Machine Engraving of Platinum Seamless Bands

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Machine engraving of seamless bands is a unique surface finishing treatment achieved by diamond tool cutting to produce bright, reflective facets. The technique can be accomplished on manually operated or CNC type machines. Often referred to as diamond faceting or Swiss cutting, the process has been used for many years to enhance the appearance of gold seamless bands. Adjustments to the basic method are required to overcome the inherent difficulties associated with machining platinum. The specifics of hand engraving or chasing techniques are outside the scope of this documentation. Coverage of the topic includes the following:

- Illustrative examples of machine engraved bands.
- A brief history of previous documentation.
- Definition and examples of tooling requirements.
- Theoretical considerations.
- A review of practical techniques and issues.

All discussion and examples relate to machining 95%PtRu or 95% PtHTA® materials or combinations of 95%Pt alloys with 18K yellow gold. Figure 1 illustrates typical examples of machine engraved seamless bands. Cuts vary in orientation, depth and reflectivity to produce different effects.

Figure 1

Literature and Previous Studies:

Documentation on machine engraving of platinum seamless bands is comparatively sparse. In 1978, Roy Rushforth of JML Research described detailed machining conditions to achieve reduced tool wear cutting platinum alloys. He noted the poor performance of conventional tools when applying standard gold machining techniques. Figure 2 depicts deep, bright surface faceting achieved in platinum.

Figure 2

A section of literature contained in the 1990 publication, An Introduction of Platinum by JML, described the chip formation process and related machining parameters, tooling, and lubricants to surface finish with limited discussion of engraving methods. Figure 3 provides an illustration of details.

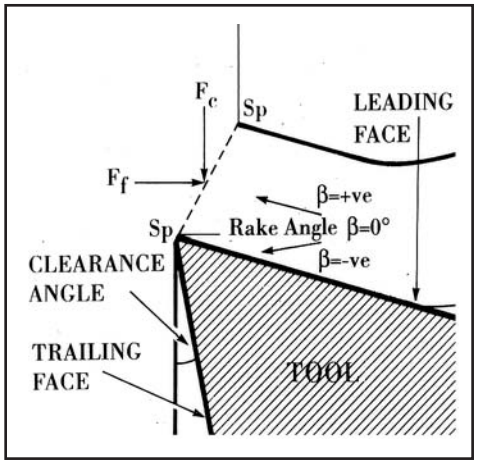

Figure 3

A discussion of platinum machining parameters was provided by T. Volpe and R. Lanam in their article Machining of Platinum Alloys for Jewelry presented at Platinum Day VII. Further work was documented at the Santa Fe Symposium in 1999 & 2000. This work focused predominantly on lathe cutting of platinum with no specifics related to engraving methods.

Normandeau & Ueno presented the results of machining studies on 95Pt HTA® materials at the 1999 Santa Fe Symposium. Specific advantages and superior tool performance utilizing an alternative alloy were noted. Examples of machine engraved bands were provided, but specifics related tooling were not discussed. Overall, there is not much literature published on platinum engraving techniques.

Examples of Equipment for Engraving Platinum:

A variety of manual and CNC type equipment is available within the trade to accomplish engraving of platinum bands. These can be single or dual tooling head manual units or 7 axis CNC configurations. Figure 4 shows a typical horizontal type unit where the ring is placed and rotated in a horizontal plane while the tooling is also driven on a horizontal spindle. Interaction between the tool and workpiece is achieved through manual vertical adjustments with the noted grip.

