

# Stone casting process with invisible setting

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## Abstract

Casting with stones in general has now been known of and practised for many years, although great progress has been made and importance gained in more recent years, due to rationalisation in production and increase in quality.

The main reason for developing the stone casting process with invisible setting was the need to drastically decrease costs with the use of synthetic stones or cubic zirconia. In fact, these stones are extremely suitable as their measurements are usually regular and they are already prepared for invisible setting.

## Keywords

Invisible setting, cubic zirconia, diamonds, ruby, sapphire, synthetic stones, princess cut, resistant, pressure of metal, purity, Square, rectangular, hexagonal, pentagon, acute angles, groove, girth, stone grooving machine, modelling in wax, model, prototype, rapid prototyping, Cad/Cam, modelling in metal, geometrical shapes, lathe, milling machine, support net, plate and wire, rubber mould, silicon, caoutchouc, vulcanisation, shrinkage, RTV, release cut, injection wax, plastic, flexible wax, special tool, positioning the stones, liquid or pasty wax, small space, magnifying glass, naked eye, embedding, liquid additive, coat, special investment, mixing instructions, boric acid, steam de-waxing, burnout oven, burnout cycle, burnout time, casting temperature, alloys, de-oxidising agent, centrifuge, suction/pressure, melting, palladium with gold, cool gradually, thermal shock, flask cooling time, finishing, automated systems, media, compounds.

## Introduction

For many years now I have been researching new solutions and procedures to improve and rationalise the production of jewelry, especially in the lost wax casting field.

Excellent results have been obtained in the following procedures:

- modelling techniques in wax, resin and alternative materials;
- casting of filigree or other extremely thin objects;
- casting of chains or objects with connecting pieces;
- union of different metals such as platinum, white gold, yellow gold, silver, etc., through casting (Bimetal casting)
- shiny surface casting;
- platinum casting and working techniques;

- casting with stones: diamonds, rubies, sapphires, garnets, synthetic stones and cubic zirconia and also emeralds cast with palladium white gold.

Owing to the need to reduce costs of invisible setting with cubic zirconia or synthetic stones, I started to look for a solution to replace hand-setting as this is too costly compared with the price of stones. However, this method is also extremely suitable for diamonds, rubies and natural sapphires.

This research project was supported by the firm Swarogem Austria, which also supplied the stones for several experiments. In the meantime, this method of setting has already been introduced by us to several firms in Italy, Turkey, Thailand, Indonesia and the USA, which are using it successfully.

*These are the advantages:*

- Setting stones in wax (invisible) is easy to learn and very fast compared to setting by hand. Example: it would take approximately 6 hours to set a ring with 30 stones by hand, whereas setting a ring with 30 stones in wax takes approximately 20 minutes.
- Stones are set more securely and the risk of breakage or losing stones decreases dramatically.
- This system can be carried out with standard casting equipment and would need only a few special tools and pieces of equipment which are not expensive.
- Princess Cut diamonds, rubies, sapphires, cubic zirconia and synthetic stones can be used for this system and it is possible to cast in red, white or yellow gold and even silver.
- Only a minimum training session of a few days is required to transfer this technology and start the system of casting with invisible setting in wax.

**Procedure**

*Suitable stones*

Diamonds are without doubt the most suitable stones, as they are the most resistant to the pressure of metal. Rubies and sapphires do not create great problems, as long as they are of a certain purity and have been cut as regularly as possible. The most delicate stones for this procedure are cubic zirconia, garnets, tourmaline, etc..

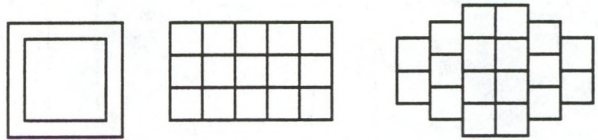
**Suitable cuts**

Square or princess cut is without doubt the most widely used and suitable for invisible setting, although rectangular and hexagonal shapes may also be used.

