Synthetic Gems and simulants

- Synthetic gemstones have the same properties as natural gems, but they are created in a laboratory.

- Material that is used as a substitute for a gem material, but is of a different chemical composition is a "simulant".

- The best example of a simulant might be the substitution of Cubic Zirconium for diamond.

Synthetic gems

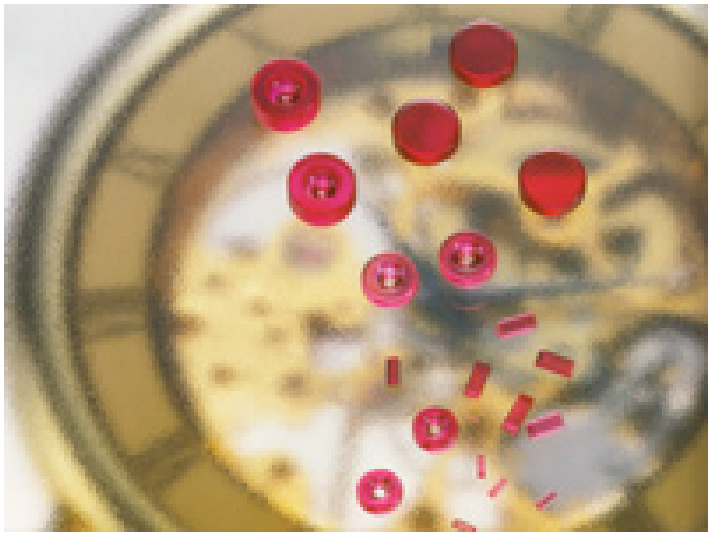
- There are quite a few methods for making synthetic gems and minerals.
- Not all synthetic minerals are used solely as gems for instance,

➢ synthetic diamond can be coated onto windows to make them scratch resistant.

➢ Synthetic sapphire is used for making watch bearings (jewels) that resist wearing.

7 Jewel watch

- These are watch jewels
- They are used as bearings
- They resist wear



Synthetic gems

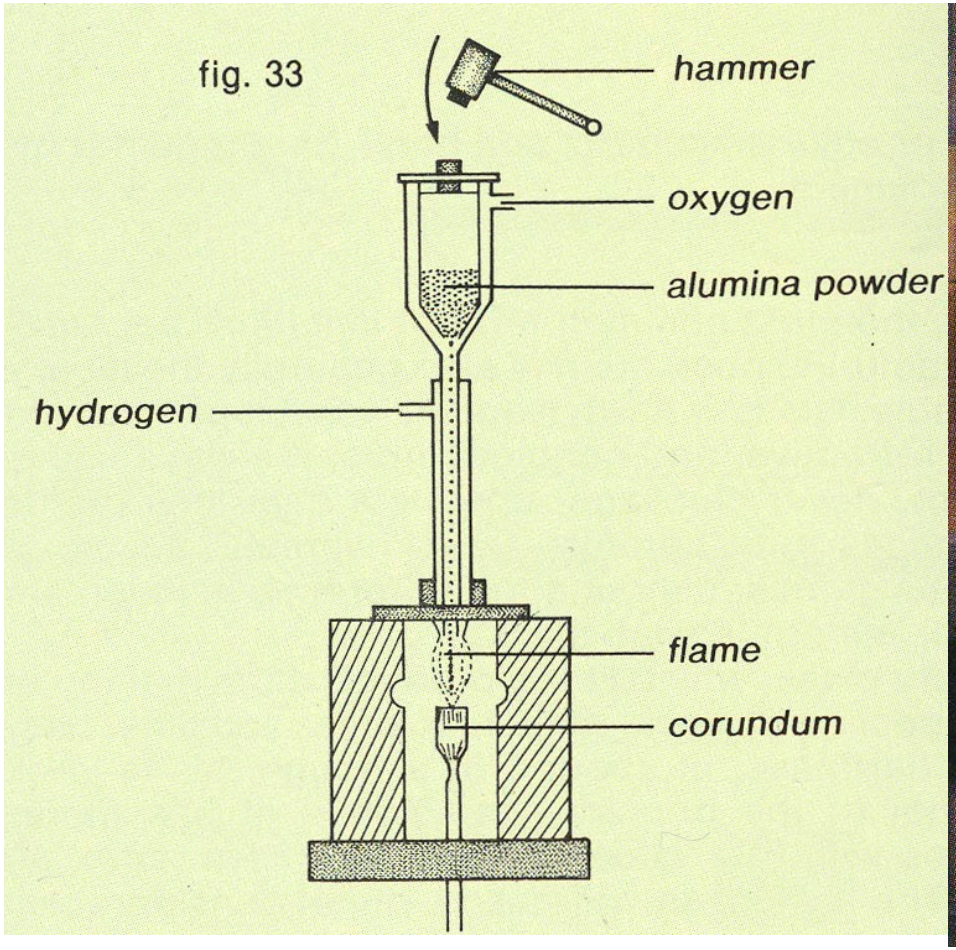
- Posses all the properties of natural stone
- They may be purer and look better
- They are cheaper than natural stones and some are mass produced.
- Everyone wants the real thing, but sometimes a good synthetic or simulant will suffice till the big bucks are available.

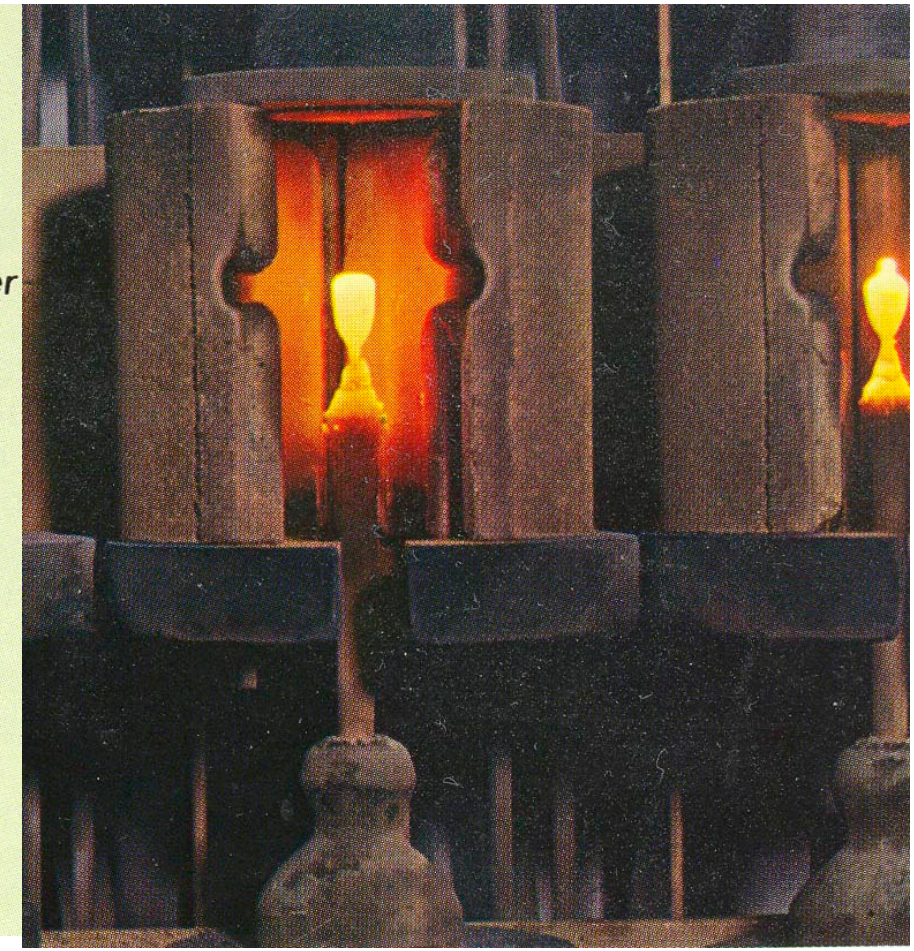
Methods of production:
Flame Fusion or the Verneuil method

