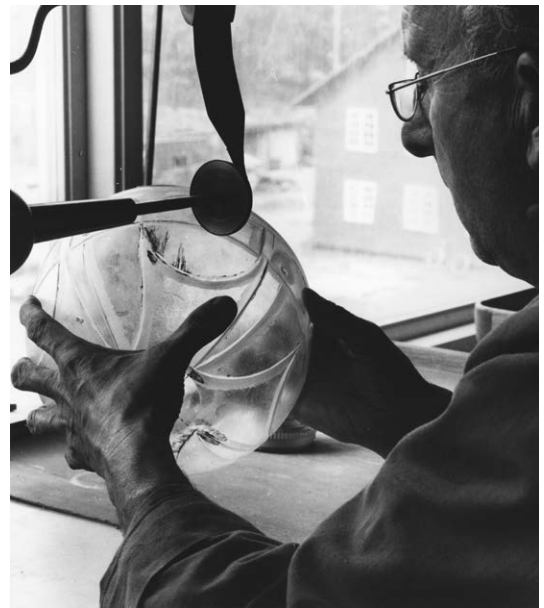
Various stages in undertaking a figurative engraving. A. The figure is marked with a rubber and water based paint mixture. B. The parts that lie deepest and will become the body are cut first with a strong copper wheel. C. The final engraving, elegantly, in 1933 is called "Nuance". Illustration from *Glaset förr och nu*, Seitz, 1933.



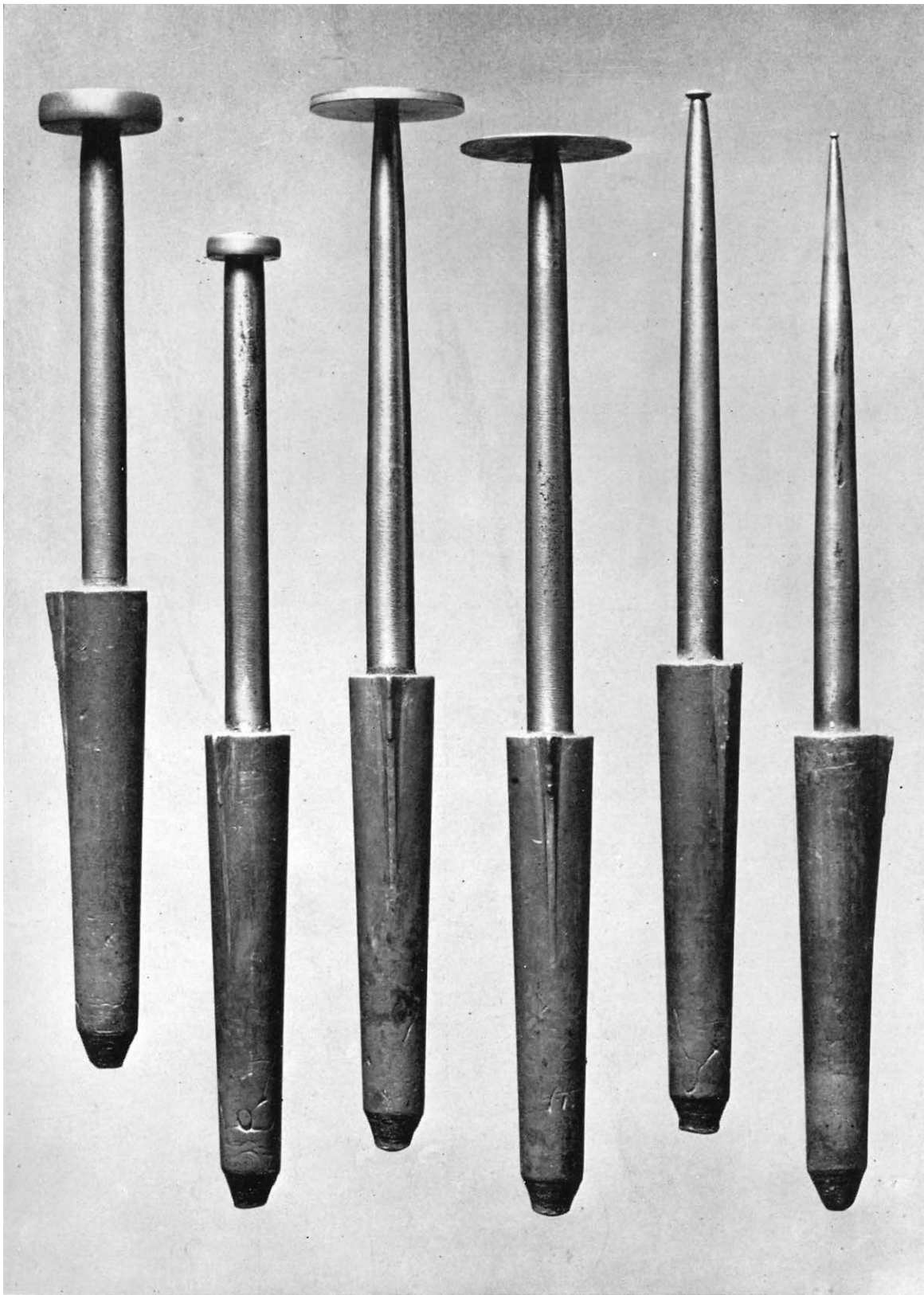
A pedal-powered engraving machine from the first half or mid-1800s. Included in Stockholm City Museum collections. Illustrations from *Glaset förr och nu*, Seitz, 1933.



Detail. The engraving machine complete with the mounted glass spindle. A felt piece is placed over the wheel which distributes the oil-bound emery paste.



Engraver with copper wheels at Pukeberg's glassworks. Photo: KLM archive.



Copper wheels riveted to steel spindles on all but the smallest to the right, which are turned directly from the spindle. The total length varies between 17-19 cm. Illustration from *Glaset förr och nu*, Seitz, 1933.

Copper Engraving

The next step is the engraving of the glass itself. The engraving machine consisted of a metal box containing a horizontal rotating shaft, at one end of which a hollow was drilled. The spindles consisted of cylindrical rods of steel, the lower or left half of which was encased with an alloy of zinc and lead. This alloy served as a gasket upon which to fit the spindle into the rotatable shaft. At the outermost tip of each spindle, was a fixed, smaller or larger copper die or wheel, riveted on and which thanks to its careful fitting, rotated with great precision.

The engraver worked in such a way that with his elbows he leaned against the table where he pressed the glass against the copper wheel. The copper as such did not bite into the glass, as the glass was harder than the copper. Therefore, emery paste was applied to the wheel. The abrasive consisted of powdered emery mixed with oil and kerosene into a paste. The paste was placed on the copper wheel with the fingers but was then evenly distributed over it by a hanging felt piece (see picture on page 15).

The pressure, grit and rotation against the glass created a recess, varying according to the size of the wheel. For different purposes, different sized wheels were used. The smallest, which produced the most delicate details, were not copper but consisted of the spindle tip which could as small as 1 mm. The largest copper wheels had a diameter of 100 mm. The thickness could also vary from as thin as a knife-edge of less than 1 mm to heavy, solid pieces of 8 mm plate. The spindles could be in hundreds of different sizes for each machine. They were stored on the workbench in an easily accessible place.

The engraver let the wheel slide lightly over the glass and copied the pattern, making points and circles, so to speak, rolling the glass against the wheel and creating the soft shapes of the figures through gently nuanced imprints. The engraving appeared as a depression in the surface. You can also engrave in relief, which is considerably more difficult. For this, the surrounding parts must first be removed and the pattern sculpted.

The engraved surface, which had a silver-like white tint, was initially matte and of a coarser or finer character, all depending on the fineness of the powder. The abrasion was graded in various degrees, numbered from 1–7. The coarser varieties worked much faster and were therefore used extensively for simpler work. The finer emery allowed the engraver to create a higher quality final result and was therefore used on more exclusive objects.

