

Casting

10 Rules for good castings

1. Start with a good quality melt
2. Don't make the meniscus go too fast – max 0.5m/s for most metals
3. Don't stop the meniscus.
4. Avoid bubbles
5. Avoid core blows
6. Avoid shrinkage
7. Avoid convection
8. Reduce segregation
9. Reduce residual stress
10. Provide location points

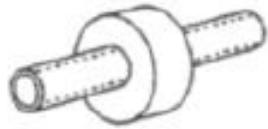
- Cope – top half of mould
- Drag – bottom half of mould
- Pattern – the shape to be cast
- Moulding flask – the cope and drag together
- Parting compound – powder to ease the separation of the pattern and mould
- Pouring Basin – where the liquid metal enters the mould
- Sprue – vertical metal transfer channel
- Runner – horizontal metal transfer channel
- Ingates – connect the runners to the mould cavity
- Riser cavities – reservoirs of molten metal which are fed into the casting as it cools to compensate for solidification shrinkage

The Sand Casting Process

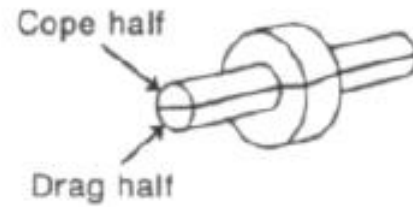
- A *pattern* is made of the shape to be cast
- The *pattern* is positioned on a bottom board and surrounded by the *drag* of the *moulding flask*
- A *parting compound* is sprinkled over the pattern to facilitate separation of the pattern from the mould prior to pouring the liquid metal
- *The sand* is packed tightly and excess sand removed. The drag is inverted and the *cope* of the mould prepared.
- The feeding system to deliver the molten metal is formed in the cope. This consists of a *pouring basin*, a *sprue* (vertical metal transfer channel), *runners* (horizontal metal transfer channels) and *ingates* connecting the runners to the mould cavity.
- *Riser* cavities are designed into strategic positions. These serve as reservoirs of molten metal which are fed into the casting as it cools to compensate for *solidification shrinkage*

- The cope and drag are separated and the pattern removed.
- The cope and drag are reassembled and clamped together
- The metal is poured from a small ladle into the sprue, flows into the mould cavity and solidifies.
- After solidification, the mould is broken and the cast part removed.
- The sand is cleaned off and the riser and the feeding system cut away