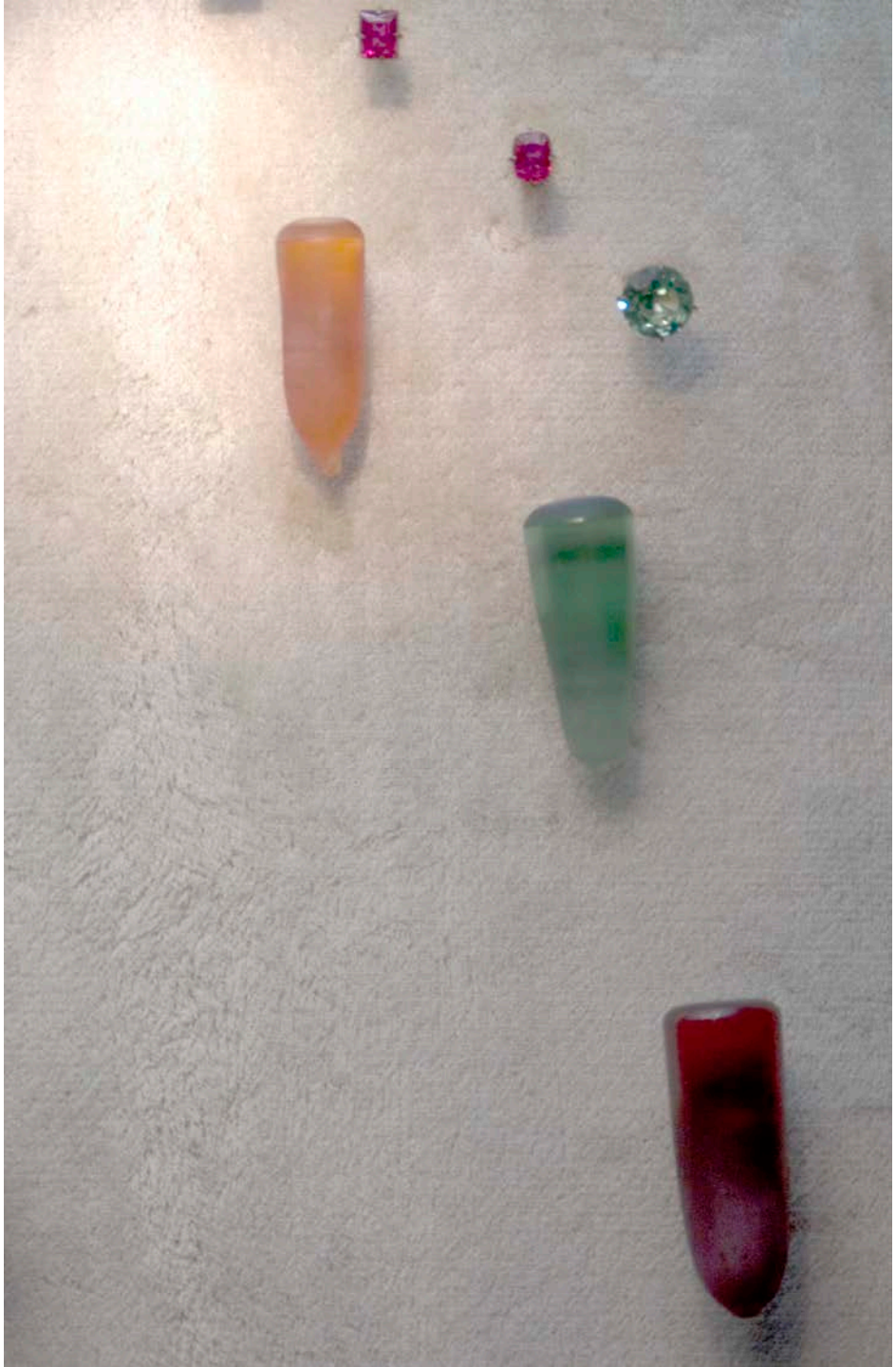
- Developed in the early 1900s, by August Victor Lewis Verneuil for production of ruby, and sapphire. It can also be used to make spinel, star rubies & sapphires, and simulants such as strontium titanate & rutile.

- Powdered material is melted as it drops through a flame. The melt falls onto a growing 'boule' crystal that is lowered as it grows. The carrot-shaped 'boule' can be several inches long and weigh a few hundred carats.

Verneuil Method





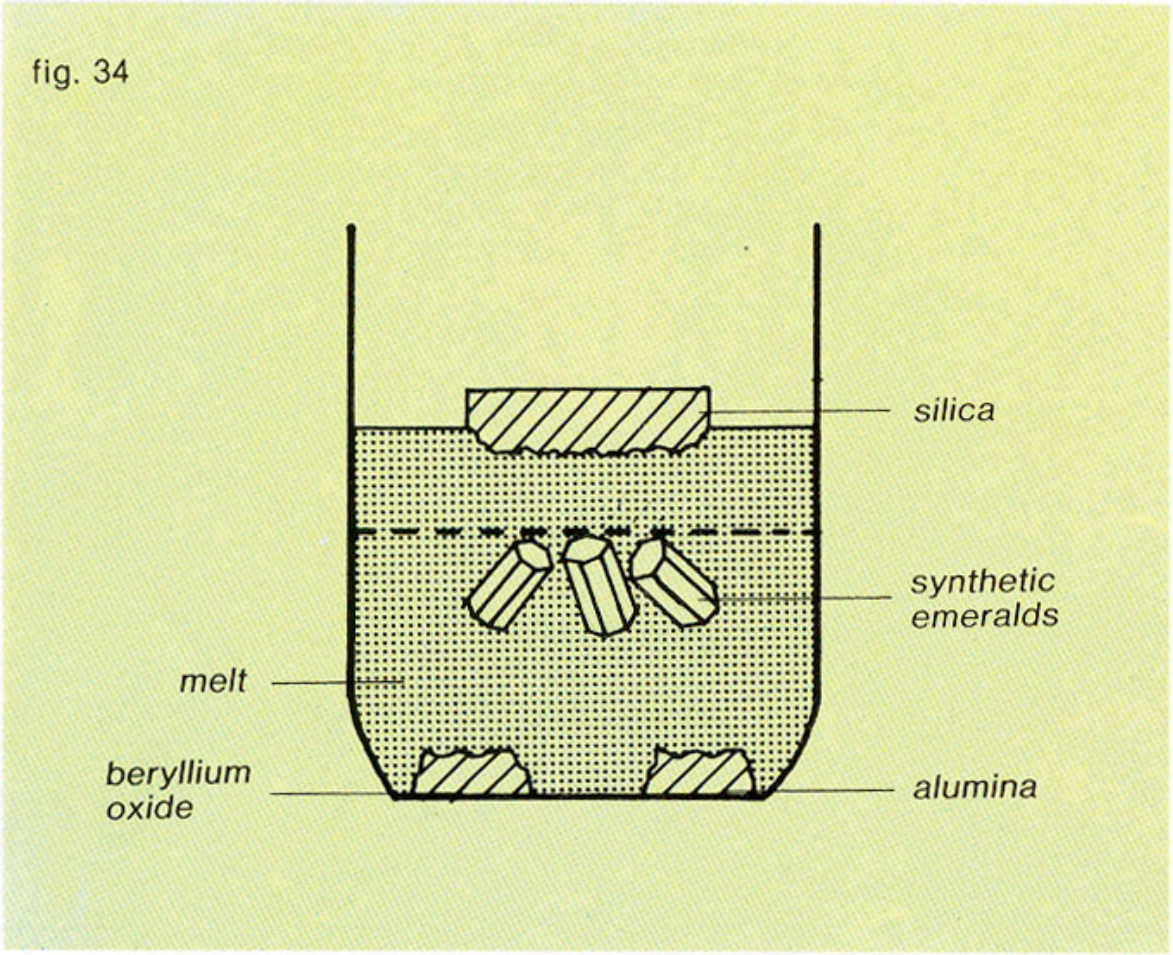


Boules and partly faceted stones

Flux Fusion

- Rocks and minerals melt at high temperature. Adding flux lowers their melting point and allows you to grow gems in the laboratory.
- Flux method is used to grow: Emeralds, Rubies, rarely Sapphires,