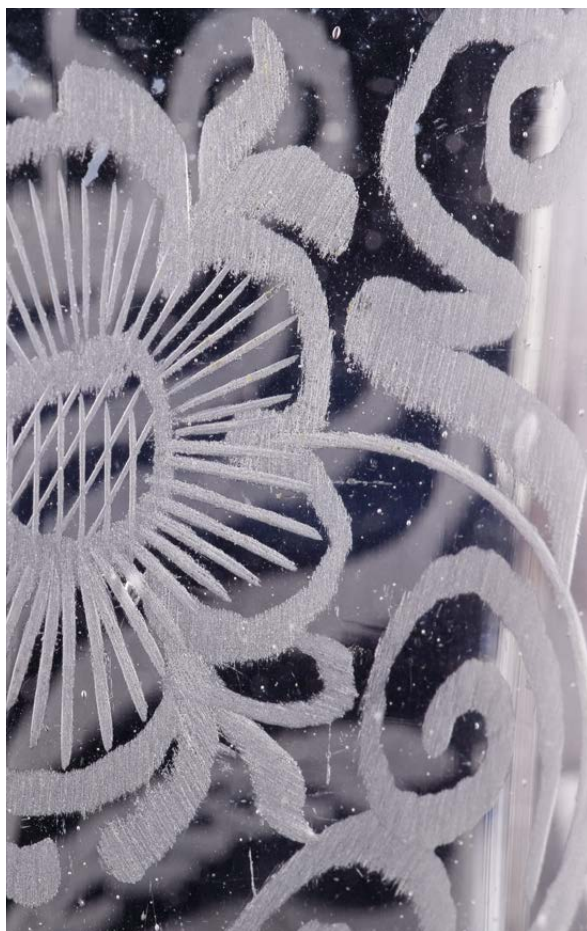
Polishing

The matte surface that was created by the engraving could be polished in several ways. By smoothing certain places, and thereby creating a gloss, one could achieve a vibrant effect with completely shiny parts in contrast to the surrounding silver matte surfaces. Polishing was usually done with wooden, cork or lead/tin wafers, each turned like the copper wheels and then coated with a slurry of crushed pumice stone and water. There was also acid polishing. The glass is immersed in a bath, generally consisting of ten parts of water, five parts of sulphuric acid and five parts of 70 % hydrofluoric acid, all mixed together in a particular way and stored in a lead vessel. The acid polishing, which only took about 8–10 seconds, was based on the corrosive effect of the acid on the small irregularities that remained after the engraving.



Modern engraving

Modern engraving is a technique that is performed with a machine, an engraving pen or flexible shaft tool, similar to a dental drill. The tip of the engraving pen is interchangeable so that you can switch between different roughness in the surfaces, and thus shifts in shades of tonality (see image to the left). The final engraved surface has a quality like an imprint in wet sand. The rotating bits alter the glossy surface of the glass and engrave the subject millimetre by millimetre. The work is time-consuming and requires a great deal of professional skill. The grinding dust is bound in a liquid or sucked out. The technology was introduced gradually from the late 1950s and today in 2018 it is the method by which you engrave glass. In the photo to the left: The glass artist Leif Swahn photographed in 1985 while working on engraving a vase. Photo: Ola Leijonborn, KLM archive.



Different types of engraving

Hatching

A type of engraving where the copper wheel/modern engraving pen has, as the word implies, imparted “hatching” on the glass surface, without any deep effect. The picture shows how the copper wheel has marked the surface, a clear example of hatched engraving. If you touch the surface on such a glass, there is hardly any relief at all, so shallow is the hatching. The hatching gives a less “tight” aesthetic feeling that goes along with its often rickety design. In an enlargement, you can see an “open” outer edge. Photo: Jörgen Ludwigs-son, Kulturparken Småland.



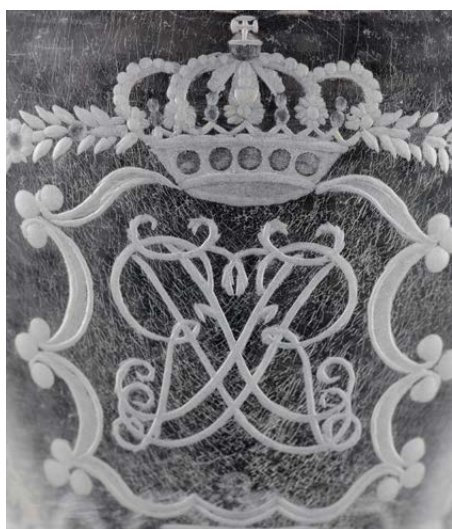
Surface engraving

Surface engraving is, as the word indicates, the opposite of deep engraving, but not to be confused with hatching engraving. Here in the picture on the left, you will find a surface engraving made with the help of a copper wheel. The woman stays just within the framework of a surface engraving as to how deep the engraver has descended into the glass. Being able to create a hint of 3D effect in this thin glass is an example of great professional expertise. Photo: Jörgen Ludwigsson, Kulturparken Småland.



Deep Engraving

The picture shows an example of a deep engraving made with copper wheel. Here the engraver has worked his way into the material and with meticulous precision created a magnificent work. The engraver “digs” down. Another example is the “Bacchus’ Train”. It supposedly took about 300 hours to engrave it (see picture on page 10). Photo: Jörgen Ludwigsson, Kulturparken Småland.



Line Engraving

Line engraving requires great skill from the engraver, in their ability to create engraved lines of various types. The text and grapevines in the detail to the left are “squiggly” and natural, undulating and very sensitive. In the engraving above, next to the entry on Surface Engraving, one can see instead with the use of straight thin lines in 90-degree formations. All are made with copper wheels, and the precision in that example is outstanding. Photo: Jörgen Ludwigsson, Kulturparken Småland.

Grinding – the historical development

At Kungsholm glassworks (1686–1815), the grinding of glass started in the 1780s. During the first half of the 1700s, facet-cut crystal objects had begun to be made in England. Previously, cut glass had existed in Constantinople, Venice and, from the 1500s, in Prague. The English influence, when it came to cut glass, reached Sweden in the late 1700s. At Kosta Glassworks, work didn't begin on the manufacture of cut glass until 1828. The square-cut feet on, for example, wine glasses, bowls, salt bowls and urns a typical detail in glass from England at that time and that was also easy to copy; this approach was quickly adopted

by the Swedish glass grinders. In the 1840s, the fully ground glass products became popular, that is, objects where the entire surface was ground in various facets. These full-cut pieces required fairly thick blanks and therefore was best on larger objects. In the 1870s, the full cut look became less the modern fashion. Instead, it was so-called "olive grinding" that became typically requested look for tableware and decanters. The golden age of cut glass, in terms of volume, occurs in our country between the late 1800s and early 1900s. The large Swedish glasshouses often each had more than hundred full time grinders.



The grinder at his workplace, the early 1900s. The location where the photograph was taken is unknown. Next to the grinder is the rinsing bath. Illustration from *Glaset förr och nu*, Seitz, 1933.

Grinding in Sweden during the 1800s and early 1900s

The mechanical device was called a grinding chair. This grinding chair consists of the grinding wheel with a centre spindle that is inserted into two rods, one on each side. Underneath is a wheel for connection to the belt drive. Underneath the grinding wheel is a trough, a low rectangular or oval wood vessel that collected water and grit. The grinding was performed in three different steps:

Grit grinding

The initial grinding was performed with a coarse grinding surface, a cast-iron disc or a wrought iron disc, as the wheel in the grinding chair. From a funnel with a hose above the workplace, natural sand grit was added to the plate and under the grinding wheel, was the catchment vessel (see photo on page 22 from Strömbergshyttan). There you can see the funnels hanging from the ceiling. From the Alsterfors glass-works, the following description of how the grinding grit was prepared sometime in the early 1900s:

“The grit rinse was also a job that required far more time than is the case now. The grit was never rinsed in the grinding barrel, but when it had run down from the funnel, the water was poured off, and the grit was scraped down into a tub. Then it was carried out to the pond, where the tub was filled with water. The rough grinder and the fine grinder then bumped the tub with their sand rakes, until the grit was brought into motion. By tapping the edge of the vessel, the grit was easier to divide, so that the roughest fell to the bottom. The finest was poured into a barrel, where it was taken care of for edging thin glass. Then the tub was filled again with water, and the same procedure was repeated, after which the grit was clean. Now the tub was filled with 2 buckets of water before it was brought in. This would be used in the sifting of the new sand, which was replenished instead of being thrown out. If the work was not too rough, about 15–20 kg grit was consumed per day per grinder”.

Fine Grinding

The fine grinding was carried out with stone plates in several steps, depending on the glass product to be

produced. The grinder had by the side of the grinding chair and trough, a bath to rinse off and see how far he had come in his fine grinding. The sandstone slabs that were used for the wheels used could either be purely natural stone, i.e., carved directly out of sandstone, or artificial. The latter were made from sand grains of sifted size, which with the addition of a binder, e.g., water glass, they were mixed and pressed into moulds to be fired at high temperature. With wheels made of emery plates, these were made of both artificial or natural emery. The latter were largely sourced from the Greek Island of Naxos. The artificial grinding emery wheels were made using fine corundum sanding grits.