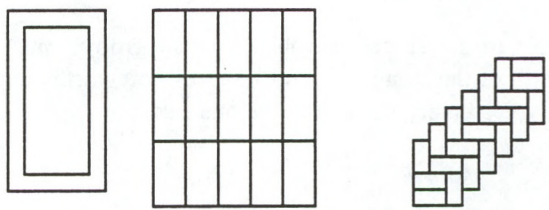
For the choice of cut it is important that when a group of stones are placed side by side there are no empty spaces between them, in such a way that the metal is not visible below the stones.

Some examples:

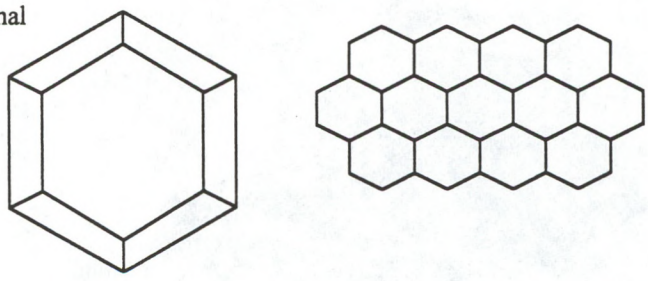
1.) square



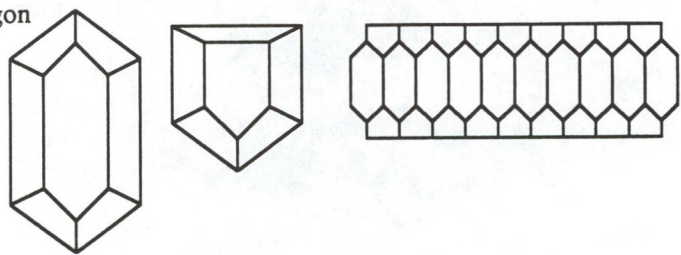
2.) baguette



3.) hexagonal

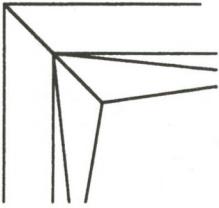


4.) hexagonal + pentagon

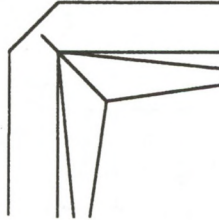


*Preparation of the stones*

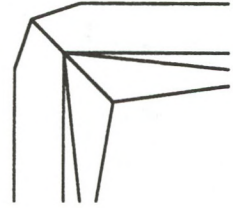
1. To make stones more resistant to breakage caused by pressure of the metal, acute angles must be dealt with in the various ways indicated below.