Flux Fusion in a Platinum Crucible



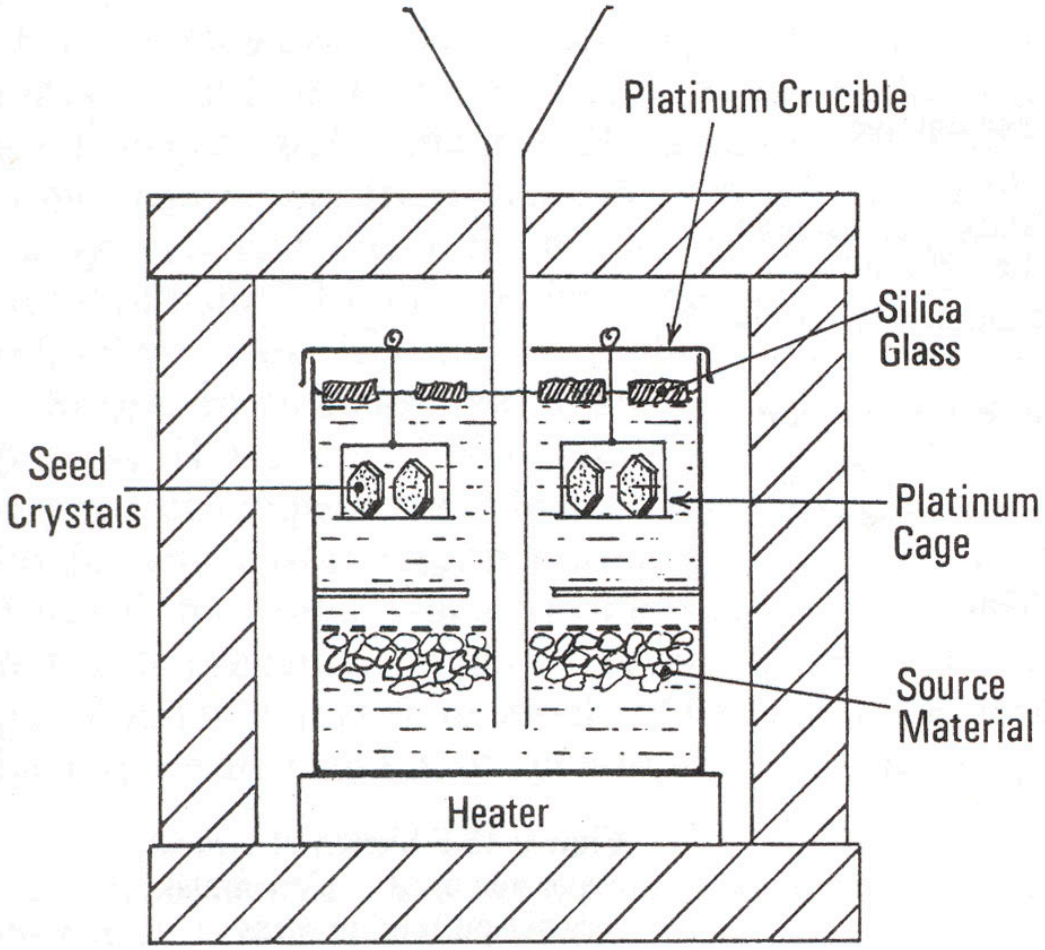
Ramaura Synthetic Ruby

- Platinum Crucible in oven

Pouring Off Flux

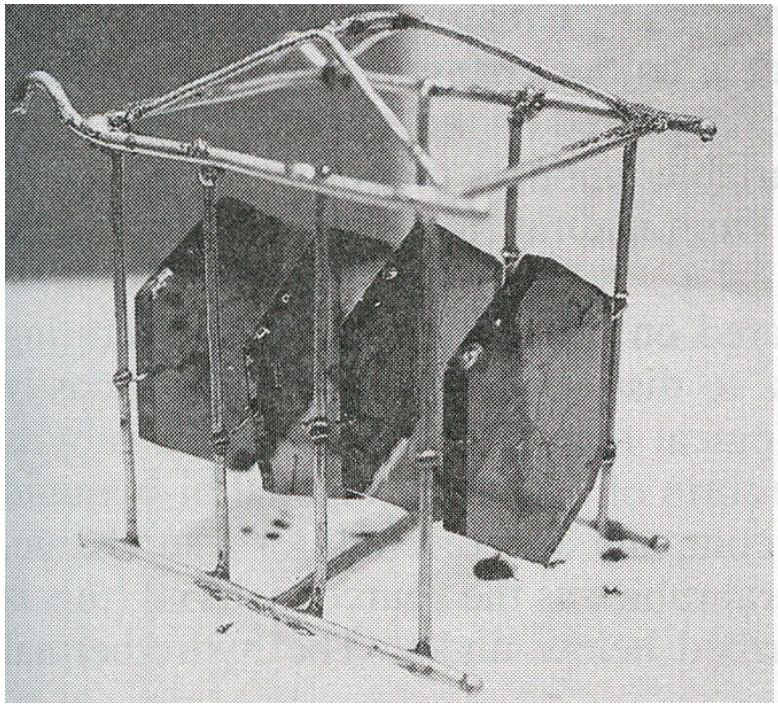
The Results

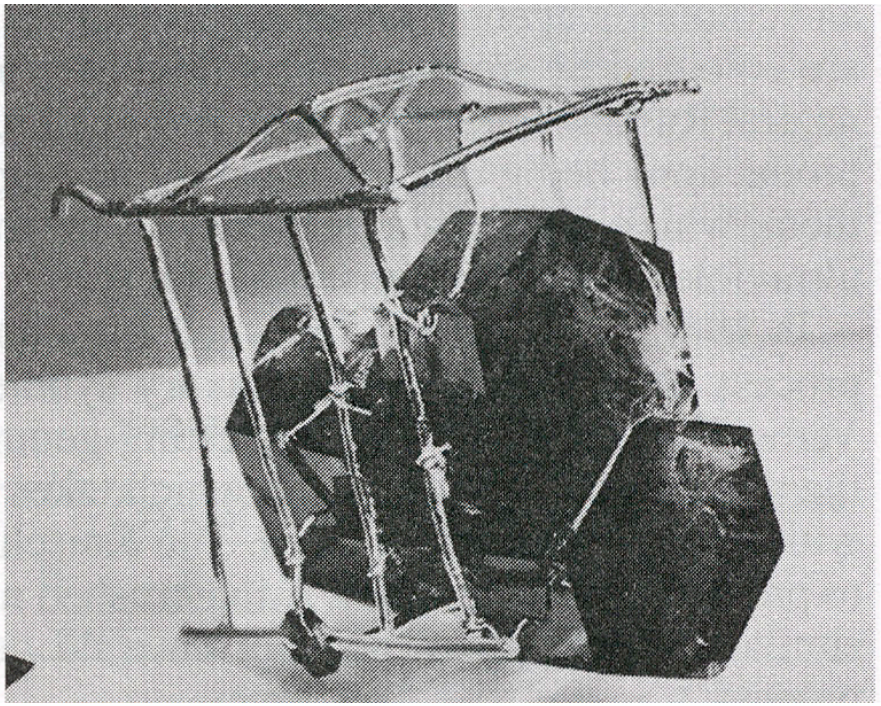
Hydrothermal Bomb



Synthetic Hydrothermal Emeralds

- Page 179 of Read Gilson synth emerald

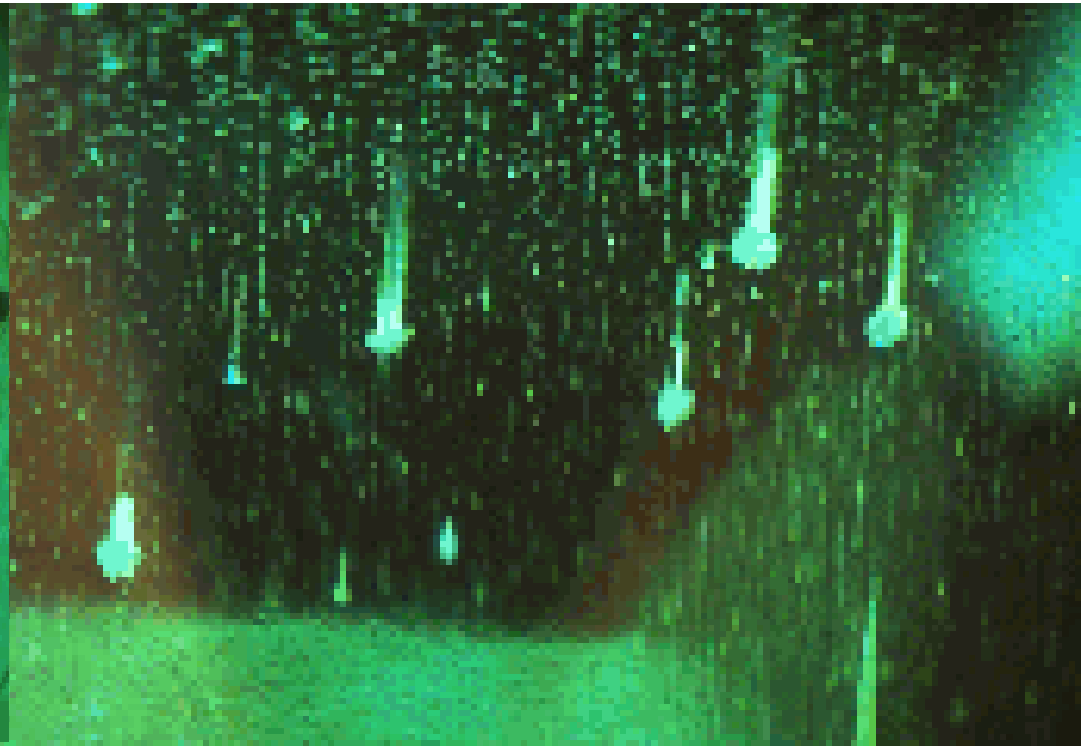




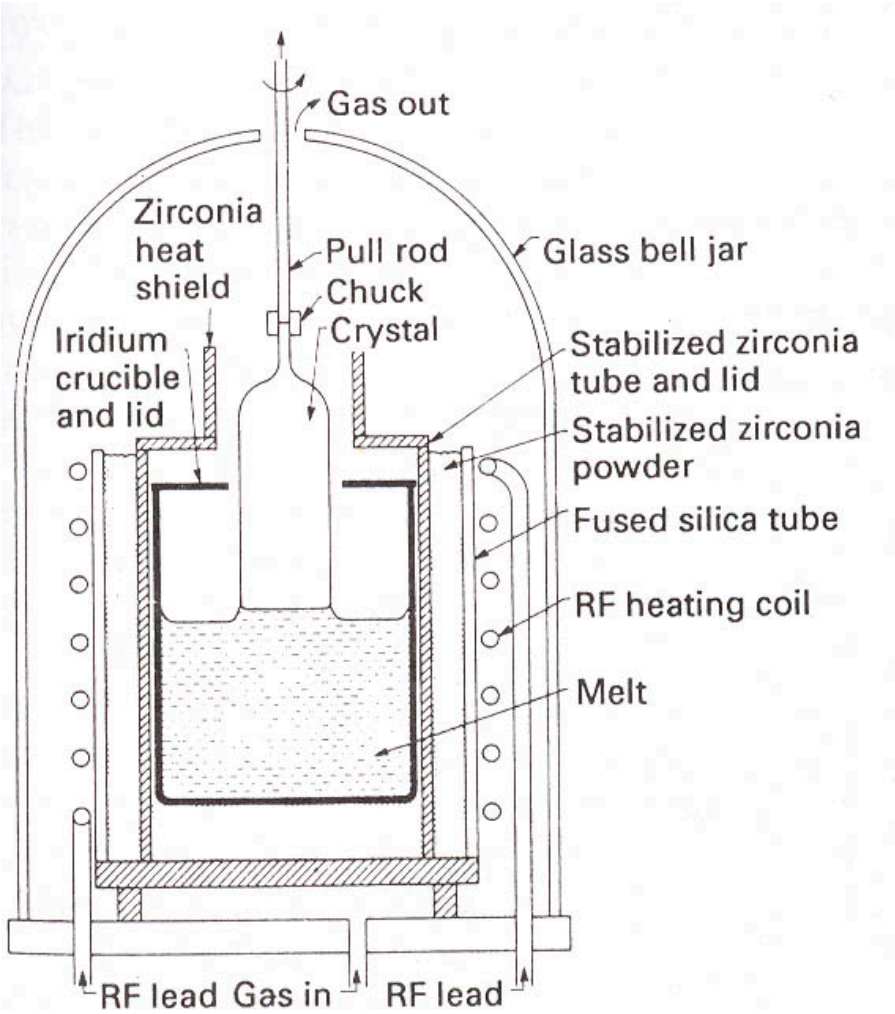
Hydrothermal crystals are well formed