Polishing

It was only after the final polishing that the treated glass surface appeared clear and glossy, which was either done with an acid bath or a rotating cork wheel applied with pumice powder and water.

Grinding in Sweden during the middle of the 1900s

Rough grinding

This step was called initial grinding. The grinding wheels were now artificial and at this time had an abrasive surface consisting of silicon carbide. During the actual grinding, a grinding grit was used which also consisted of silicon carbide.

Fine grinding

The fine-grained slab of natural sandstone was replaced more and more by wheels made of artificial ceramic-bonded aluminium oxide sheets that were used with constant water flow during the grinding process.

Polishing

Pressed cork wheels and pumice powder was used here. First, the glass surface was roughly polished with pumice slurry in water, then finely polished with cerium oxide and water on a felt or pressed cork. Since the early 1920's full optical chemical polishing was added as final stage using an immersion in a lukewarm mixture of hydrofluoric acid and sulphuric acid. This work was dangerous and required special protective equipment.



From the grinding workshop in Strömbergshyttan, the 1930s. The Bergqvist family's private photo album.



Cut grinding. Photo: KLM archive.



Grinding at Orrefors glassworks. Photo: Winell, KLM archive.

Grinding at Kosta 2018

The various steps used for modern grinding consist of the following steps.

Course grinding

coarse grinding, a rough synthetic diamond disc with grain size 252 is used. During grinding, the disc or wheel is constantly cooled with water to avoid overheating, which could damage both the glass and grinding disc.

Intermediate Step 1

For the next step in the grinding process, a synthetic diamond disc with grain size 151. When grinding, the disc is cooled with water.

Intermediate Step 2

For the next step in the grinding process, a synthetic diamond disc with grain size 91. When grinding, the disc is cooled with water.

Fine grinding 1

For the next step in the grinding process, which is the fine grinding, a synthetic diamond disc with grain size 46 is used. When grinding, the disc is cooled with water.

Fine sanding 2

For the next step in the grinding process, which is the fine grinding, a synthetic diamond disc with grain size 25. When grinding, the disc is cooled with water.

Polishing

The glass is polished after grinding to make the surface shiny again. For this, synthetic polishing discs are used which are effective and last a long time. The older type, pressed cork wheels and pressed felt wheels and pumice powder are also still used to a limited extent.

Fact box: Abrasives

Corundum

Corundum is a mineral consisting of aluminium oxide. Corundum occurs sparingly in some rocks. Opaque crystals of grey colour are called ordinary corundum while a blue-grey to a brown mixture of small corundum crystals in other material is called emery. Pure corundum is chemically one of the most persistent substances known. A form of corundum (contaminated by iron oxide and silica) is called emery and is used as an abrasive in sandpaper and sanding stones. Emery is found in Greece on Naxos and Samos. Synthetically made corundum, with the same hardness as the natural, is obtained by a special form of melting of aluminium oxide.

Carborundum

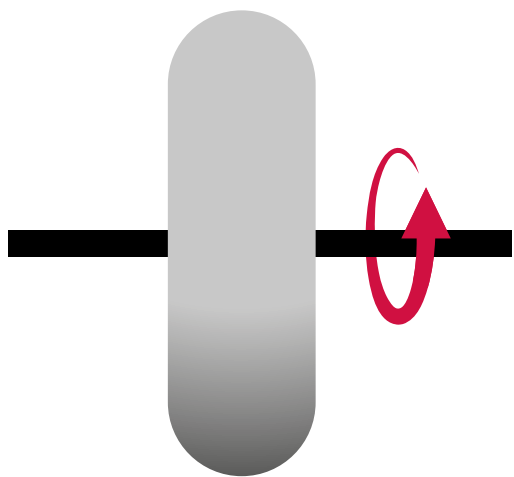
Carborundum is the same as silicon carbide. Chemical formula SiC. It's a chemical compound which, due to its hardness, is used as abrasive.

Synthetic diamond

The method of making artificial diamonds was invented in 1953. The so-called synthetic diamonds, which are mainly used in industry, have several uses. Among other things, they are used for grinding wheels in various arrangements, which consist of cast "diamond gravel".

Different types of cutting

Cutting is done with rotating grinding stones (for example carborundum or corundum) or coated with industrial diamond. Corundum is a mineral consisting of aluminium oxide. Grinding discs can have grains of silicon carbide or diamond and is available in various sizes and shapes. The cut in the glass is affected by the abrasive applied, how hard the glass is pressed against the grinding wheel, the angle used and the speed of the grinding wheel. Cutting is carried out in principle with four types of grinding stones; olive stone, facet stone, groove stone and cutting stone (with one or more cuts). The four could be used separately or combined into a single decorative composition.

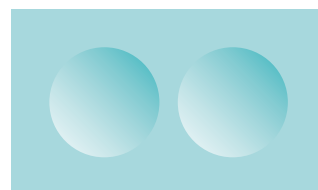


The shape and rotation of an olive stone.

Olive stone

Soft rounded profile on a grindstone. This grindstone, as the name implies, gives an oval depression in the glass. The oval shape can be made longer or shorter, called “olive”. Small fully rounded recesses are called “balls”.

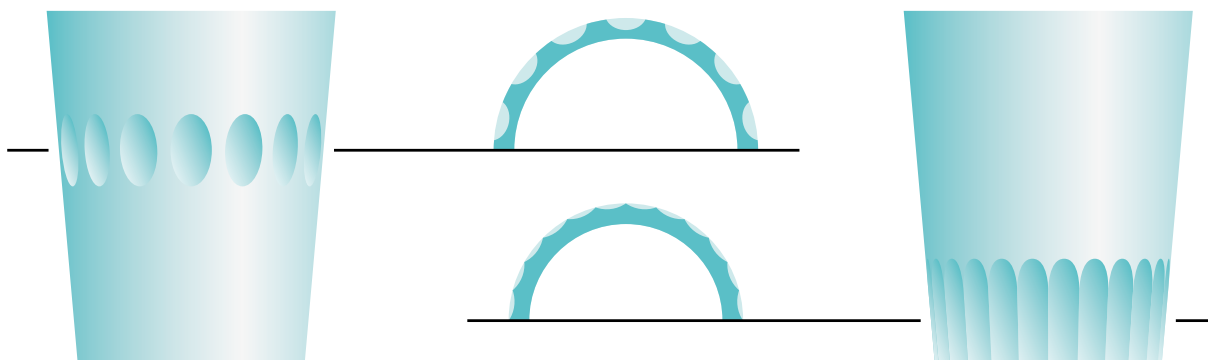
Balls



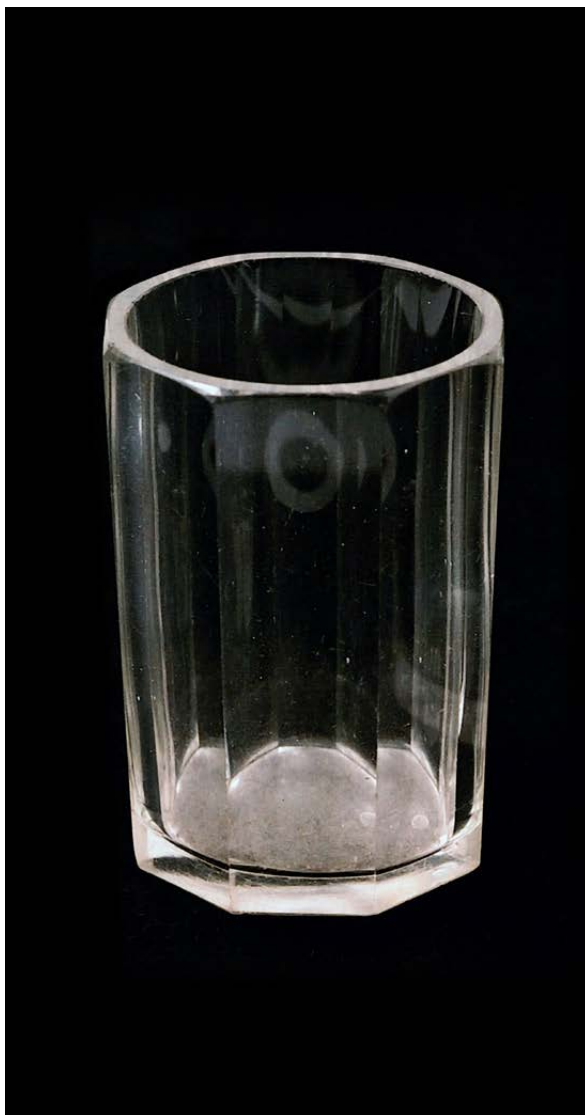
Olives



Examples of common shapes cut with an olive stone.