Solidification and casting processes



Desired shape of finished casting

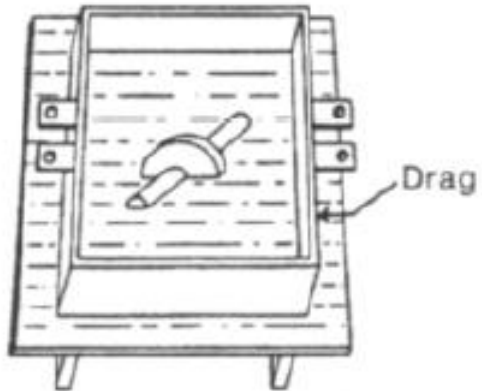


Wooden pattern



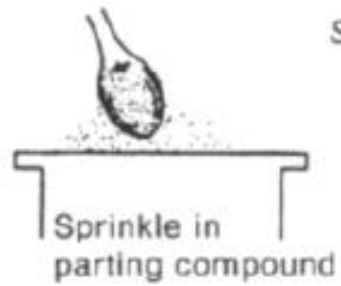
Sand core

Step 1



Drag half of pattern is placed in drag half of flask

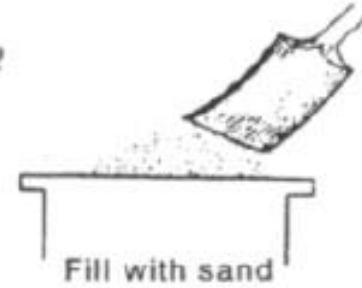
Step 2



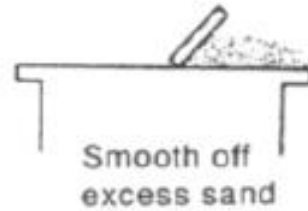
Sprinkle in parting compound



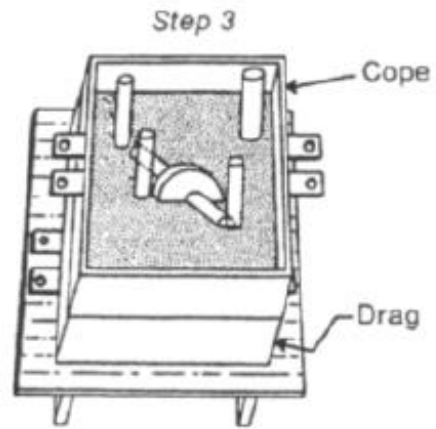
Pack sand in



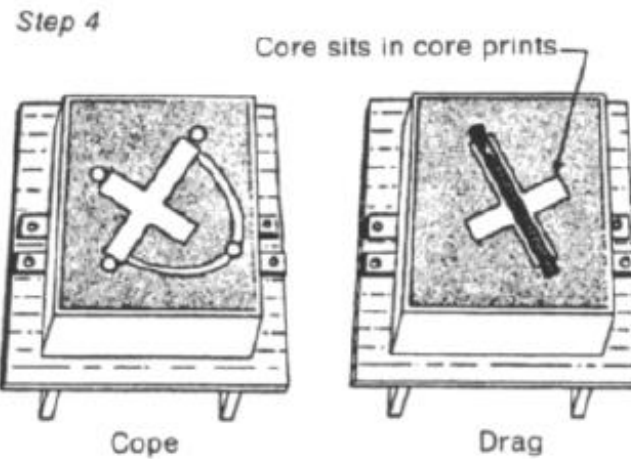
Fill with sand



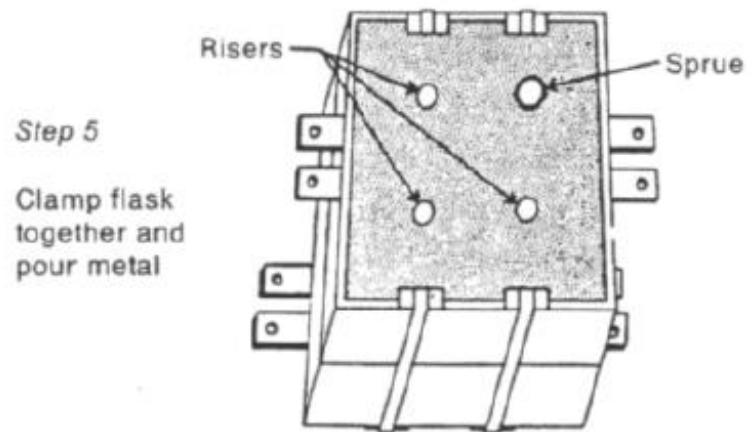
Smooth off excess sand



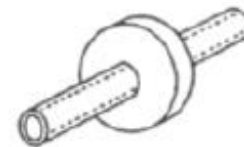
Invert drag and place cope half of pattern; position sprue and riser sticks



Separate the cope and drag; remove pattern, riser sticks and sprue plug; make gating system



Clamp flask together and pour metal



Finished casting after trimming

The Sand Casting Process

- A (1) is made of the shape to be cast
- The (2) is positioned on a bottom board and surrounded by the (3) of the (4)
- A (5) is sprinkled over the pattern to facilitate separation of the pattern from the mould prior to pouring the liquid metal
- The (6) is packed tightly and excess sand removed. The drag is inverted and the (7) of the mould prepared.
- The feeding system to deliver the molten metal is formed in the cope. This consists of a (8), a (9) (vertical metal transfer channel), (10) (horizontal metal transfer channels) and (11) connecting the runners to the mould cavity.
- (12) cavities are designed into strategic positions. These serve as reservoirs of molten metal which are fed into the casting as it cools to compensate for (13)

Answers

1. Pattern
2. Pattern
3. Drag
4. Moulding Flask
5. Parting compound
6. Sand
7. Cope
8. Pouring Basin
9. Sprue
10. Runners
11. Ingates
12. Riser
13. Solidification shrinkage