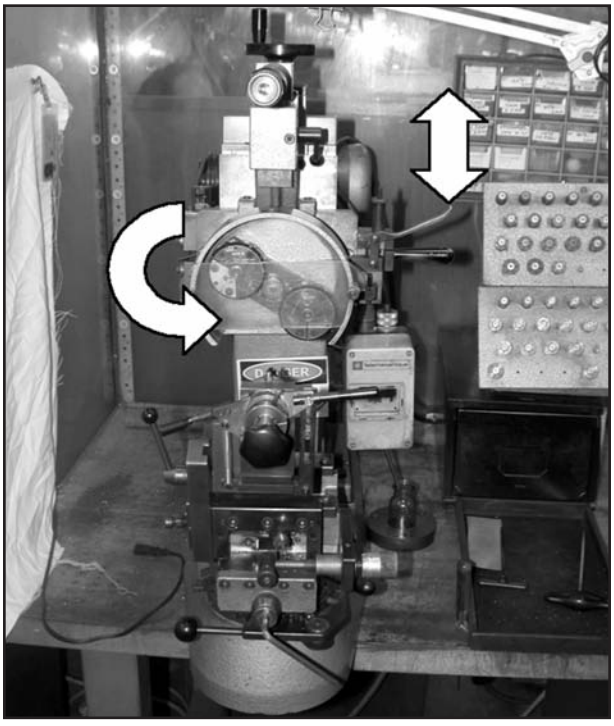

Figure 4: Machine Overview

Figure 5 illustrates the tooling spindle during rotation. This configuration holds 6 different tools for quick and easy changeovers. Cuts are intermittent based on delicate hand motions to lower the rotating tool into the same plain as the ring blank. This motion limits the width and depth of cut that can be achieved. Metal removal from transverse cuts occurs in a 6" radius dictated by the size of the tool holder.

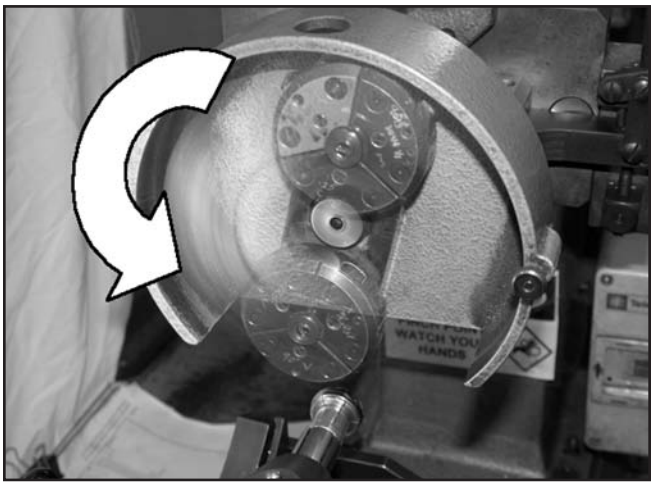

Figure 5: Spindal Detail

This limitation is overcome in a D-Head type unit where the ring is placed in an area within the rotation of a specially shaped spindal head that allows the diamond tool to track a radius similar to the one used to machine the ring profile. Long cuts that follow the ring surface with minimum depth are possible. Figure 6 shows an example of this tooling.

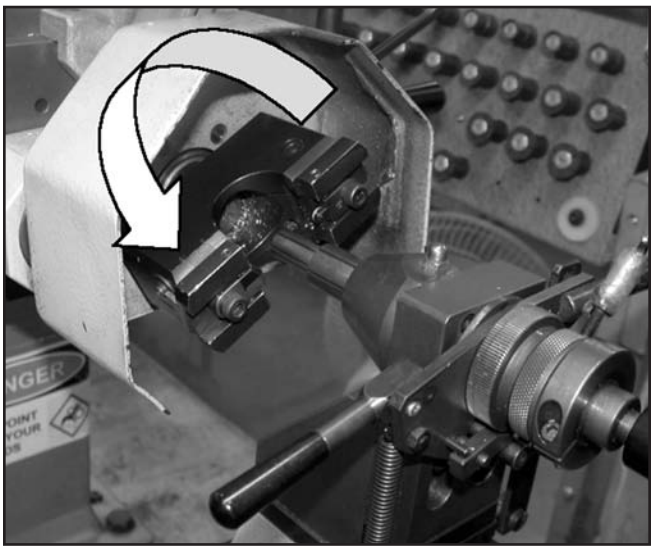

Figure 6: D-Head Unit

Detailed observation of the ring surface during cutting is achieved through a microscope on the unit. Graduations and centerline alignment provide a basis for controlling the cut geometry through depth manipulation during the engraving procedure. The ring can be continuously or discretely rotated in a horizontal plane.