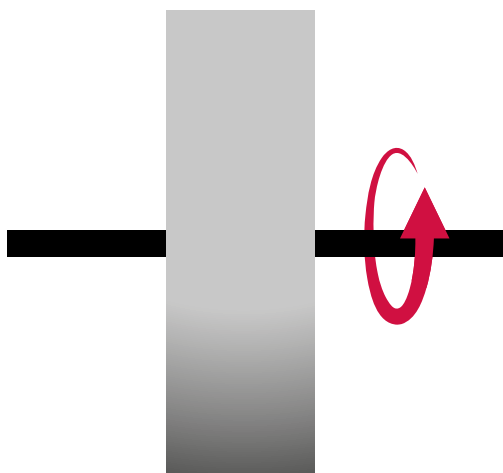
Examples of olive cutting of glass, with the profile in cross-section. Illustration: Stefan Siverud, reproduced from Carl Hermelin's Fakta om glas.



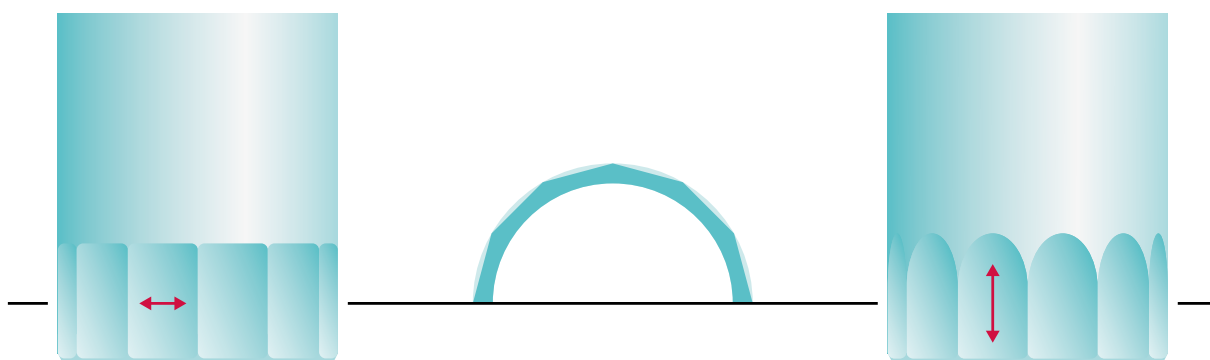
Faceted water glass from the 1800s. Photo: KLM archive.

Facet Stone

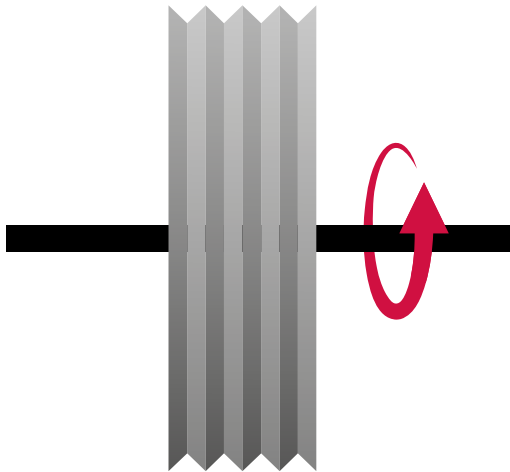
Straight profile on the grindstone. This grindstone provides a flat surface or flat surface at an angle. Often used to sharpen facets around, for example, a stem of a wine glass, or as in the photograph, on entire surfaces, if the glassware is thick. Can also mean a slanted narrow decorative border, with a small facet profile.



The shape and rotation of a facet stone.



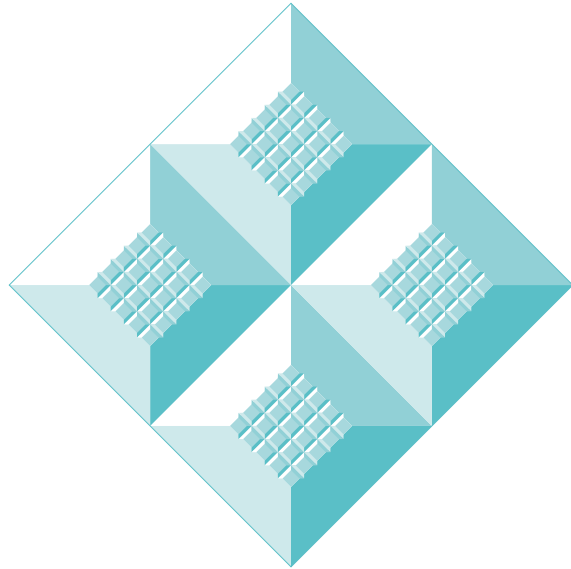
Examples of facet cutting on glass, with the profile in cross-section. The red arrow shows the angle of rotation of the grindstone against the surface of the glass. Illustration: Stefan Siverud, reproduced from Carl Hermelin's Fakta om glas.



A groove stone's shape and rotation.

Groove stone

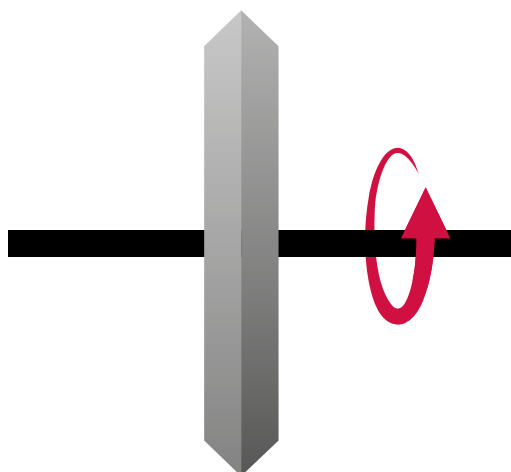
Several small cut grooves next to each other on one and the same grinding stone. This grindstone creates thin shallow parallel lines in the glass surface.



In the middle of the cubes, we see an example of the use of grooved cuttings.



Examples of grooved glass. Photo: Kulturparken Småland.



The shape and rotation of a cutting stone.

Cutting stone

V-shaped pointed grindstone. The angle and size of the tip vary, as does the diameter of the grinding wheel. Several angles of tips also occur. This type of grindstone has many uses. It can create shallow “brooms”, “fans” and “stars” as well as deep-cut known as “brilliant”, or square-cut or shallow-cut strips. Deep grinding is a variant that can only be done on thick-walled glass, and preferably “crystal” glass, as the lead in the traditional “crystal” formula makes the glass softer for grinding and polishing. Using this type of glass formulation also wears less on tools and after polishing the glass has an especially appealing lustre.

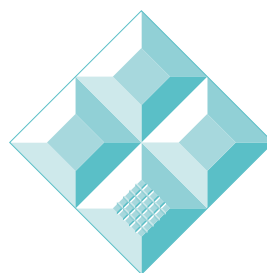
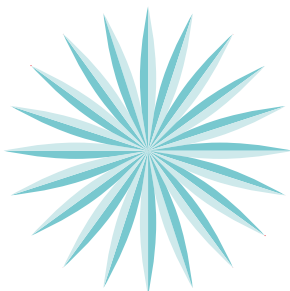
Broom



Fan

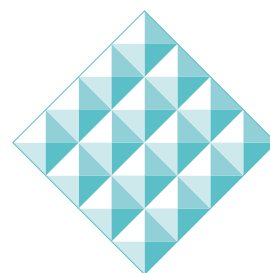


Star



Brilliant or grid cutting

The lower brilliant with
grooved or antique
panelling



Diamond cutting

A



B



C



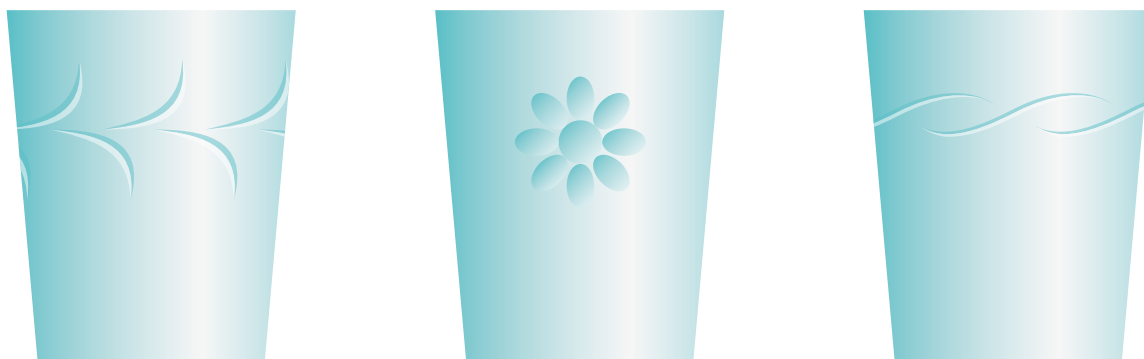
Examples of glass cutting. A. Cut. B. Cut with broom. C. Cut with broom and grooving. Illustration: Stefan Siverud, reproduced from Carl Hermelin's Fakta om glas.