Sand Casting Mould



<http://www.gwfoundry.com/portals/0/Sand%20Mold%201.jpg>

Gravity Die

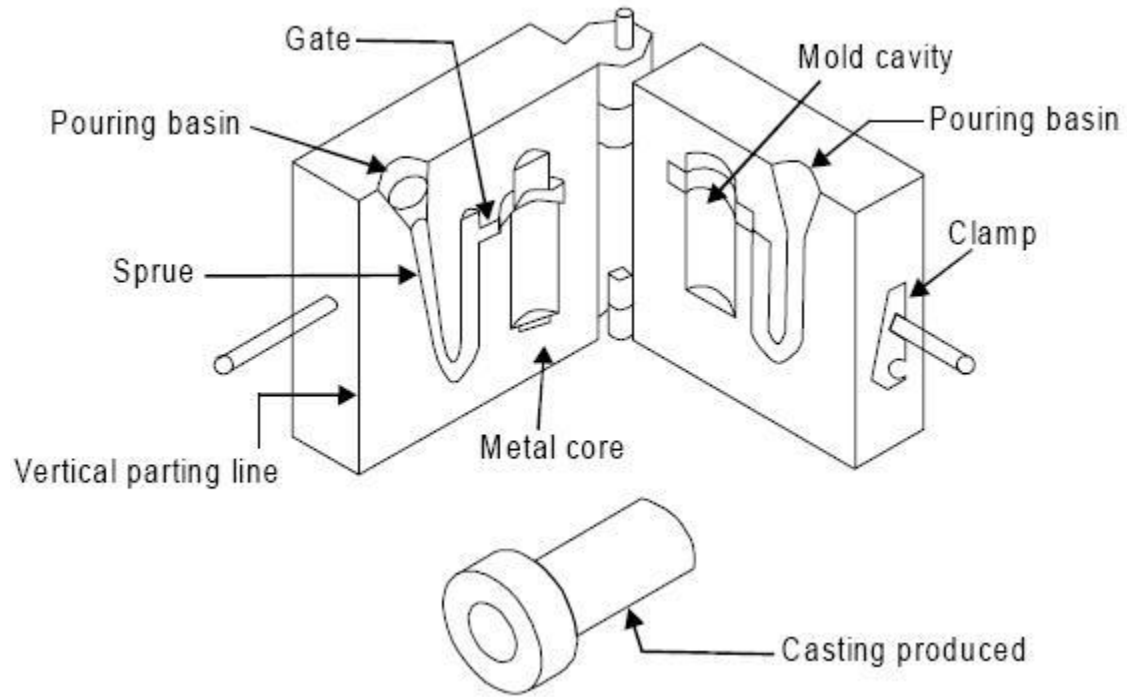
(a type of permanent mould)

- The process is ostensibly the same as sand casting except the metallic mould is not broken after each part is made
- The metal fills the mould with the assistance of gravity only

