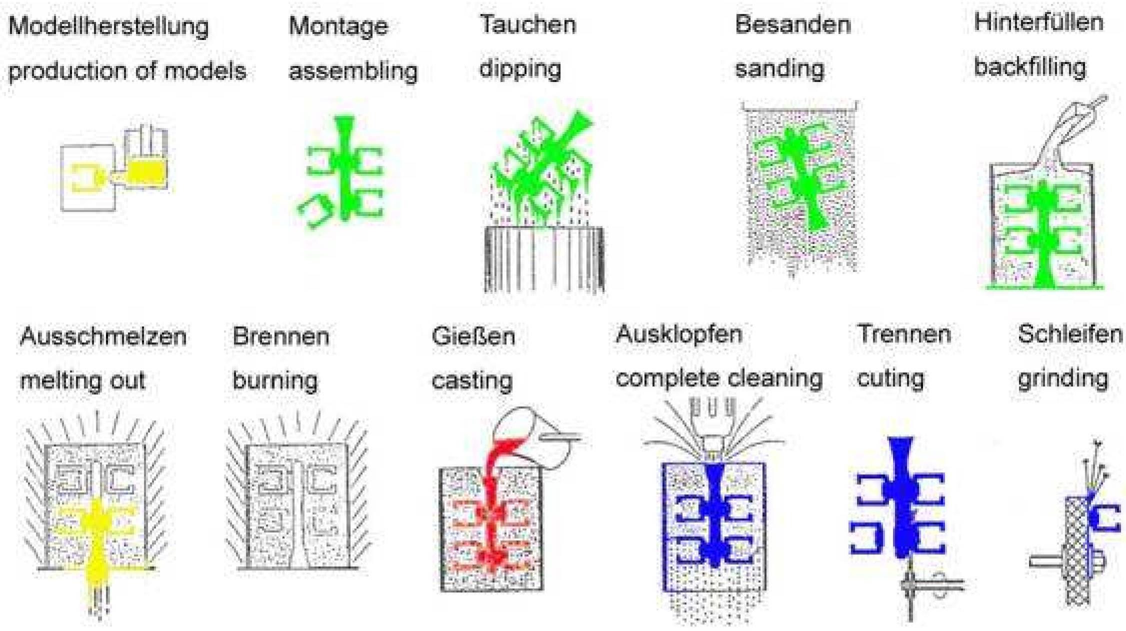
TiAl - precision casting

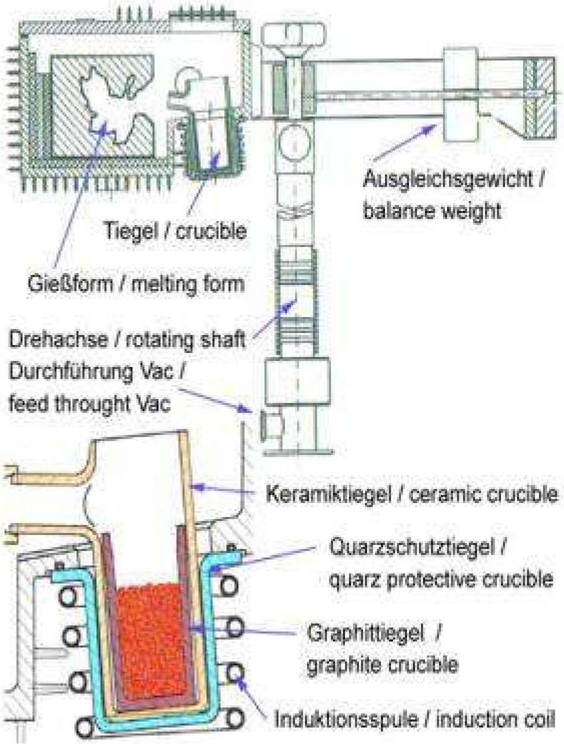
The deciding move in manufacturing technology of filigree parts was already done 3000 years ago by the lost-wax process (cast with lost mould). The process has been the same up to this day although materials and machines have dramatically developed.



The original model, for example made of metal, will be moulded in silicone or rubber. This original mould reproducible by filling with wax or plastic. Then the parts will be mounted in treeform and the wax model is backfilled with ceramic mass in a moulding ring made of heat-resisting steel. Depending on the material tube slurry the mould will be preheated and fit into the casting machine to fill in the metal.

For this there were special rotating-hearth furnaces developed in which one can dewax, burn and preheat many moulding rings. The melted wax/plastic is flowing inwards on the rotary hearth and it will be drawn off via tubular shaft. Then the firing curve can be driven automatically by program control. A continuous heating of the moulds is guaranteed because of the rotary hearth. The necessary mould can be taken out safely and without heat loss. Dwell period at end temperature should be 30 to 300 min depending on size of parts and moulds.

After solidification the form will be destroyed. Mechanical machinery as cutting parts from the tree, grinding and polishing are the next steps.
The casting of high melting metals, for example titanium and its alloys or TiAl which is highly reactive, became more economic by development of more efficient induction casting machines with electronic control, protective gas and vacuum chamber, pyrometric temperature measurement with decreasing cast weights and higher quality.



The up to date process for this is the induction heating with high or medium frequency in combination with centrifugal casting. The casting procedure is taken out as follow:

An induction coil is placed over a melting crucible and in assistance of a laser optimally adjusted. With high frequency or medium frequency generators the material will be liquefied in a short time and be mixed optimally. That means highest homogeneity and reproducible casting results. Eddy currents in the material effect a fast heating and mix of the melt. After reaching melting temperature the centrifugal cast procedure will be set by lowering the induction coil.

An extremely powerful special electrical motor which is speed-controlled makes possible that material specific cast parameters will be kept exactly. The processes are controlled automatically in all parameters by a program controller.

The casting of TiAl (we are working exclusively with **MTU-Aeroengines**) can be made by titanium casting machines Titancast 700 Vac as well as Titancast Super. With these intermetalic phases compared to pure titanium the fast acceleration of the casting arm as well as the mould temperature are even more important. The extreme solidification speed (appr. +/- 3℃) of TiAl poses a problem. Another fa ctor besides the melting power of the casting system is the crucible design and material. Melting of TiAl in a graphite crucible is nearly no problem, but cannot be used for all applications especially when no carbon pick up in the melt is accepted. In this case a special designed ceramic crucible has to be used. It is important to keep the melting process as short as possible to reduce the reaction time between the highly reactive melt and crucible material.

TiAl compared with titanium has a lower density but also a better hot strength. Due to this property there are many applications for example aircraft industry, engine components, pistons, turbo chargers, turbine blades and valves. This material also is used in optical industry, medical instruments and so on. The manufacturing of ingots for the casting machines can be done with arc furnaces and cold wall crucibles. The moulds needed can be manufactured for a reasonable price.