Flower cutting

A variant of cutting has the collective term flower cutting. The name has been used at least since the mid-1920s. In 1966, the glassworks manager Carl Hermelin's "Fakta om glas" was published, where the concept is described as follows: "By flower cutting is meant simpler, silk-matte figure grinding (leaf edges, stylised flowers, birds and fish, etc.), which is carried out freehand with fine grinding stones. Flower cutting is often confused with the more expensive and considerably more accomplished engraving, which, however, is not considered as grinding in the usual sense."

Flower cutting is illustrated by Hermelin with three different decorative details that do not say anything about the end result. Flower cutting can be a simple small figure or bouquet on a less expensive glass, but it can also be a near-total surface cover of decoration that looks very exclusive and expensive.

The various decorative elements are combined in a clever way that can be reminiscent of engraving. A competent grinder could complete large functional wares in series with intricate flower cuttings at a much lower cost than if an engraver had made a similar product. An example of such a luxury product aimed at a bourgeois audience is the tableware series "Mac Guirlang" created by the designer and grinder Fritz Kallenberg at Boda Glassworks, see the image to the right. At first glance, this looks like an engraved glass. If you study the glass more closely, however, you will discover that it consists of the three basic forms of flower cutting combined with sharp cutting. The flower in the middle is an olive cut with a broom cut above and a wreath beneath in the form of thinly cut line with wider leaves.



Examples of flower cutting of glass. Illustration: Stefan Siverud, reproduced from Carl Hermelin's Fakta om glas.



Flower cutting in a simple design. Photo: Pierre Rosberg, Kalmar läns museum.



"Mac Guirland" tableware, a wine glass with full flower cutting. Photo: Private.



The grinder Anders Nylander holds up a finished example of the Sarek vase.

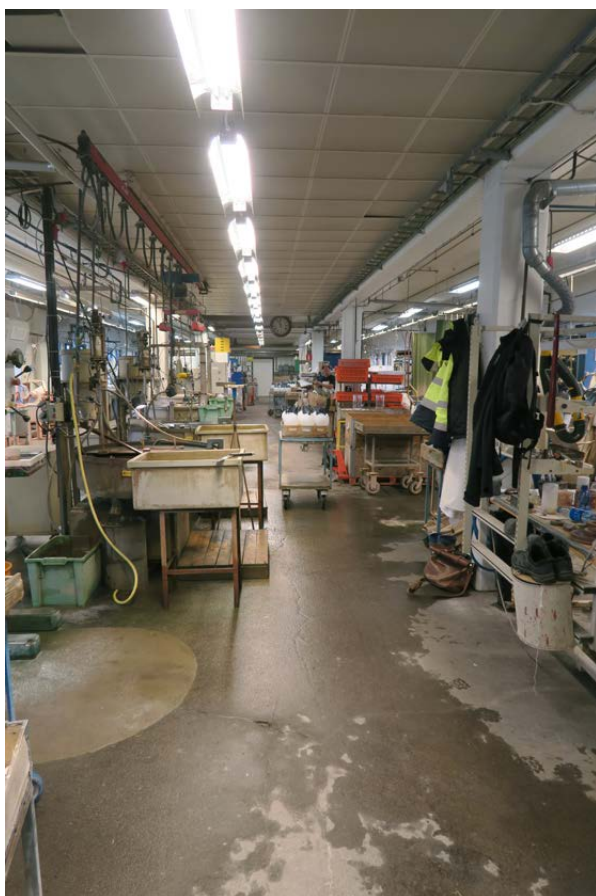
The grinding workshop at Kosta Glassworks 2018

– a conversation with grinder Anders Nylander

The grinder Anders Nylander (1955–) started at Orrefors glassworks in 1971. After an introductory period trying various parts of the glass-making process, the supervisor at the factory suggested that he should probably work on “the cold side”. In his case, that meant grinding. Anders became an apprentice of grinding at Orrefors glassworks and remained in the factory as a grinder until the business was closed down in 2013 when he was offered a place at Kosta Boda. With the move to Kosta, large parts of the machinery collection

were also moved from Orrefors. At Kosta, they currently employ eight grinders. Rejuvenation seems difficult to achieve. In addition to being cut, the glass can be finished in several other ways.

In addition to being cut, the glass can be finished in several other ways. The type of cut glass or tableware glass that has passed through Anders's hands over the years has changed according to fashion and the customers' changing taste. An example is a cut crystal bowl from 1961, designed by



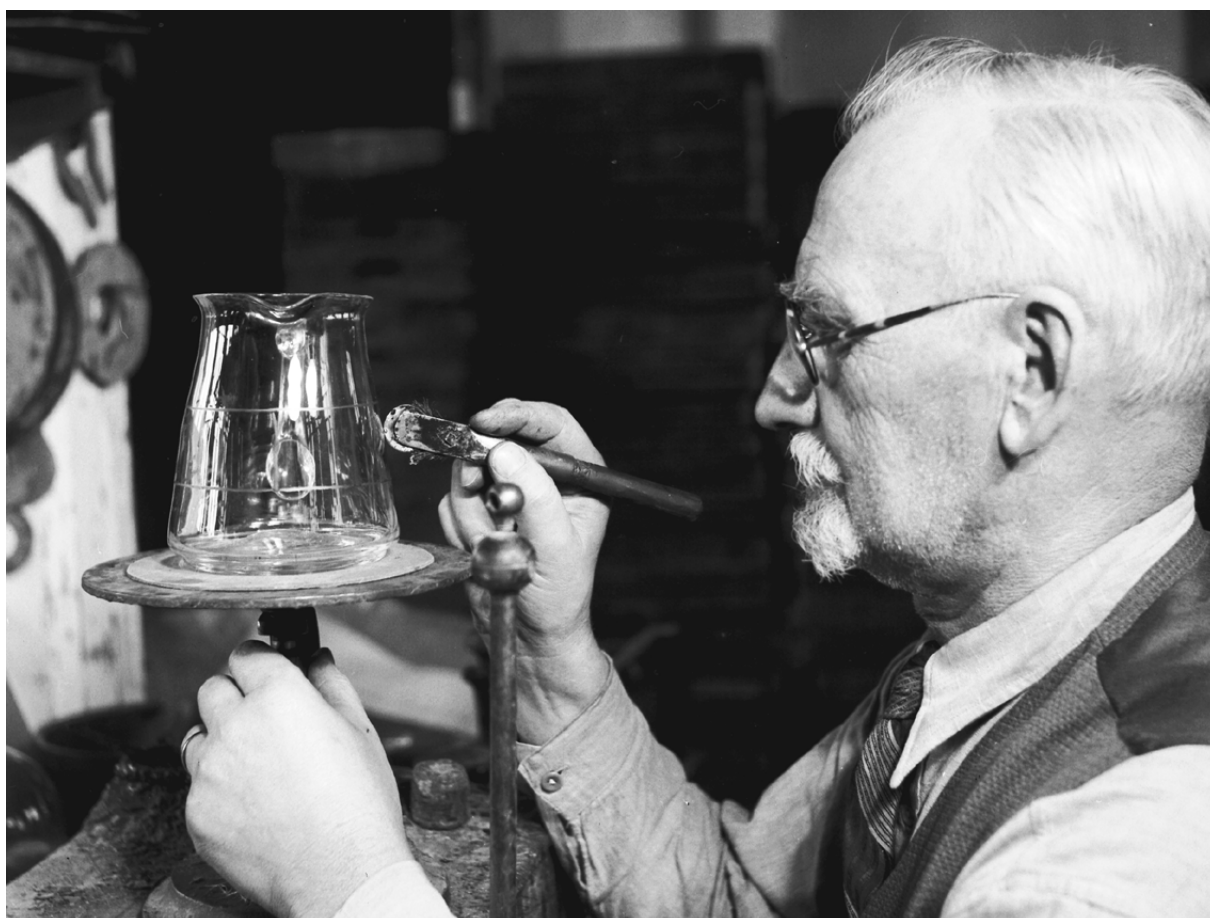
The grinding workshop at Kosta Glassworks 2018.