A vertical type unit has the tooling spindle driven in a vertical plain. The ring can be adjusted to a variety of angles while the rotating tool is lowered onto the blank. A microscope is not fitted to this unit, making operation more difficult. Figure 7 illustrates the detail.

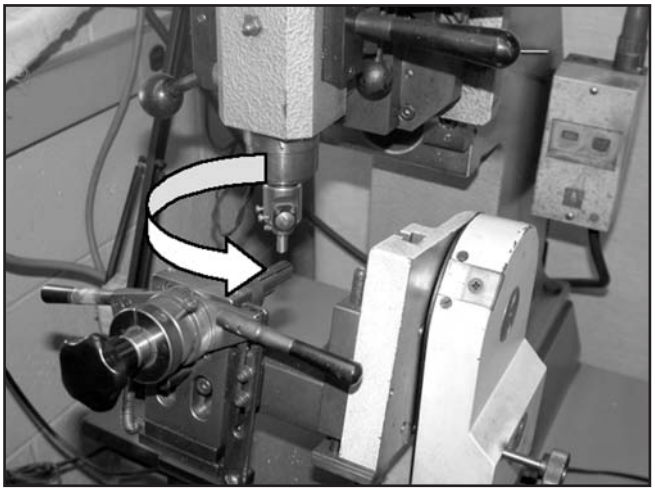

Figure 7: Vertical Unit

Manual type units are practical for small volumes or numerous setup changes. A broad variety of styles can be made, but tooling and machine changeovers become an issue. A combination type unit deploys a horizontal and vertical tool spindle on the same machine. A single ring blank holder travels on a bed to bridge the distance between heads. Rotation may be manual or servo-motor driven. Figure 8 shows a typical unit.

CNC type units provide an opportunity for enhanced productivity on volume runs of the same style. Thoroughly tested programming, specialized tooling and enhanced skills are required to maximize output on the units. A large capital and training investment is required. Normally, substantial volume or specialized work with diamond setting are required to justify the investment. Figure 9 shows a typical unit.

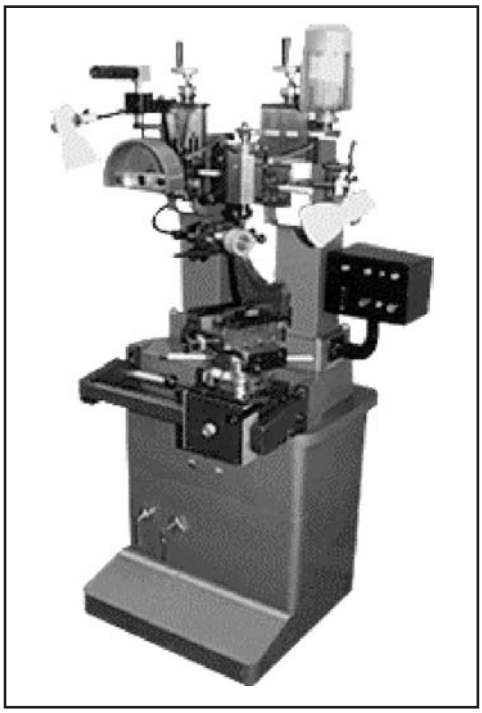

Figure 8: Combination Unit

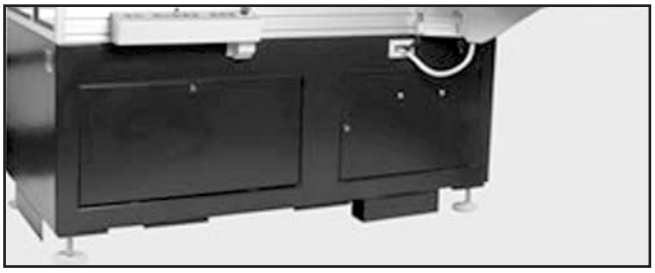

Figure 9

Theoretical Considerations:

Most of the published studies involved issues related to lathe turning or drilling. A selection of tool materials, feeds, speeds and lubricants were investigated to overcome platinum's inherent adhesive tendency. Consider the work piece to tool adhesion problem shown in figure 10.