Critical -

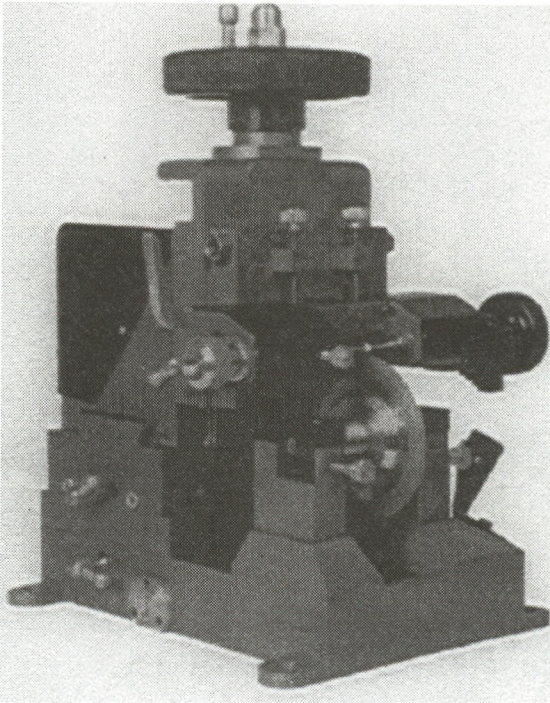


good -



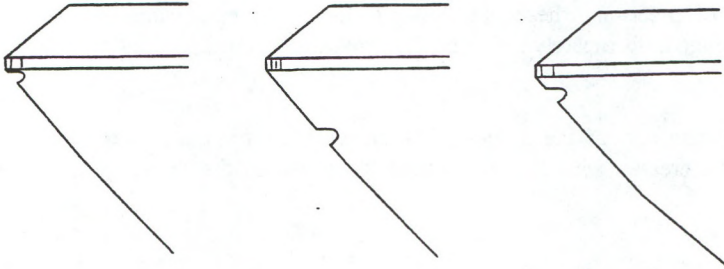
best solution

2. To be able to set stones invisibly, a small groove must be effected under the girth of the stone. This cut requires noteworthy experience and the use of a special machine such as the one below.



Stone grooving machine for diamonds and coloured stones in a wide range of shapes, such as princess, baguette, hexagon and others. Presented by Gesswein USA.

*These are the various systems and criteria for cutting a groove under the girth of the stone:*

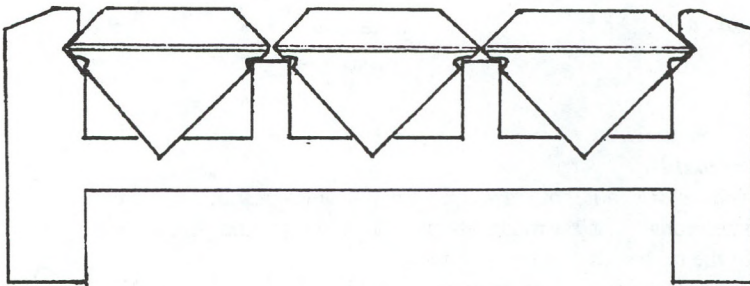


*to high*  
stone get  
broken easily

*to low*  
groove is visible  
from above

*best solution*

*Cross section of a support net with stones*



### *Preparing a suitable prototype*

There are different methods for preparing the model.

#### *1.) Modelling in wax:*

to create the model by hand with simple bench equipment, requires a high degree of dexterity and precision, for those who do not have the chance to use rapid prototyping (CAD/CAM).

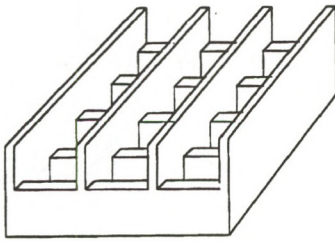
#### *2.) Direct modelling in metal:*

this methods is above all suitable for models with extremely geometrical shapes. A lathe or milling machine can be used to help. The support net for stones can be made with the aid of a milling machine or directly with plate and wire.

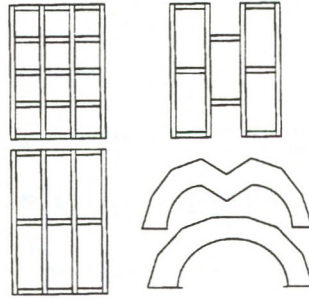
### 3.) *Rapid prototyping:*

the various systems are described and illustrated in the book "The Santa Fe Symposium" by Mr. Bud Krahn, page 447, 1998 edition. Due to their high degree of precision, these are without doubt the most suitable systems, although unfortunately they have high investment costs.

The most delicate part of the model is the *support net* for the stones, which must be created with specific criteria illustrated in the drawings below.