Gunnar Cyréns Sofiero, that has been manufactured in very large numbers over the years.

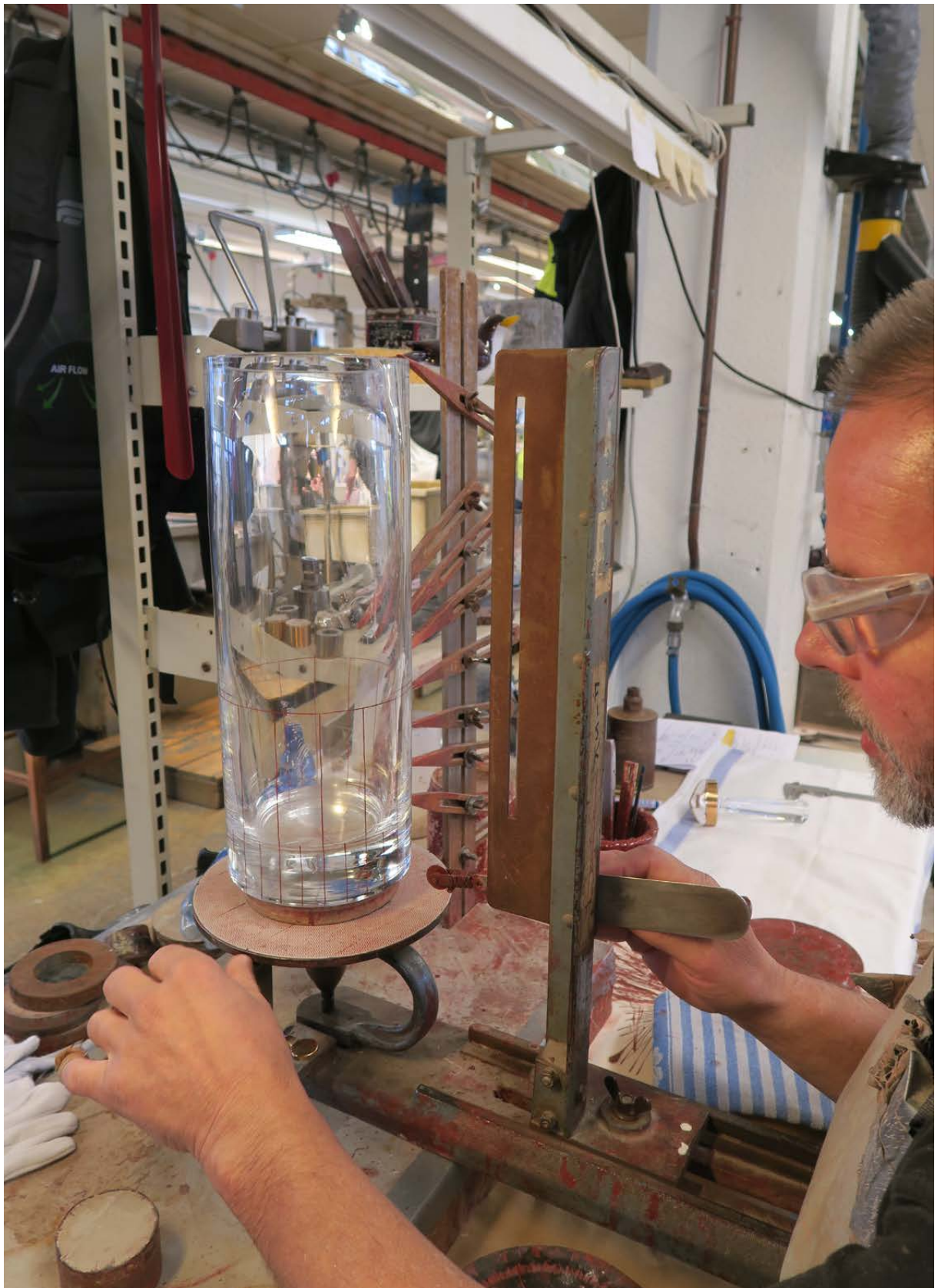
The bowl was offered “for engagement and loyalty in service”, it was, among other things, a gift for government employees after long and faithful service. The glass designer collaborates with Anders and his grinding colleagues in their process of developing new products in the same way as in the glass workshop between the glass designer and the glass-blowing master. This collaboration with the grinder is not as well-known. Cut glass was long appreciated by American customers and for them, Swedish glass was synonymous with high quality, a tighter and more sparsely decorated aesthetic than the competing Bohemian crystal. The glass is ground in several steps. First, it is rough-cut, i.e. “a lot” of glass is removed in a short time with the aid of fairly coarse grit on the grinding wheel.



At this workstation, vases are prepared for grinding.



Marking of lines in Målerås glassworks. Photo: KLM archive.



Here Anders has placed the uncut vase on a turntable. He marks with red lines before the grinding.



The vase has now received the desired number of lines needed for Anders to grind the vase.



In the pictures, Anders grinds the bottom section of the vase Sarek. The step he performs in the picture is called rough grinding.



In the pictures, Anders grinds the bottom section of the vase Sarek. The step he performs in the picture is called rough grinding.



Anders after rough grinding of the Sarek vase.



To facilitate the work, abrasives powders are used if they are not already baked into the disc. The disc constantly has water applied to it so that the glass does not overheat and to remove the glass that is ground away. The glass is refined further with a grinding wheel with finer grains. The pattern that is created is completely dull. To get a glossy glass surface again, the glass needs to be polished with an agent on a polishing disc that previously would be made of cork or felt. Today, synthetic material is used. Although the disc sits on a open shaft, there are limitations in accessing areas on the glass object. Different grinding wheels with different materials, angles and diameters create different imprints on the surface of the glass and make it possible to create advanced designs. The larger the discs, the straighter the lines. With the help of acid, you can both create newly soft matte surfaces or polish ground glass. You can also use a sandblaster to create matte surfaces. A traditional type of product that is ground in Kosta is the large vase “Sarek” designed by Lena Bergström for Orrefors, Kosta Boda. Sarek is a mouth-blown series in crystal. According to information from the glassworks, the design language is inspired by the Nordic craftsmanship, especially its braided diamond-shaped pattern. The series includes a vase, bowl, candle holder and bottle stopper. Before Anders begins to grind the vase’s decor, he needs to mark the pattern on the glass. For this, he uses a type of rotatable turntable, called a kavalett, which can be divided into even “notches” when turning it, allowing a round object to be symmetrically marked all around. The marking is done with a red colour which can later be easily polished off. For Anders and his colleagues, it takes 1.5 hours to grind the vase and 1.5 hours to then polish the ground parts on the vase so that they achieve the same smooth surface as the vase in general. The new type of “crystal” glass that has been used since 2003 is tougher than the traditional lead crystal but works just as well as its predecessor.

Product photo: Sarek, Orrefors, Kosta Boda Glassworks.



In the picture, Anders holds up an object, a gavel consisting of two parts in glass.



The glass block from which the blank for the handle has been drilled.



The picture shows the two different parts that are part of the gavel before polishing begins.



Anders here shows a type of polishing that is initially used on the glass gavel handle.





Anders shows how polishing is done with a synthetic polishing wheel.



Anders shows another type of fine finishing polish.



Anders says that much of their work today consists of special orders and sometimes collaborations where a part is made to be combined with something else. They may be different types of awards or polished glass pieces. A larger special order consists of gear knobs for one of Volvo's car models. There are about 300,000 pieces, all of which are processed by hand. Volvo has also made a holder and a pair of crystal glasses for the back-seat passengers.

Anders likes to produce small series and is happy to make awards. A favourite is the Polar Music Prize, which is designed by Efva Attling, whom he looks forward to producing every year. Some awards are made by in larger numbers at a time and therefore stock is built up.

Kosta Boda makes the gear knob for a particular model of Volvo. Anders shows the polished gear shift knob.



Gear shift knob in place in the car. Photo: Volvo Cars.



Engraver Mats Jonasson while working in his workshop. In the picture, he processes a glass block, with the motif of a lion. Several steps remain before it is completed.