Synthetic Crystal inclusions

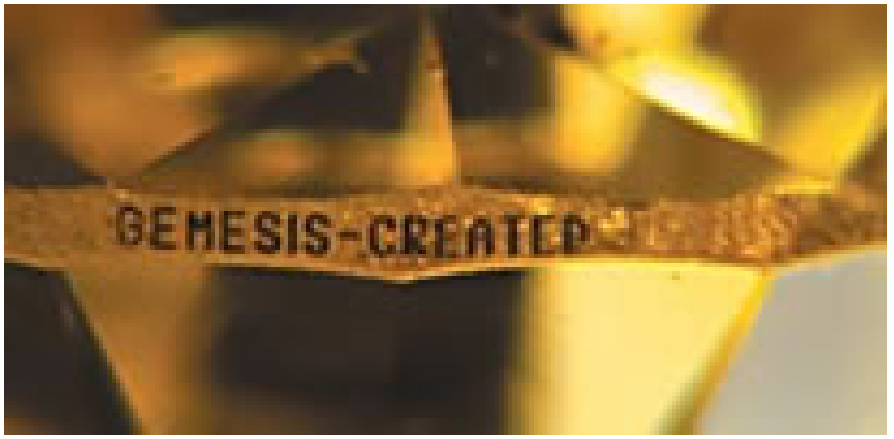
- Phenakite is not found in nature
- Parallel phenikite is hydrothermal in origin



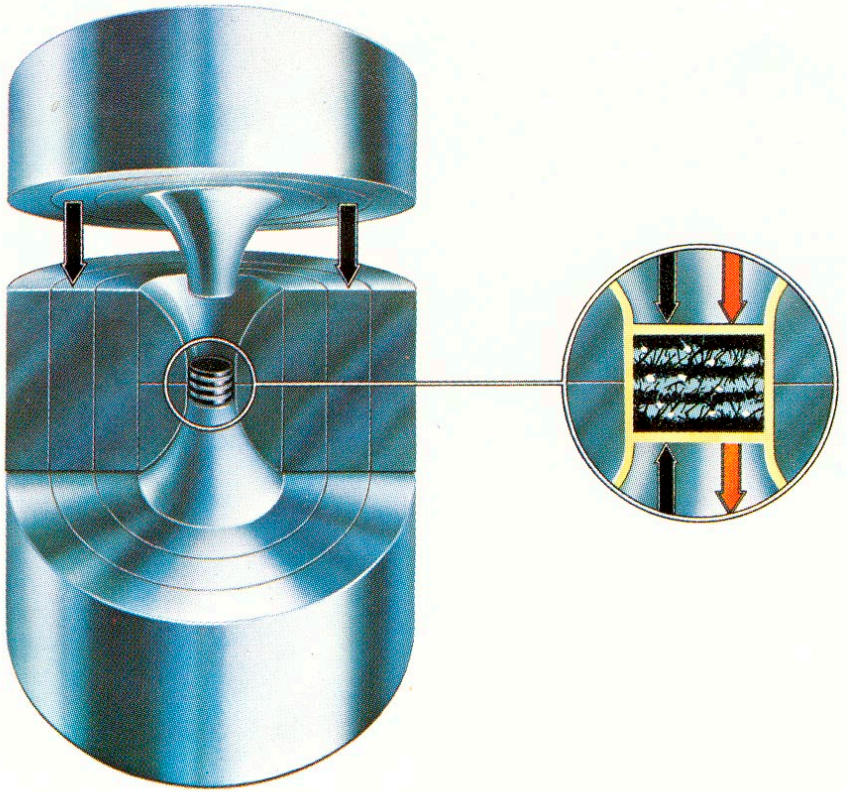
Crystal Pulling (Czochralski)



Diamonds (High temperature high pressure method)



A hydraulic press is used



The first commercial synthetic diamonds were industrial

- Diamond drill bit

High pressure and high temperature (HPHT diamonds)