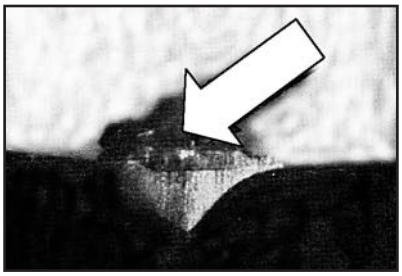

Figure 10

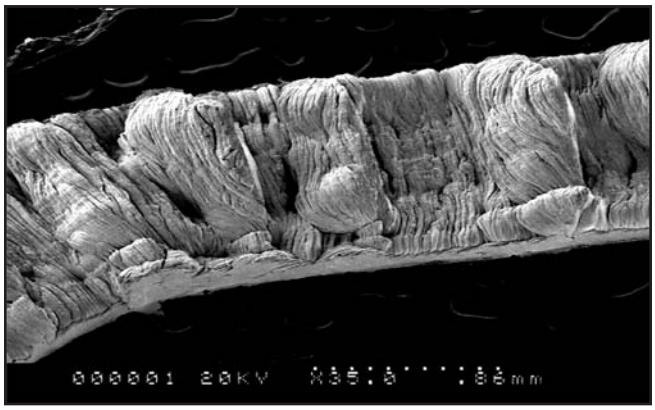

Figure 11

Machining conditions must be adjusted compared to conventional gold cutting to overcome the extreme work hardening rate of platinum. Figure 10 shows an SEM view of chip formation with 95%PtRu alloy.

The material in figure 10 hardened from 170 to 270 (HV) during the cutting operation. Conventional machining studies involved fixed tool, rotating workpiece conditions. Diamond faceting involves a rotating tool with a fixed workpiece. Variations in spindle speed are limited on manual machines. Flood lubrication is not possible. The chosen depth of cut is a significant process variable. Tooling design basics are summarized in figures 11 & 12. Conventional gold tooling has a blunt negative rake angle and a gloss flat that polishes the cut gold surface. This design cannot be applied for tooling that cuts platinum.

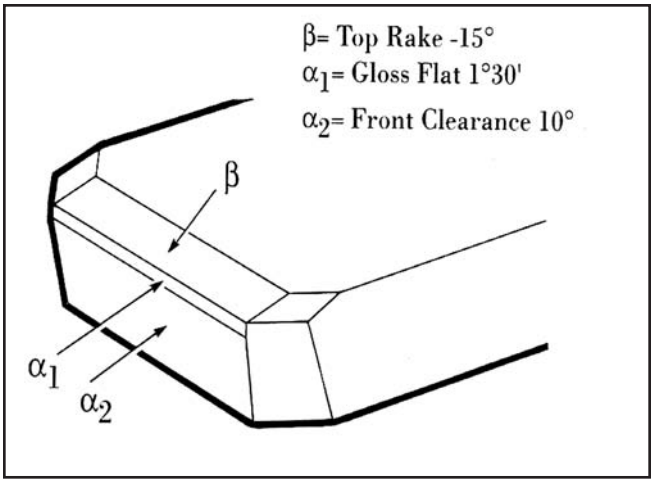

Figure 12

The extreme adhesion of platinum creates significant heat from friction on the gloss flat. Tool design is altered according to figure 13.

The positive rake angle provides less support for the cutting edge, but chip formation and clearance are significantly enhanced. The gloss flat must be eliminated. The inherently low thermal diffusivity of platinum requires steps to eliminate heat buildup at the tool face. Flood lubrication is essential to assist the cooling process and reduce reactions between the tool and workpiece.