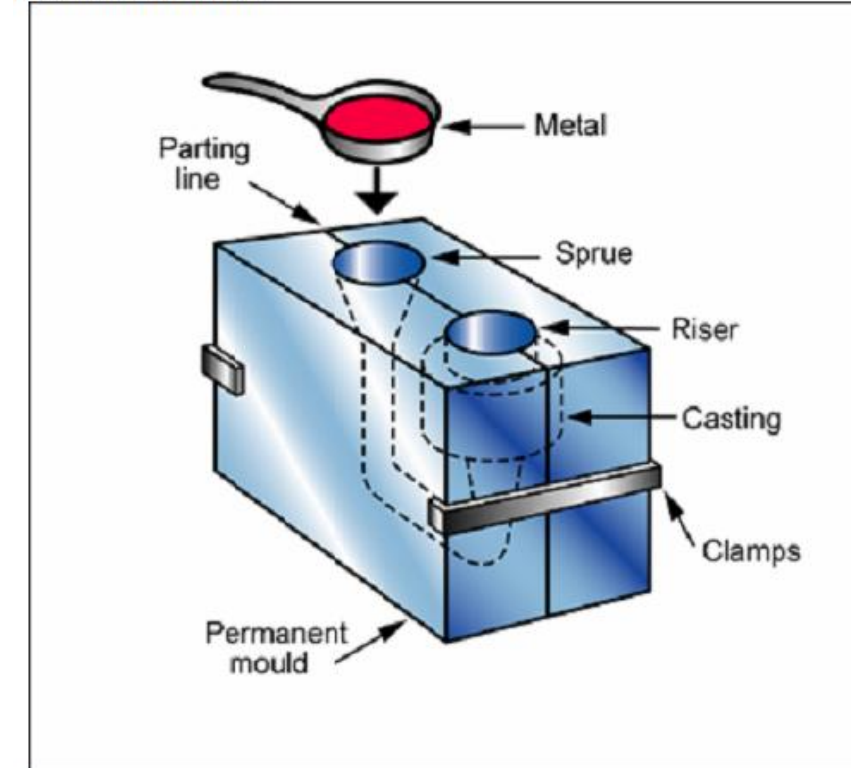
Gravity Die machine

- <https://www.youtube.com/watch?v=2m3IcKbWYG8>

Gravity Die



Process Schematic



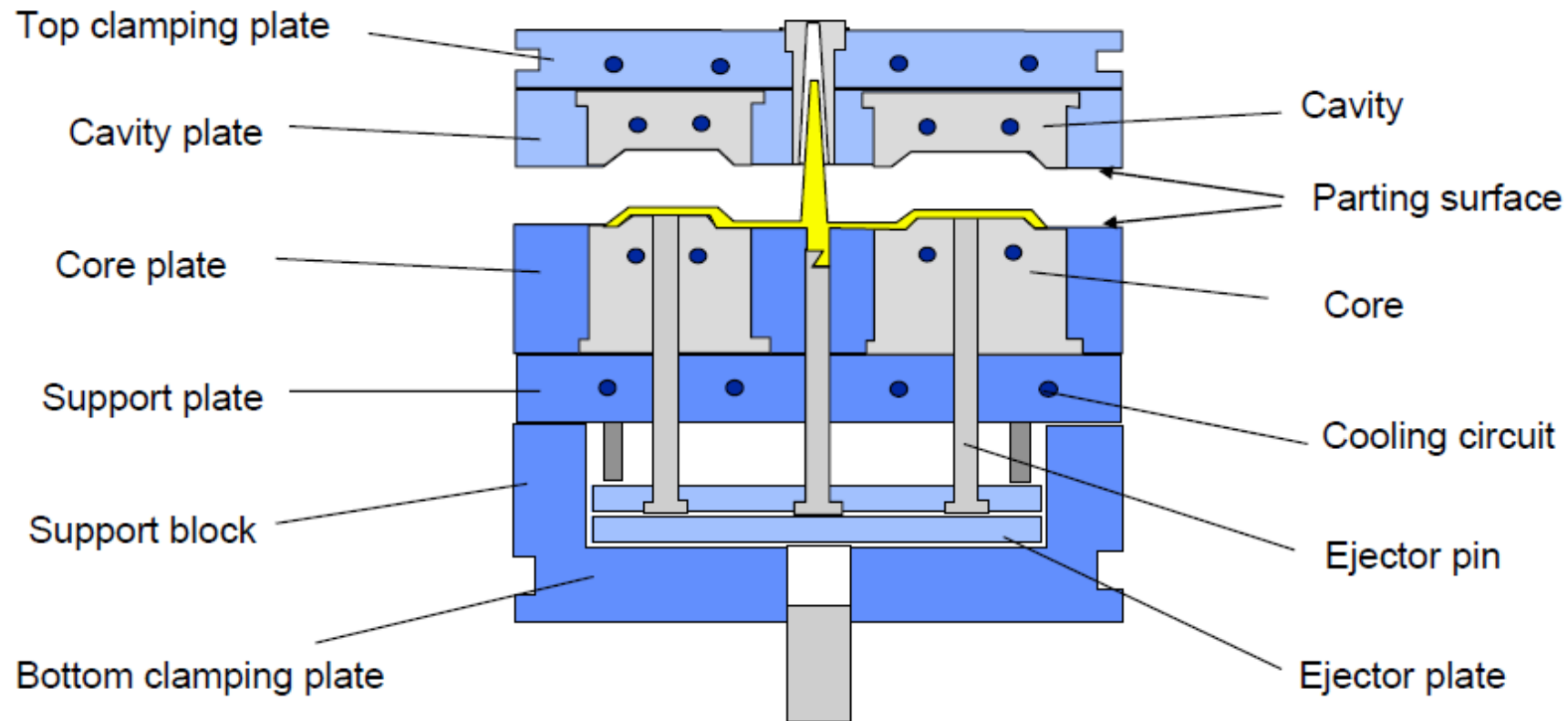
Gravity Die Casting – permanent mould

- Advantages
 - Good dimensional accuracy
 - Smooth cast surfaces
 - Thinner walls can be cast as compared to sand
 - Inserts can be cast-in (such as threaded inserts, heating elements, and high strength bearing surfaces).
 - Reduces or eliminates secondary machining operations.
 - Rapid production rates.
 - Casting tensile strength is higher than sand casting.
- Disadvantages
 - High initial cost.
 - A large production volume is needed to make this an economical alternative to other
 - processes



- Gravity Die Casting employs cast iron moulds which allow aluminium & zinc castings to be produced more accurately and cheaply than with sand castings.