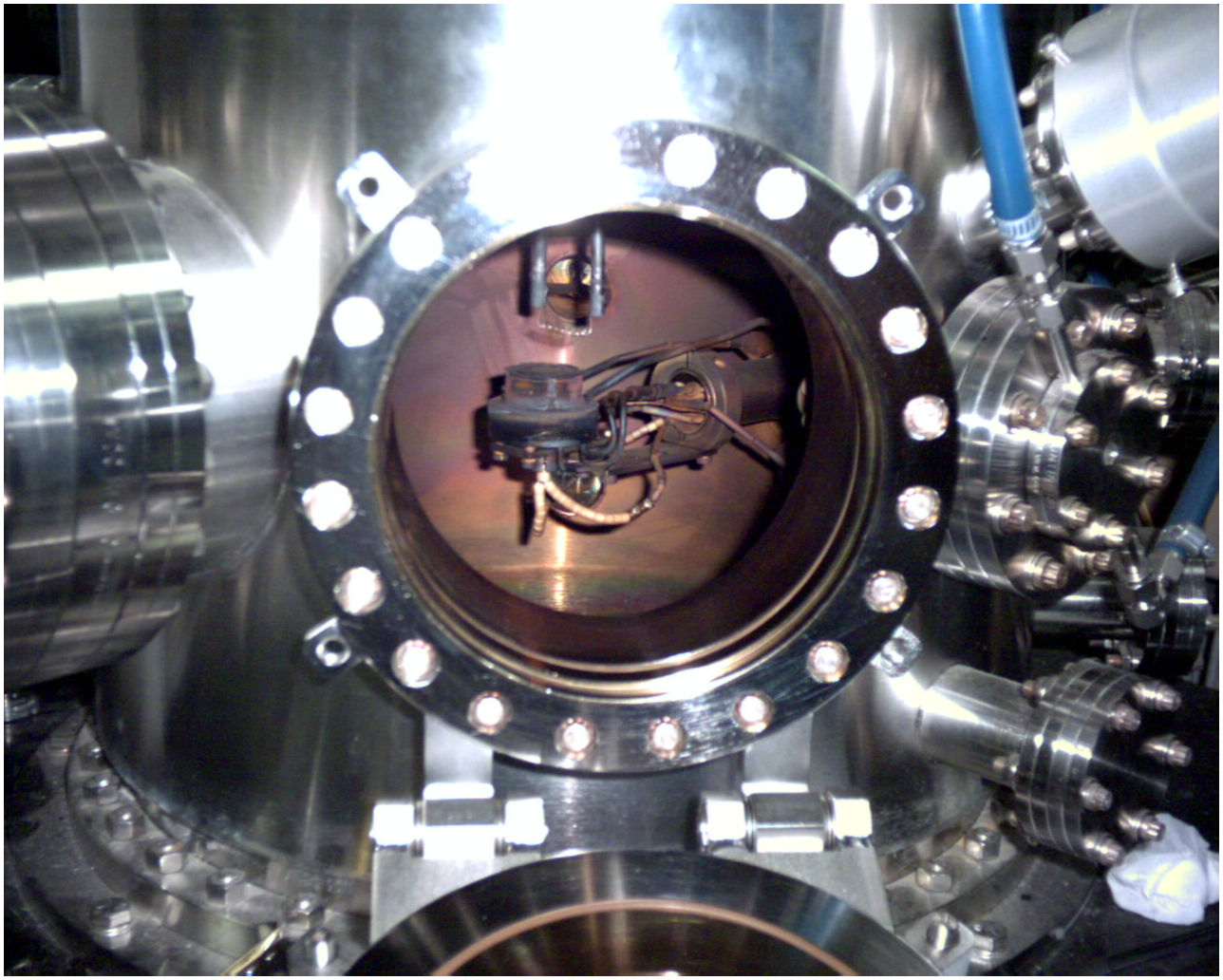
- This method is the classic method first used by GE in 1954 to create industrial diamonds and led to the creation of gem grade diamonds by around 1970.

- The GE engineers made diamonds from peanut butter!

Chemical vapor deposition method (CVD)

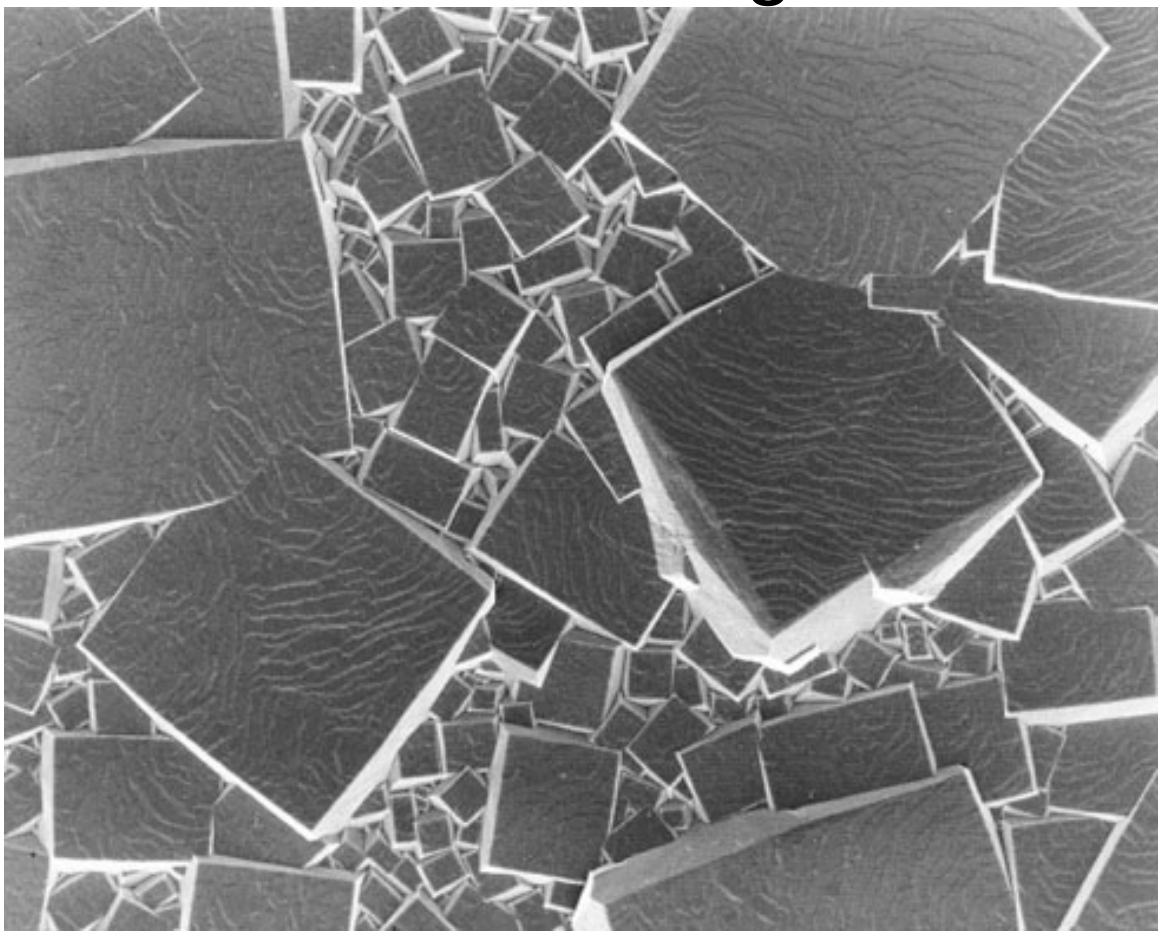
- This method is often used for depositing a thin layer of diamond on cutting tools or other objects that need a hard surface.
- The term vapor implies a gaseous phase and the gas used is often methane (CH_4).
- There is no need for high pressure, but temperatures are moderately high, between 750-1,000^{o}C.

CVD Apparatus



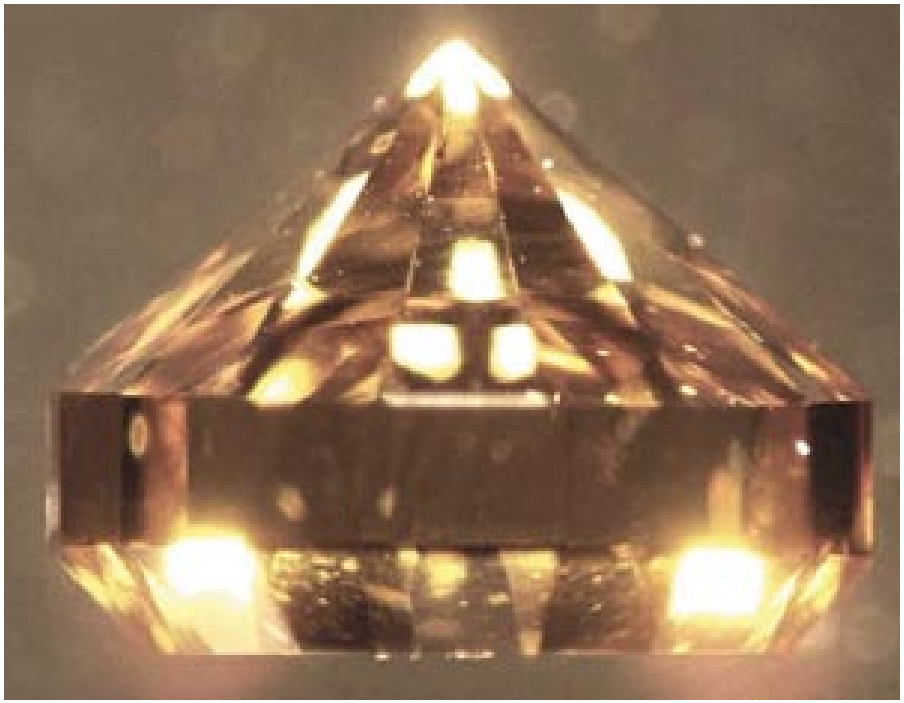
CVD method (Cont…)