Målerås Glassworks 2018

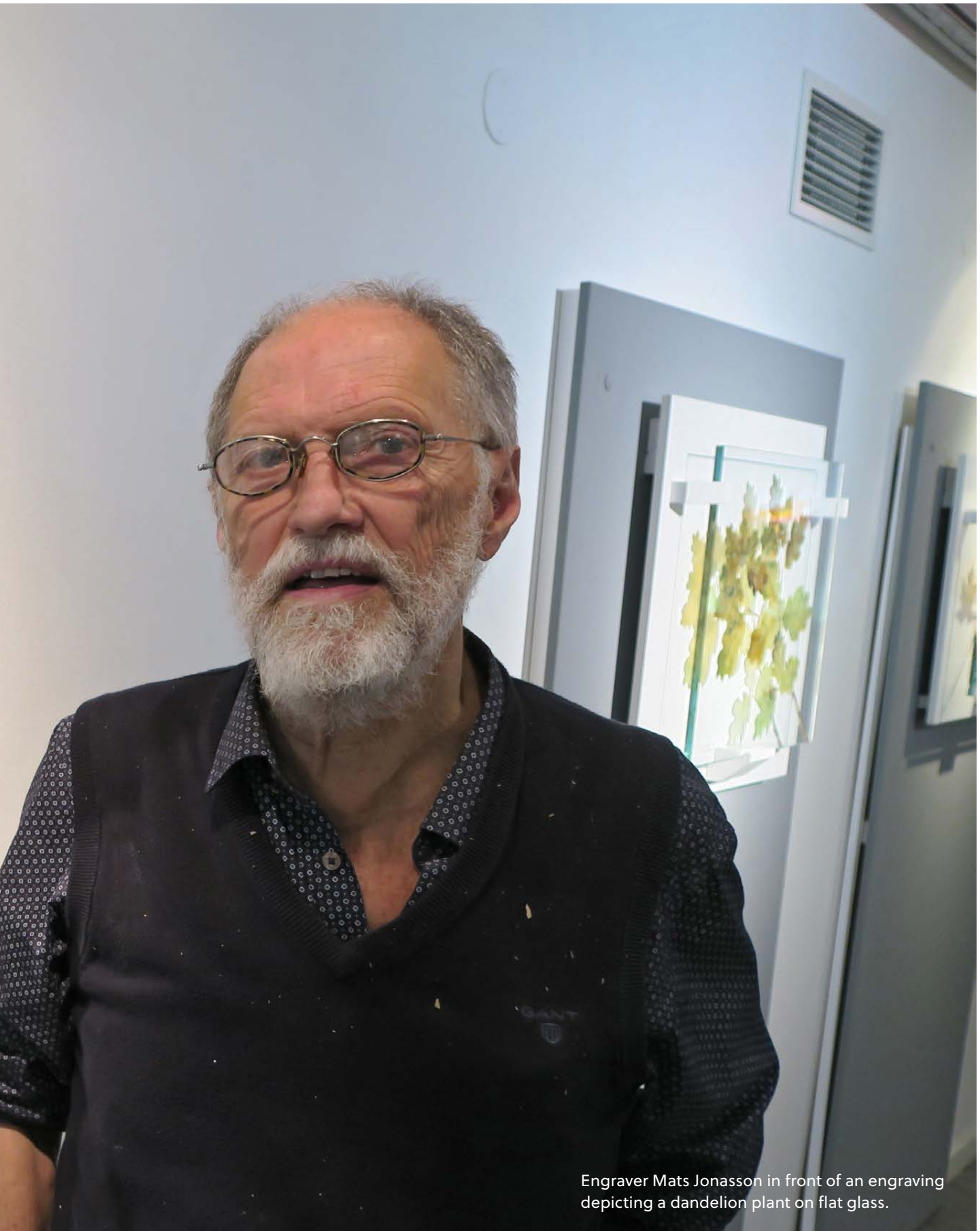
– conversation with engraver and designer Mats Jonasson

Mats Jonasson started as a 14-year-old in 1959, as an engraving apprentice of Folke Walwing at Målerås glassworks. Folke who in turn had been an apprentice at Orrefors under Simon Gate and Edward Hald was now a designer at Målerås. Mats had particularly good grades in drawing. The work at the factory for the young Mats essentially consisted of engraving "rummers", a then popular and rather expensive wine glass with meandering engraved vines on the cup. The glass was one of the bestsellers at the glassworks. In 1996, Mats shared in book form some memories from that time, "Just taking care of the tools was a whole science, then engraving was done with copper wheels and emery. And copper wheels were available in almost innumerable dimensions". Each object was teamwork between glassblowers, grinders and engravers. Mats recalls: "When you made seven hundred rummers seven hundred new ones came," "I could still do them in my sleep! But of course, it was an educational time, he adds. I learned not only to engrave but also tried other finishings and refinements of glass". Mats came to work at Kosta from the late 1960s and together with the factory employed artist Lisa Bauer (1920–2003) who gave room for improvisation with her drawings, which suited Mats Jonsson well. He understood that Lisa's beautiful flowers should be engraved with a light hand and not engraved in depth, something that broke the tradition at Kosta, and they started a productive collaboration. In the late 1960s, 22 grinders worked at Kosta. After some years Mats

was back at Målerås Glassworks, where in the late 1970s he developed the now well-known animal reliefs and crystal reliefs. The first motifs were otters, polar bears and seals. In 2018, Mats Jonasson continues to push glassmaking in the same way he has done since the start. At the factory, three engravers are all working in their 50s. Of the employees in production, 30% work in the hot part of glass production and 70 % in the cold glass production, which includes grinding and engraving. In the 1990s, Mats hired a Bosnian engraver, Robert Ljubez. He is now one of the factory's most experienced engravers. Robert was trained as an engraver and in his homeland where he worked with gravestones in black granite, the result being an engraved image of the departed.

Mats has recently made several engravings on flat glass with motifs taken from the surrounding nature. There are themes such as pussy willow branches and dandelions. For the dandelion engraving, Mats has used several different modern engraving tips that he alternated between during the work. Mats creates a three-dimensional effect on the "seed parasols" of the dandelion by working the glass plate from both sides and the result is a 3D effect. Mats looks forward to the future with confidence. The defining factor for the future is new ideas that can be translated into products that are appreciated by the buyers, according to Mats.





Engraver Mats Jonasson in front of an engraving depicting a dandelion plant on flat glass.

The grinding workshop and the energy supply

When Kosta Glassworks was built in 1742, as the first factory in the Kingdom of Crystal, there was no access to hydropower for use in the glassworks. The majority of the glass was probably made then as furnish finished products, with a hand opened edge. During the 1800s it became increasingly popular with different types of cut glass. Therefore the need for power to operate grinding wheels increased. During the 1700s and the beginning of the 1800's, discs were probably used which were driven by trampling power from the grinder, ie pedal-driven machines. The engraver also had a pedal-driven engraving machine. Over time, two smaller waterfalls that were located a few kilometres south and west of the glassworks may also have been used over time: Högaström and "The Mill". In 1840 a grinding workshop must have been set up at Högaströms mill (it is uncertain if it was built up inside the mill house or if a new building was erected). In the mid-1800s, however, this was not sustainable, and a completely new and very large grinding workshop was built along the country lane in the middle of Kosta. The house itself is also remarkable as it is built of large granite blocks and with lavish facade decor. This grinding workshop, which was completed in 1859, was driven by steam power. A steam engine drove the belts that operated the grinding chairs, up to 20 at a time. Despite the increased capacity with 20 grinding chairs near the glassworks, the demand increased further. Then Kosta glassworks built a grinding works at Johanstorp's glassworks, which was located about a mile north of Kosta. This workshop could relieve the workshop inside of Kosta. One problem, however, was the heavy, time-consuming and risky transport. The roads were poor and the glass was transported by horse-drawn carriage. Inevitably, some of the glass broke

on the way. Therefore, in 1840 a new road was built between Kosta and Johanstorp. Nevertheless, the transport was still risky and time-consuming. In 1901 a new grinding mill was built east of the new glassworks. These grinding chairs were also driven by a steam engine, but one much larger than the former. The steam boiler stood in a house east of the workshop. It reportedly had a drive wheel about two meters in size and the force was transferred to the grinding wheels utilizing a belt approximately 75 meters long and 50 cm wide. In the new grinding plant, the capacity had been increased so that 250 grinders could work with grinding. This development reflects the high demand for cut glass at this time.