Engraving Tool Design Issues:

Different tool designs are required for machining platinum compared to gold. Diamonds for engraving gold are natural specimens with controlled crystal orientation. Platinum tools are synthetic single crystal (sumitumo) or polycrystalline materials (PCD). Rake angles are set at 0_ for Sumitumo and -5_ for PCD type tools. Typical tools are shown in figure 13 & 14.

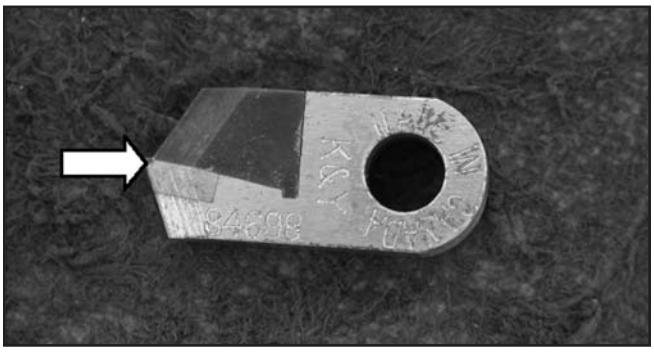

Figure 13

With this style of tool, the diamond, noted with an arrow, is brazed into place and covered with a screw fastened cap. A 6mm standard tool holder lock screw fastens it in place on the rotating tool. Vacuum brazing the tool into place eliminates the need for screw cap security, as shown in Figure 14.

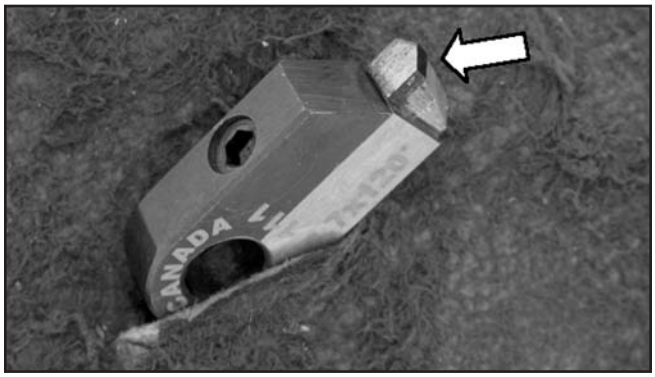

Figure 14

Diamond preparation for the final tool shape is achieved by grinding and lapping with progressively finer grades of diamond paste to achieve a smooth polished finish. Sumitumo type diamonds are purchased close to final shape. PCD diamonds can be EDM cut to shape from a larger mass. They are designed to experience slow, progressive wear of blunt shapes. Specialty shaped diamond products with small or large cut radii can be prepared as required. A larger shaped tool requires a more expensive large diamond as starting stock. Grooved tools, like the one shown in Figure 15, are made through patient grinding with a shaped brass master wheel loaded with diamond paste.