- Tooling costs of gravity die casting are a fraction of those needed for high pressure die castings.
- The rapid chilling gives excellent mechanical properties whilst non-turbulent filling ensures production of heat treatable gravity castings with minimal porosity.

Pressure Die mould



Low Pressure Die Casting

- Instead of gravity a pneumatic pressure of 0.5-1atm forces the metal up the feeding system
- Mould must be rigidly clamped
- Very fluid alloys make the casting more prone to internal porosity than high pressure die casting that use a pneumatic or hydraulic plunger
- High pressure is more suitable for complex shapes and internal porosity is reduced

Low Pressure Die Casting

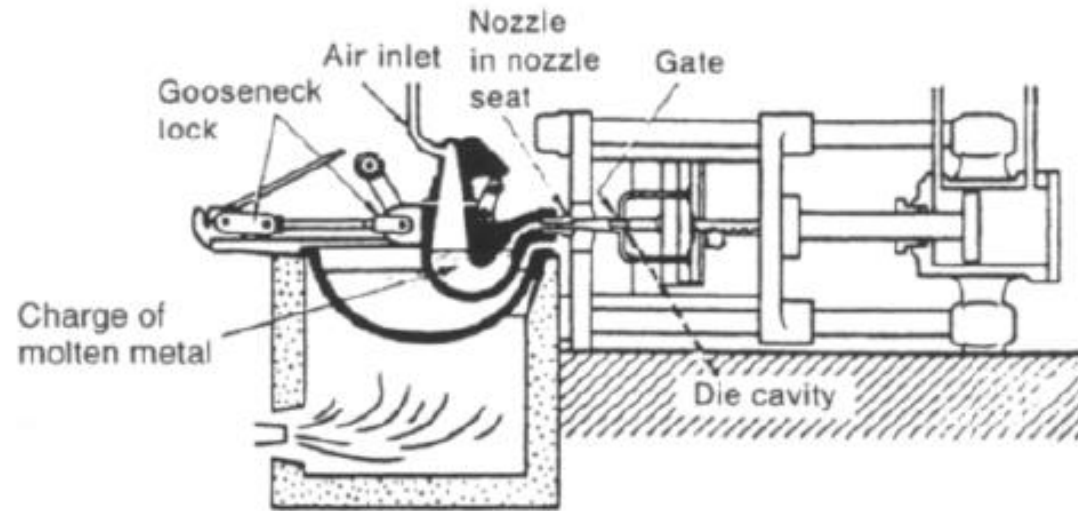


Fig. 2.8 Schematic of a low pressure or gooseneck die casting machine. (Reproduced from *Casting Aluminum*, with permission of Alcan Aluminium Limited.)