"Support net"



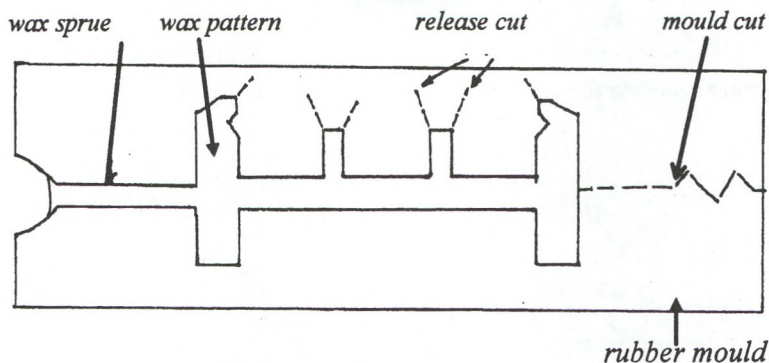
### *The rubber mould*

If silicone rubber or caoutchouc are used for hot vulcanisation, all of the model's dimensions must be made about 5% larger to compensate for shrinkage of the rubber.

This is not necessary when using rubbers for cold vulcanisation type RTV silicone, such as the series "Ditto TM Mould compounds" by **Rio Grande**.

To obtain perfect waxes, it is imperative to make release cuts in the rubber along the corners of the support net.

### *Cross section of the rubber mould*



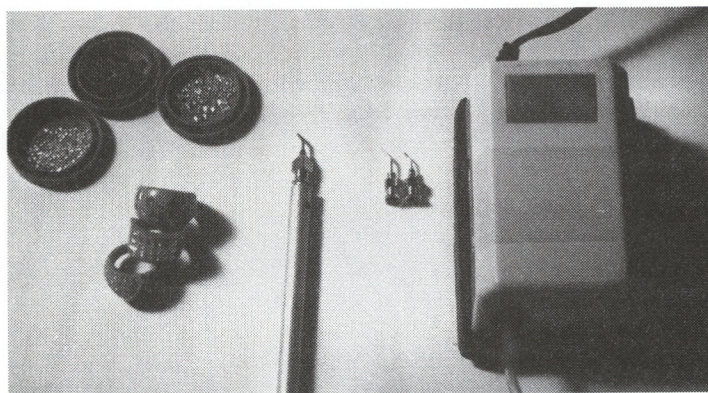
### *Injection waxes*

It is advisable to use elastic or flexible waxes, coloured blue if possible, such as "Plast-O-Wax", "Flexiplast", "Magnaject" or similar.

Each wax must be checked thoroughly and repaired and cleaned if necessary.

### *"Setting" the stones in wax*

A special tool, such as VACU-SET must be used to position "set" the stones in the wax rapidly without damaging or scratching the latter

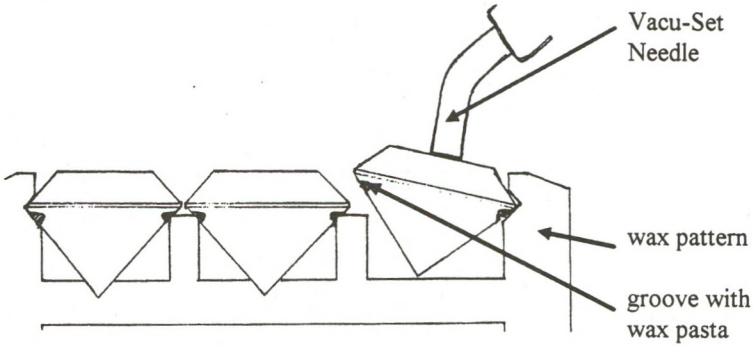


Before positioning the stones in the wax, "grooves" must be filled with liquid or pasty wax, such as "Disclosing wax" by Kerr.

When setting delicate stones such as cubic zirconia, garnets, tourmaline, etc., it is imperative to leave an extremely small space between the stones to prevent these from breaking after the metal is cast. Diamonds, rubies

and sapphires are less delicate and can be placed closer together. The space between stones must only be visible with a magnifying glass and not to the naked eye (about 0.05 mm).

### *Setting stones in the wax*



### *Embedding*

When casting with diamonds it is imperative to use a liquid additive such as "Pro-Tech:D or to coat the tree with a special investment such as "Goldstar Gem Set". It is important to comply strictly to the manufacturer's mixing instructions.