- You can coat tools and glass with diamond

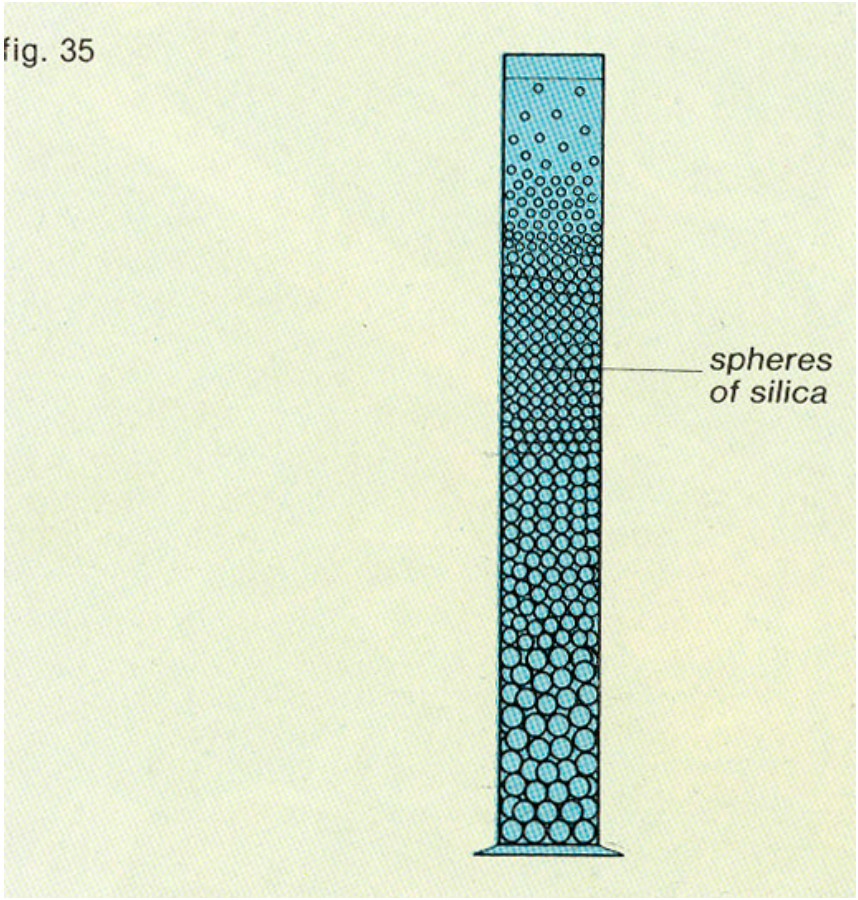


CVD creates diamonds fast

- A synthetic-cut single-crystal diamond, about 2.5 mm high, grown by chemical-vapor deposition at the Carnegie Institute.

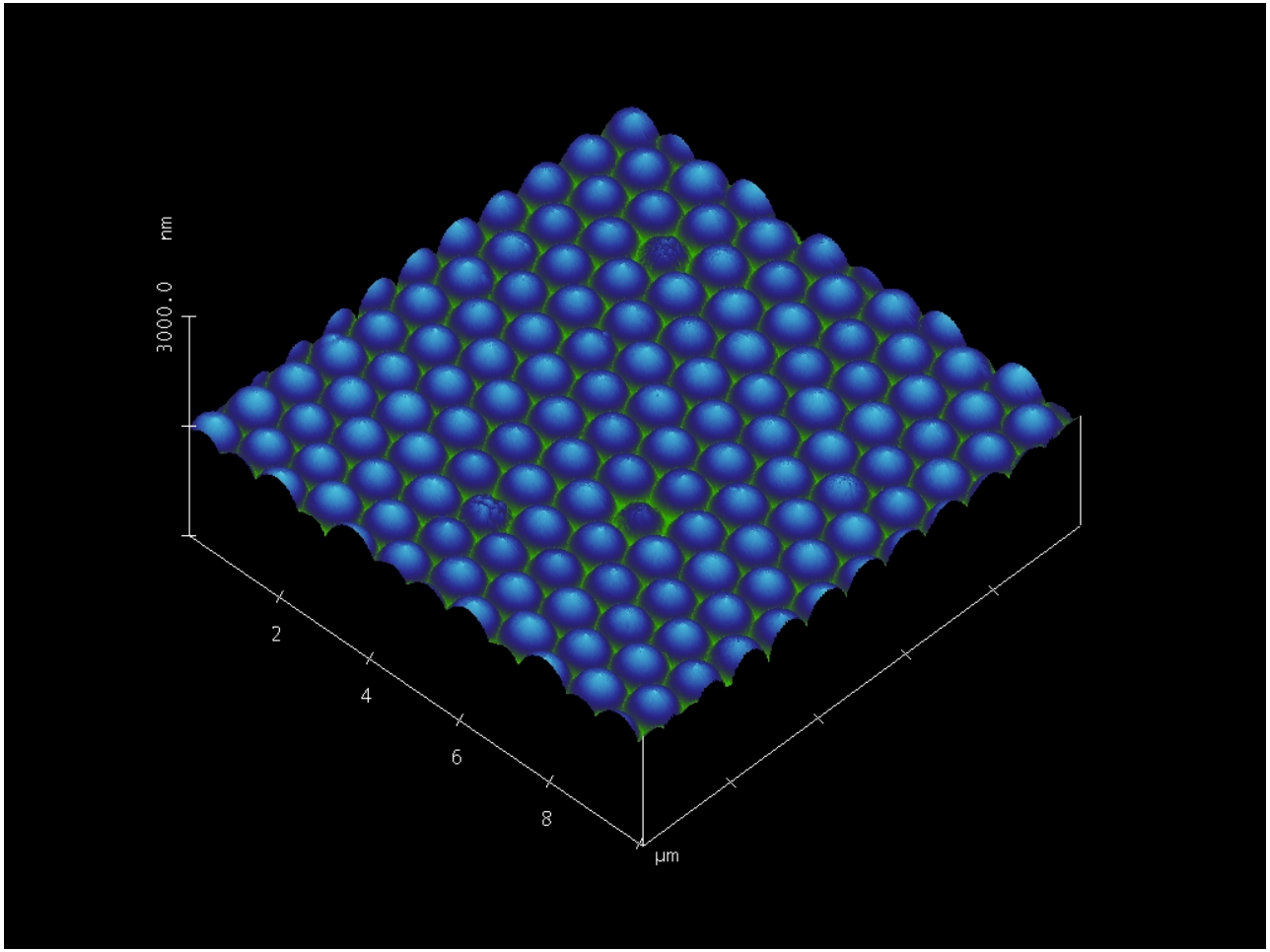


Synthetic opal



- Sphere of silica settle
- The composition of opal is $SiO_2 \cdot H_2O$
- After settling the spheres are fused by heating