High Pressure Casting

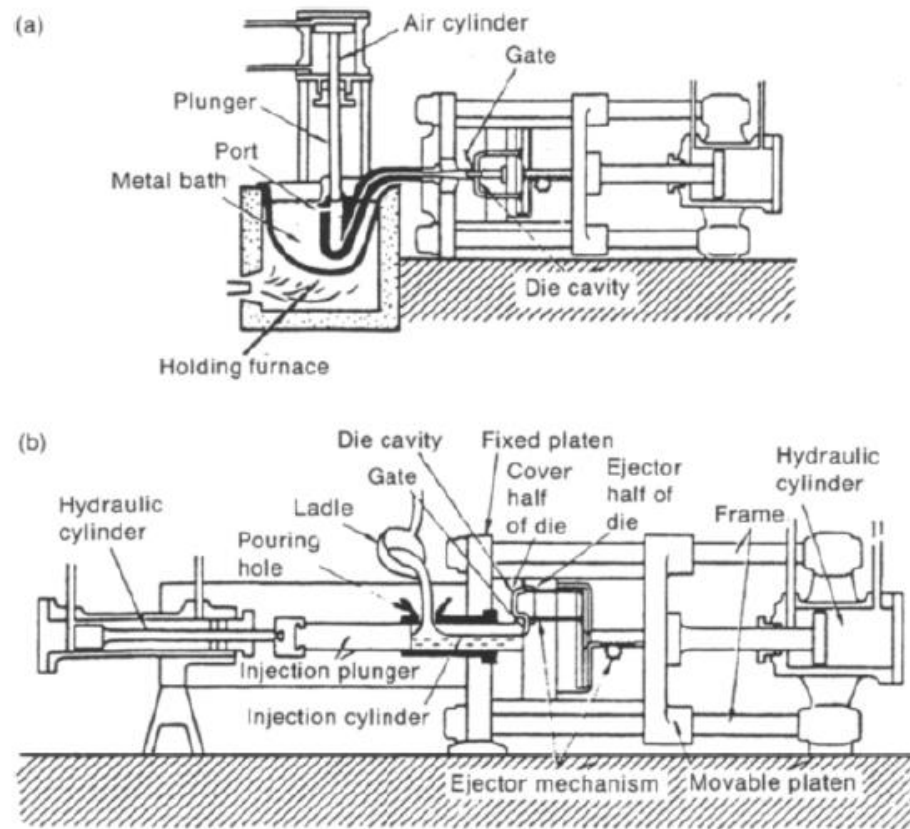


Fig. 2.9 High pressure die casting machines utilizing (a) a holding furnace or (b) a ladle and plunger for filling the die cavity. (Reproduced from *Casting Aluminum*, with permission of Alcan Aluminium Limited.)

Investment Casting

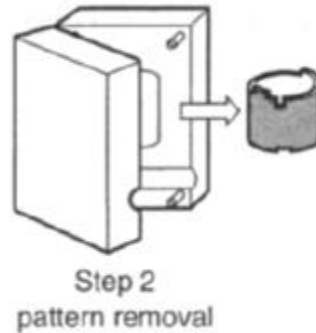
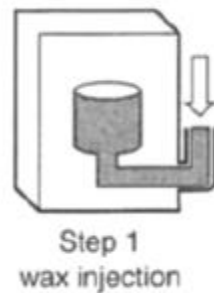
Wall Colmonoy

Investment Casting

- Also called lost wax casting
- Castings allow the production of components with accuracy, repeatability, versatility and integrity in a variety of metals and high-performance alloys
- Process is generally used for small castings
- Steel castings of up to 300 kg and aluminium castings of up to 30 kg
- can produce complicated shapes
- requires little surface finishing
- minor machining

Process

- A mould is used to prepare a wax pattern of the part to be made.
- The wax pattern is made using sand or gravity die casting.





Sand casting

The wax pattern is made using a process similar to that of gravity or die casting

Moulds ready to go



Spacer inside sandcast mould

Initially a mould is used to prepare a wax pattern of the part to be made

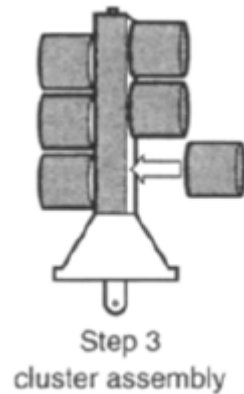


Wax moulds



Process

- Individual patterns are assembled, using wax, into a cluster of several patterns.