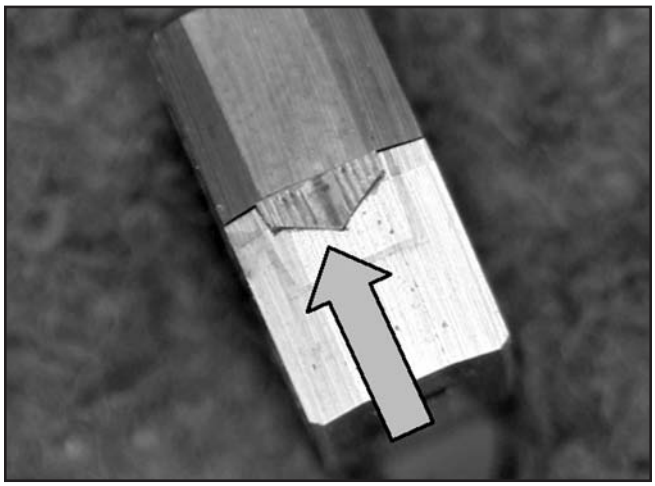

Figure 15

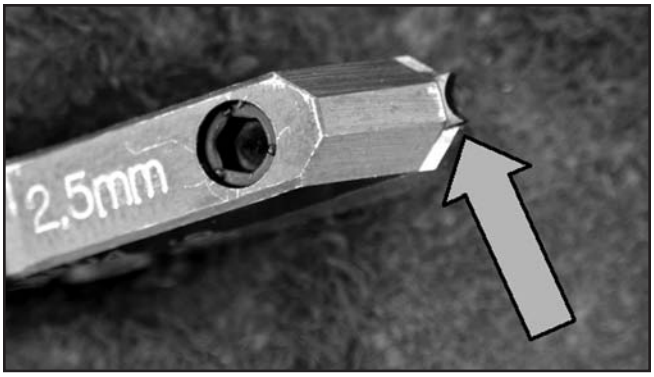

Figure 16

In general, natural diamonds have internal flaws that alter performance from one relapping (sharpening) to the next. Consistency and overall performance are much better with synthetic varieties, especially the predictable wear of a PCD type. A specialized set of tools for engraving only platinum will perform better over an extended period of time provided patience and caution are mixed with proper tool selection. The cost of sharpening is 1/8 to 1/20 of the original cost of basic tooling. Diamond tools dull much more rapidly (20-40X) during platinum machining compared to conventional gold cutting. Solid tool holders (like those associated with CNC equipment) reduce the rate of wear.

Practical Engraving Issues

Tooling speed of rotation is a critical variable in the process. It cannot be reduced significantly or discrete, large metal cuts will be visually apparent on the ring surface. Polishing to remove tool chatter lines may blur or eliminate the crisp detail of specific styles. High tool rotation speed minimizes surface chatter lines, but increases wear significantly.

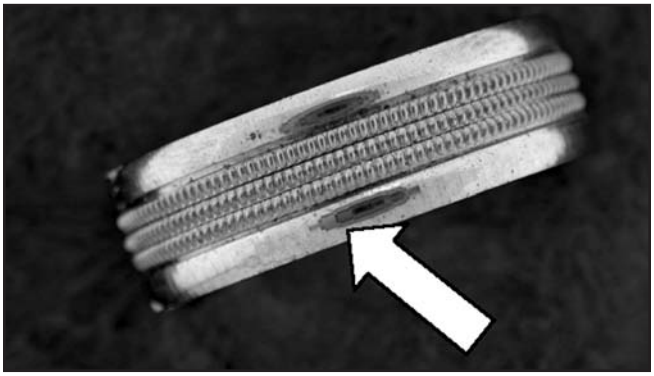

Figure 17

For optimum tool life when cutting platinum, it is imperative that a small depth of cut be used at all times. Patient repeated cutting reduces tool wear. There is an audible difference when an engraving machine cuts Pt as opposed to gold. More energy is required to shear platinum than gold. Careful coarse and fine depth of cut adjustments, noted in Figure 18, for a fixed speed of rotation are the main process variable to reduce high tool loads.

Lubrication is difficult to control with conventional high tool rotational speeds. Brushing thick oil of wintergreen or petroleum oil between cuts or coating the item with beeswax can assist lubrication. Continuous flood feed presents a major spraying problem on open manual equipment. An enclosed CNC unit affords some possibility for enhanced lubrication.

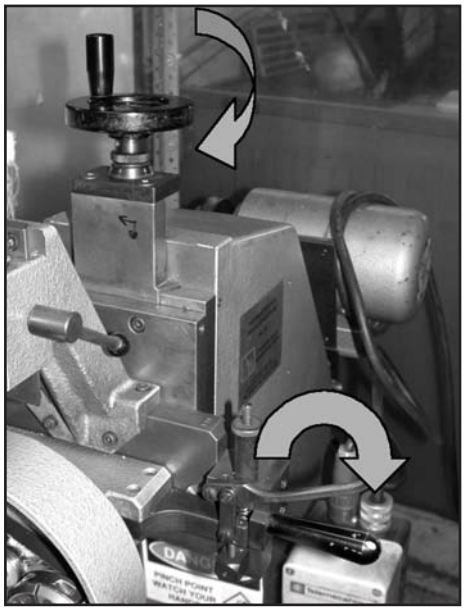

Figure 18

Examples of Engraved Rings:

A number of different styles are presented to show the flexibility in designs that can be engraved in platinum with various tools and equipment. For each style, the primary and secondary engraving equipment is noted for reference purposes.