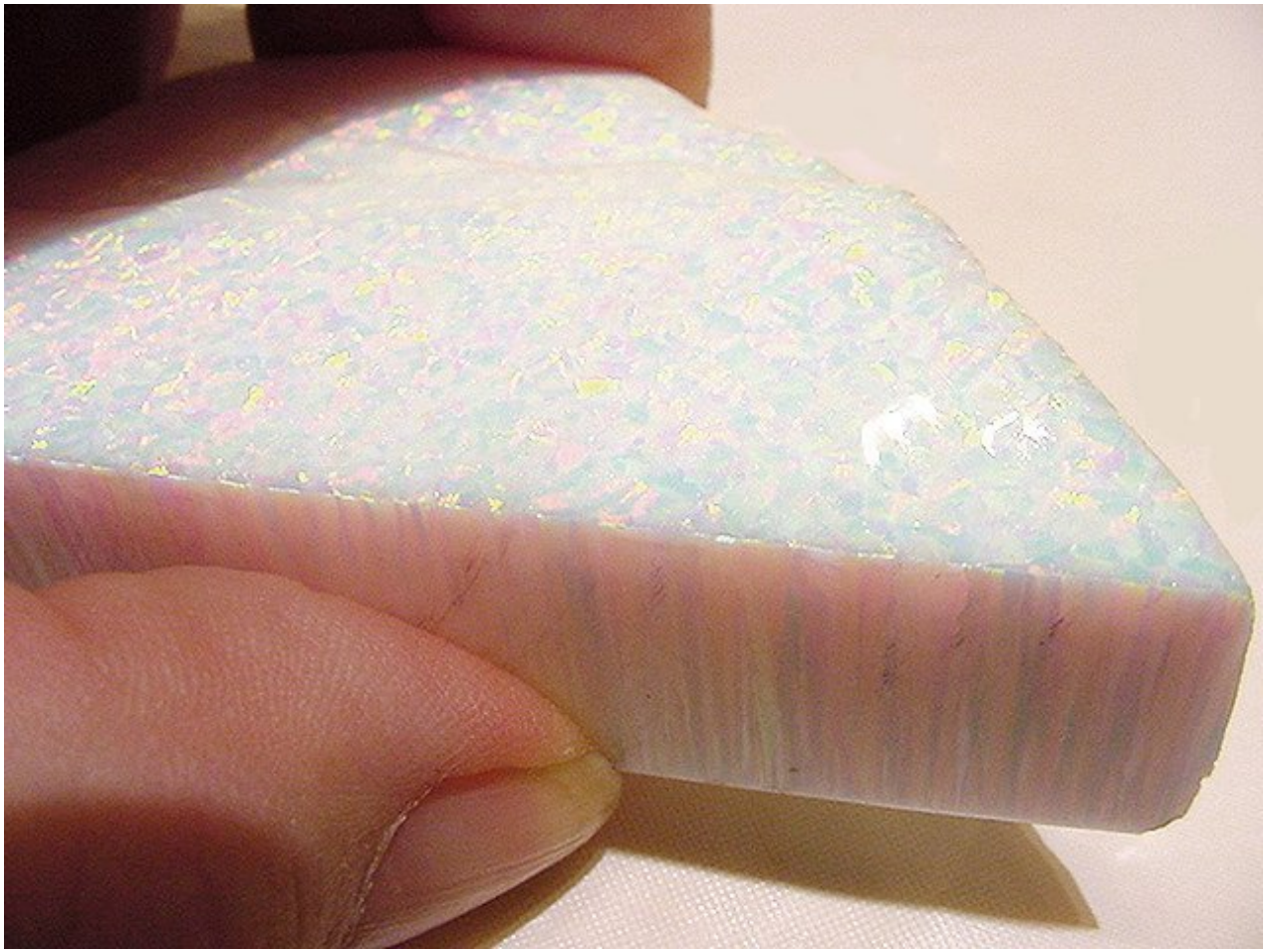
Spheres of opal



Lots of spheres cause play of color

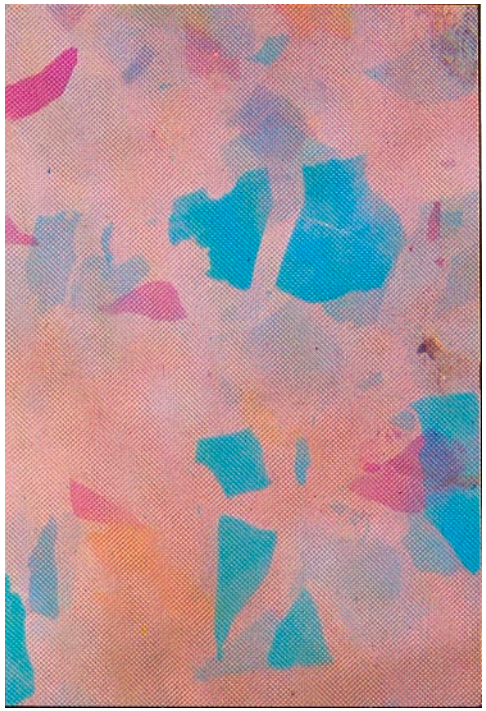
- All the small spheres of silica cause diffraction of light. This creates “play of color”
- Silica spheres are pretty much the same a desiccant used in packaging to keep things dry, just a lot smaller.
- Settling separates the small spheres because in water small spheres take longer to reach the bottom.

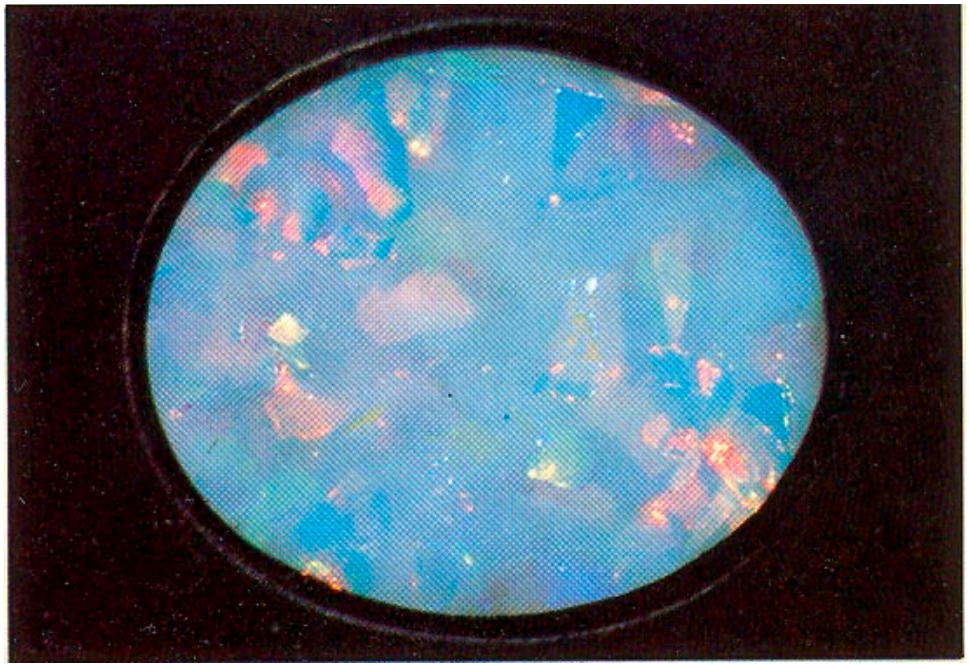
Synthetic opal



Slocum stone

- Imitations opals are often a variety of glass called **Slocum Stone.** Glass with foil





Cubic Zirconium (CZ)

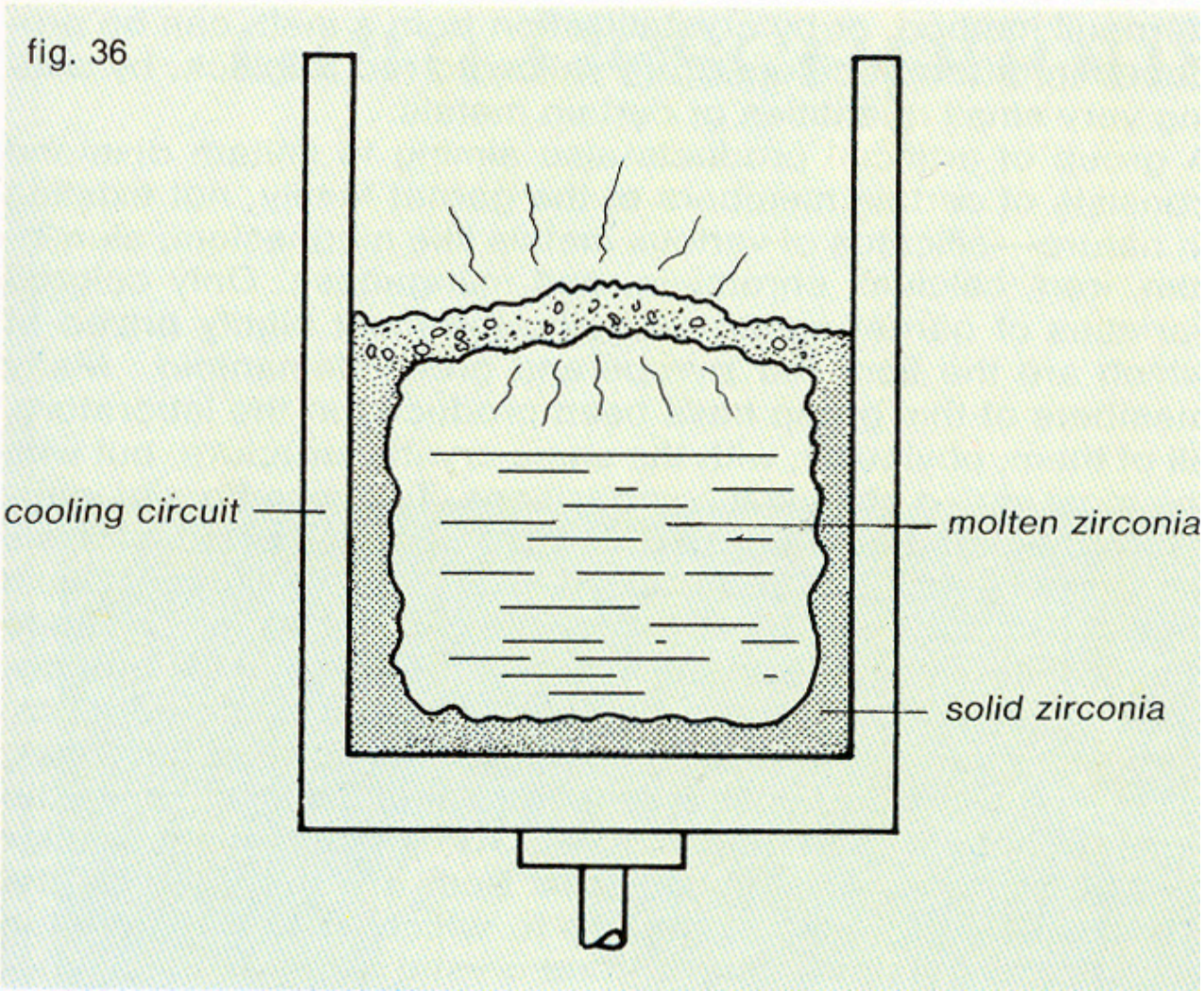
- To produce CZ: ZrO_2 is heated 2300 ^{o}C (5,000 ^{o}F). Platinum melts at 1770 ^{o}C. A stabilizer, Yttrium, must be added to prevent breakdown upon cooling.
- This requires such high heat that a special radio frequency "skull crucible" must be used to melt the zirconia powder. Nothing else can contain the high heat

Physical Properties

- **Chemical composition** -- ZrO_2- Zirconium oxide plus yttrium or calcium.
  Color -- Colorless when pure, but many colors are provided by small chemical additives
  Dispersion-- .060-.066 (Diamond is 0.044)
  Hardness -- 8.5
  Specific Gravity -- 5.65 - 5.8 (Diamond is 3.52)
  Crystal structure -- Isometric (cubic).