Kosta was the only glassworks that existed in the Kingdom of Crystal until the 1860s. Surely, expansion is linked to the introduction of new laws meaning any common person was allowed to start a business. All these glassworks were built at waterfalls to use the power for grinding glass from the beginning. Several older mills that already existed were purchased and converted for grinding purposes, such as Boda and Åfors glassworks. In general, therefore, the oldest grinding workshops are directly adjacent to the river, while the blowing workshops are a bit further away, on more solid ground. The distance between the grinding shop and the blowing workshops could be about a hundred meters, but still meant a large amount of transport of glass between the blowing room and the grinding room, and back again. This caused a lot of problems and extra costs. The transport was solved in different ways. In the beginning, reliable ox and cart or horse and cart, or other custom-built small wagons pulled by manpower, possibly also hand-drawn wagons on rails, were



Group picture in front of the cutting workshop at Pukeberg's glassworks in 1918. The saw-toothed roof with windows on the shorter sides was built to let a lot of light into the workrooms. This type of roof has also become a symbol for the term "industry" Photo: KLM archive.



The large windows let in the light in the grinder's workshop, Boda glassworks in 1989. Photo: KLM archive.

used. In Pukeberg, a cableway was built between the grinders on the river and the glass workshop.

One of the challenges of the glass grinder in the past was to be able to have enough light to see the work, which requires high precision. One way to get more light to this part of the process was, therefore, to build particularly large windows in the grinding workshops. These large windows are still typical characteristics of an older grinding building. Before electric light made its entrance, except for daylight, workers used the light from kerosene lamps. In memories from Alsterfors glassworks, there are stories that the grinders turned up the wicks to get the flames as high as possible, but it also resulted in significant amounts of soot in the room.

Gradually, production facilities were collected closer together in older factories. Electricity became a way to solve it. Therefore, many glassworks were early to initiate and build water-powered electric power plants, at the dams they already had. The 1910s–1920s saw hydropower plants installed at many types of factories. In Boda, a generator was installed at the grinder's building on the river as early as 1911. In the same year, electric power plants were also built on the river by Johansfors Glassworks. In Alsterbro, a power station was built in 1918. Kosta Glassworks built electric power plants in 1920 at the old mill site Högaström. During the 1920s, Boda was able to get electricity via transmission lines. The electricity arrived at a transformer station, which was built in a typical 1920s style, and is still today an important historic building in the village. The new electric power was not only used for manufacturing, but an electricity grid was extended to all houses in the locality, since in principle all houses around these early small glassworks were a part of the glassworks. With electric power, it became possible to move the grinders buildings from the river to a location next to the blowing room. Many new cutting buildings and premises for engravers were erected. Most are made of wood, but some also in brick. They all had a typical feature, large high windows, for maximum light penetration. Examples of saw-toothed roofs that provided

overhead light were also constructed in other nearby factory villages, for example in Pukeberg and Flygsfors. Often the glassworks had several different grinding workshops, which had different names according to the production they were used for. The flower cutting workshop is an example of such a name, which refers to the very popular glasses in the 1930s and 40s with simple, cut flower patterns. The engraving workshop is another example. By the middle of the 1900s, development had continued. The glassworks then erected large glass working complexes in brick, where different functions existed under the same roof, such as the blowing room and the grinding shop, all on the same level. This period is characterised by the finished glass from the blowing workshop being placed in a “carpet” annealing oven with conveyor belt, and picked out at the other end of the belt, inside the grinding room. The time was over for heavy, time-consuming and risky transport of glass between the glassblower and the grinder. The transport of both products and raw materials from and to the factory had instead become a more important issue. The new glassworks that were built (or moved) in the early 1900s, when electric power became available, were no longer built nearby to hydropower, but instead by proximity to the railways.

Examples of older grinding houses in wood can be found in Alsterfors (1886–1980), Bergdala (1889–), Boda (1864–2003), Hjertsjö (1906–1936), Idesjö (1887–1937) and Skruf (1897–). Examples of older cutter buildings made in stone are found in Kosta (1742–) and in Boda (1864–2003) (in the old mill). Examples of grinding workshops that were initially integrated into modern glassblowing buildings from the 1940s to the 1960s can be found in Johansfors (1891–1991), Lindshammar (1905–2008), new Målerås (1917–), Nybro glassworks (1935–2007), Orrefors (1898–2013) and Strömbergshyttan (1876–1979). Examples of other special grinding buildings are in Flygsfors (1887–1979) and Pukeberg (1871–1977) – both have cutting buildings with saw-toothed roofs, Rosdala (1895–1989), Alsterbro (1871–1969), Gadderås (1875–1967) and Rydefors (1888–1970).

Resources

Interviewees

Björn Arfvidsson, Head of Department, Kulturparken Småland, Växjö.

Maja Heuer, Museum Director, The Glass Factory.

Mats Jonasson, engraver Målerås glassworks.

Anders Nylander, grinder Kosta Boda Glassworks.

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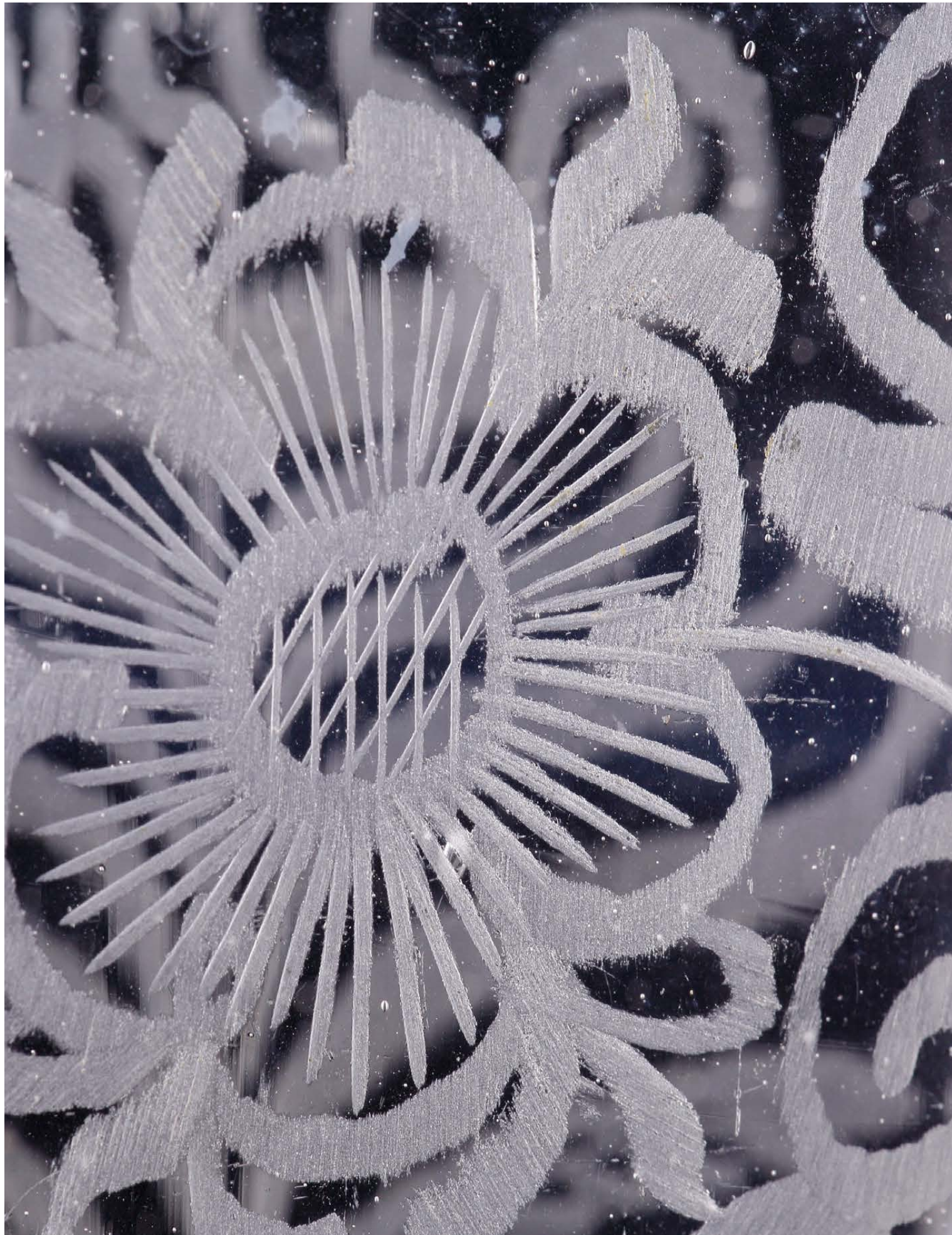
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