It is not essential to use additives or special investments for stones such as rubies, sapphires, garnets, tourmaline, etc., although this improves the quality of the casting.

It is **not advisable** to use these special products which contain boric acid with cubic zirconia stones, as they impair their shine.

### *De-waxing*

It is advisable to use steam de-waxing before placing the flasks in the burnout oven.

### *Burnout cycle*

- for diamonds and emeralds
 

max. burnout temp.	630°C	time 6 h
metal casting temperature	480°C	-530°C
  
- for cubic zirconia, rubies, sapphires, garnets and synthetic stones
 

max. burnout temp.	680°C	time 5 h
metal casting temperature	550°C	-600°C



***Suitable alloys and casting***

Alloys containing de-oxidising agents and with low shrinkage rates are the most suitable. Stone casting with invisible setting can be implemented with silver, yellow-, pink- and white gold in all karats.

***Melting and casting method***

Melting can be effected with the centrifuge system or with suction/pressure. If melting with palladium white gold it is advisable to use a centrifuge with vacuum and to accurately measure the temperature of the metal. A good melting plant will give a better and, above all, a more constant product quality.

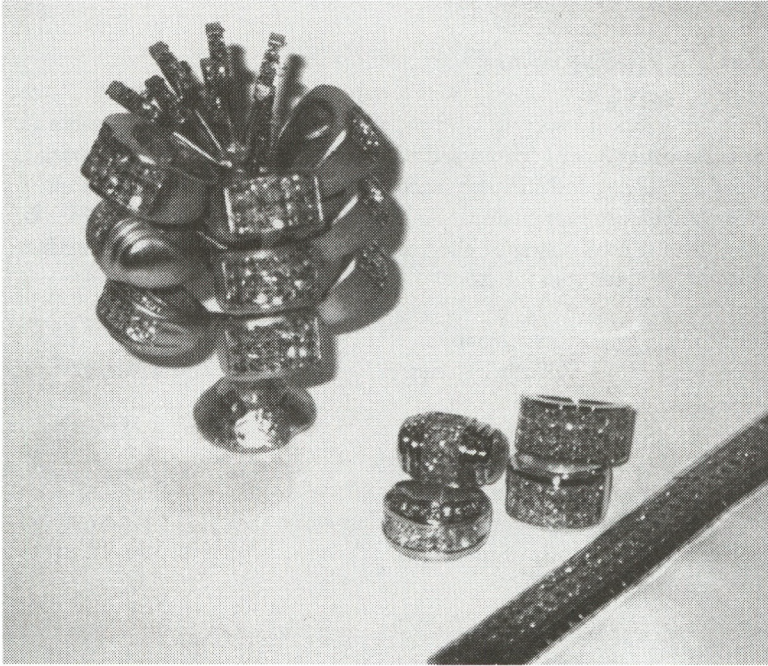
After melting, flasks must be allowed to cool gradually to prevent thermal shock which could ruin the stones.

Flask cooling time:	only diamonds	20 minutes
	all other stones	60 - 120 minutes

***Finishing of cast pieces***

Cast pieces may be finished with traditional methods by hand or with automated systems, as long as the compounds and added products are suitable for the hardness of the stones.

*Casting tree in gold with invisible setting and some finished rings and bracelet.*



### *Thanks*

Swarogem Austria for its economic support and for supplying the stones;  
 Equipe Traduzioni for their translation from Italian to English  
 Mr. Jamey Seiverling for his external technical collaboration;  
 Mr. Marco Raselli for his external technical collaboration;  
 Mr. Max Nart for his internal technical assistance;  
 My daughters Nathalie and Emily for their motivation.

### **Future research and experiments:**

- stone casting with platinum, steel and titanium alloys;
- cold "wax injection" system;
- alternative investing materials and systems for platinum, steel and titanium alloys;
- workable blue gold and blue silver;
- and others