Cubic Zirconium (CZ)

Production of cubic zirconia by crystallization from a melt according to the "skull melt" process.



Cubic Zirconium (cont…)

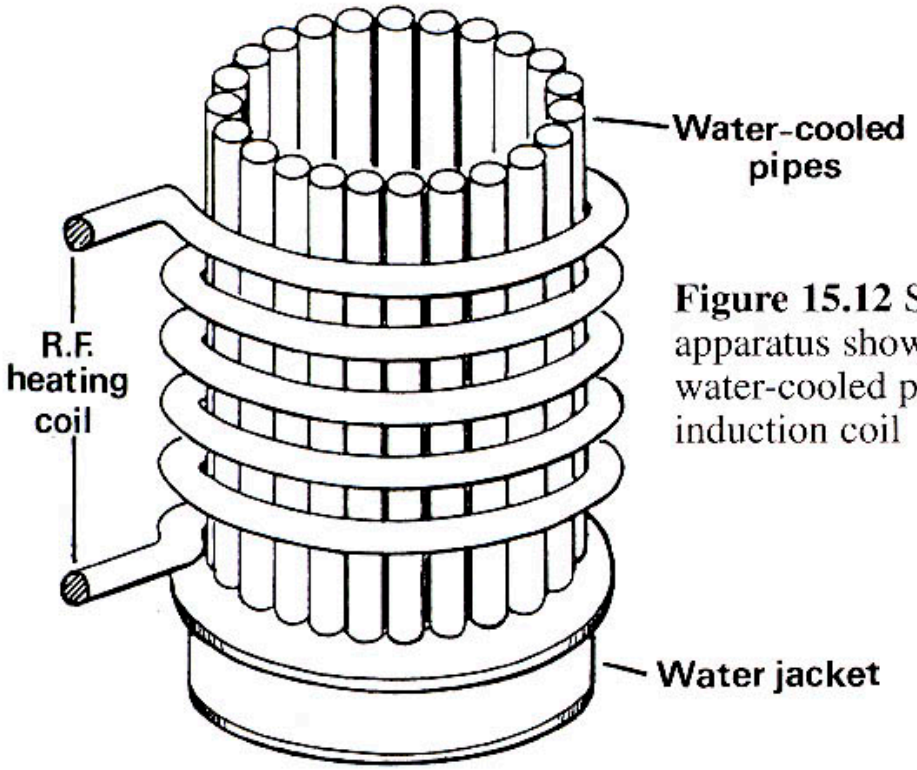
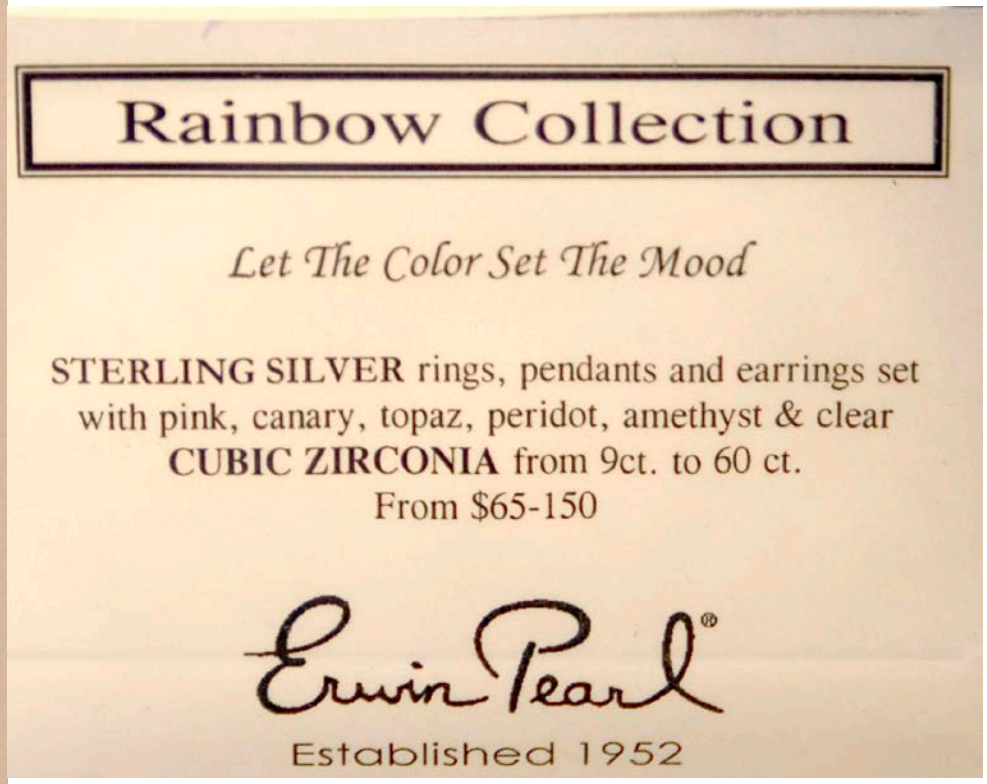


Figure 15.12 Sketch of a skull-crucible apparatus showing the vertical water-cooled pipes and the RF induction coil

The Many Colors of CZ

CZ or pink diamond?



Moissanite

- Moissanite was first discovered in meteorite fragments at Meteor Crater in Arizona. It was named in honor of its discover Nobel laureate, Dr. Ferdinand Henri Moissan.
- Synthetic moissanite, also called silicon carbide after its chemistry (SiC) and by the trade name, carborundum.

Moissanite (cont…)

- **Color:** blue, green, colorless (in synthetic form)
- **Luster** is adamantine (like a diamond)
- **Transparency:** transparent to translucent.
- **Crystal System:** hexagonal, trigonal and isometric.
- **Hardness:** 9.25
- **Specific Gravity** : 3.1 - 3.2 (average)
- **Streak:** white.
- **Other Characteristics:** crystals are thermally conductive and highly double refractive.
- **Associated Minerals:** found associated with meteorite impacts
- **Notable Occurrences:** Diablo Canyon or Meteor Crater in **Arizona**

PRESIDIUM®

Moissanite Tester

Model : PMT

As the world foremost manufacturer of Thermal Conductivity Tester, Presidium is answering her customers' demand for a reliable handheld Moissanite Tester. It took us many months of intensive research and development and a solution was found within our group-patented technology. This tester is therefore developed with the sole objective to identify synthetic Moissanite (Silicon Carbide). The new instrument is named "PRESIDIUM MOISSANITE TESTER" (PMT) and uses the technology of Capacitance and for the capacitive measurement of electrical displacement. PMT is designed specifically for identification of Synthetic Moissanite mounted on metals. The measuring procedure is very simple by touching a high sensitive measuring probe made of special grade polymer and the reading is instantaneous. Note: PMT is recommended to be used after positive testing result for Diamond with a Thermal Conductivity Tester.

Size : L-160mm x W-21mm x H-30mm
Weight : 45 gms

FEATURES

- Operates on 3 x AAA size alkaline batteries
- Low batteries indicator
- Measured Moissanite Continuous beep
- Uses very low operating voltage
- Low power consumption
- Pocket size

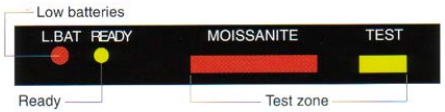
OPTIONAL

- Adaptor for AC wall mounted power source (120V or 230V)
- Alkaline batteries

1 year factory warranty

*Carrying case - standard

Measuring Zone



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Fiberlite: looks like catseye

- This is actually fused fiber-optic glass that can be colored during the fusion process, and when cut into cabochons forms a strong catseye. The material is fibrous glass so is actually amorphous