Moulds for glass bottle tops

Individual patterns are assembled, using wax, into a cluster of several patterns

Multiple wax moulds before coating

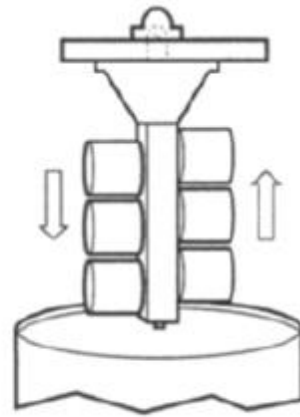


Process

- The cluster is dipped or invested in a refractory slurry (one definition of the word 'invest' is 'to cover')
- Then the refractory strengthened by stuccoing
- This yields a refractory mould containing the wax patterns which are subsequently melted and the wax collected for reuse.



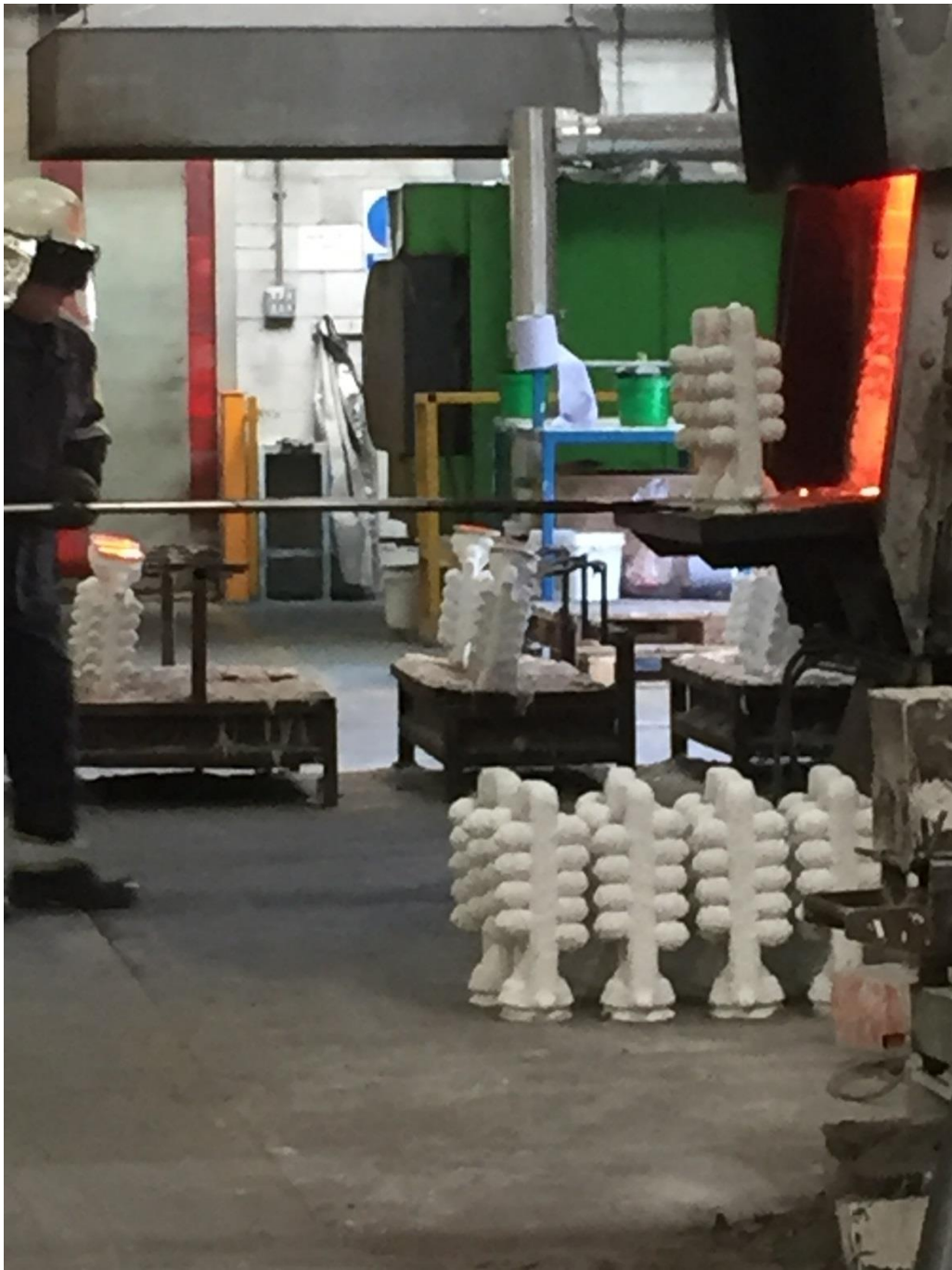
Step 4
investing



Step 5
stuccoing



Step 6
mould shell



Multiple wax moulds
dipped in several layers
of coating

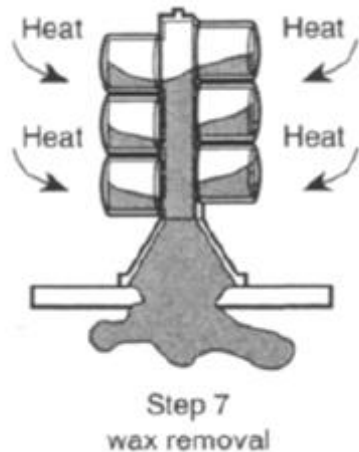


Coated wax mould

The cluster is dipped or invested in a refractory slurry (one definition of the word 'invest' is 'to cover')