Figure 19

Manual Engraved Eternity Band:
Narrow and wide deep grooves cut on horizontal unit. Multiple holes drill on vertical unit. This is a challenging style to engrave.

Figure 20

Manual Engraved Band:
Large and small radius cut around the circumference on a horizontal unit.

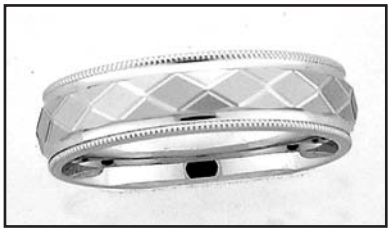

Figure 21

Manual Engraved Band:
Internal flats, grooves, convex and concave radii cut on a horizontal type unit

Figure 22

Manual Engraved Band:
Horizontal unit used to cut two grooves for rolling the beaded finish and one bright flat.

Figure 23

Manual Engraved Band:
D-head unit used to cut grooves that track the ring radius.
Horizontal unit used to cut grooves that accommodate the rolled bead pattern.

Figure 24

Manual Engraved Band:
Horizontal unit used to cut three domes. Clean cuts are required to ensure ease of polishing grooves, without flattening the domes.

Figure 25

Manual Engraved Band:
Horizontal unit used to cut fine grooves across the center and bright domes on the sides.

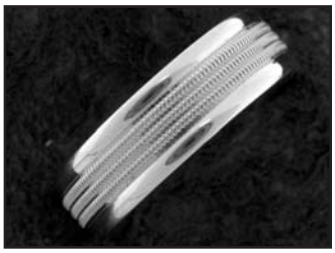

Figure 26

Manual Engraved Band:
Horizontal unit used to cut 2 grooves and 2 edges of platinum inlay for clean rolling of 3 bead rows. Minimal cleaning must be required to avoid damage of the 18K gold.

Figure 27

Manual Engraved Band:
Horizontal unit used to produce clean cut domes. Poor engraving finish could cause the center yellow bead to be damaged during polishing.

Figure 28

CNC Engraved Band:
Stone settings from platinum section require numerous delicate and deep cuts. Section brazed into gold band. 95Pt HTA® assists with metal removal.

Figure 29

CNC Engraved Band:
Bright cut deep channel for stone setting.

Figure 30

CNC Engraved Band:
Ring circumference engraved to reduce section thickness on lower shank. 95 Pt HTA ® assisted with material removal. Numerous deep and shallow grooves cut for stone setting.

Summary:

With the use of specially designed diamond tools, it is possible to engrave a broad range of styles in platinum or 18K-platinum combinations. This can be accomplished on either inexpensive manual or high volume CNC machines. Engraving parameters must address the adhesiveness, low thermal diffusivity and high rate of work hardening inherent to platinum. Limitations of the fixed workpiece rotating tooling required by engraving equipment must be recognized. Control of the spindle speed and lubrication are limited. Engraving diamonds for platinum should be dedicated to the task and specifically designed with different rake and relief angles compared to gold tooling. Synthetic single or poly crystalline diamonds are required. Be prepared for more frequent tool sharpenings compared to gold engraving. Do not attempt to re-sharpen your tools with in house techniques. Work closely with your tooling supplier to resolve issues and try different designs. Consider alternative 95% Pt alloys to assist metal removal during engraving. Patience is a virtue when engraving platinum.

Acknowledgments

- Tooling samples and technical advice supplied by K&Y Diamonds
- Engraved samples from figures 19-22 from Atlantic Engraving of Montreal
- Samples from figures 23-27 from Imperial Smelting
- Stone set engraved samples from figures 28-30 from Art-Tec Jewelry Designs of New York