Process

- The refractory mould is strengthened by firing at high temperature
- Molten metal is poured into the mould.
- Once the metal has solidified, the refractory mould is broken revealing the cluster of cast parts .
- Each part is then removed from the cluster.





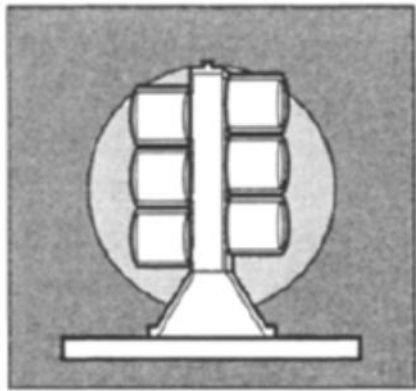
Melting wax

Ready for furnace

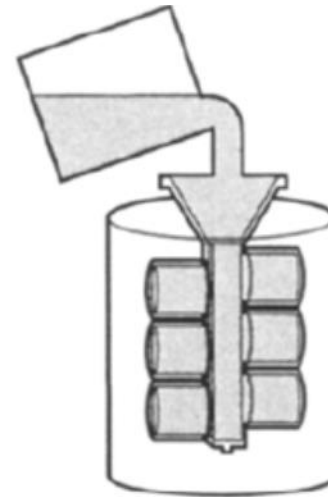


Process

- The refractory mould is strengthened by firing at high temperature
- Molten metal is poured into - the mould



Step 8
fire refractory



Step 9
metal pouring

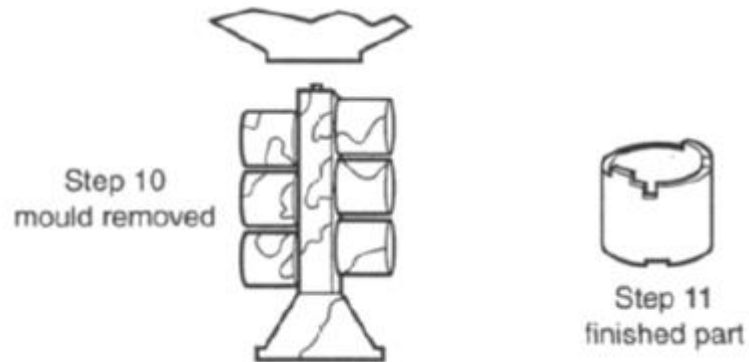


Molten metal is poured
into the mould



Process

- Once the metal has solidified, the refractory mould is broken revealing the cluster of cast parts
- Each part is then removed from the cluster

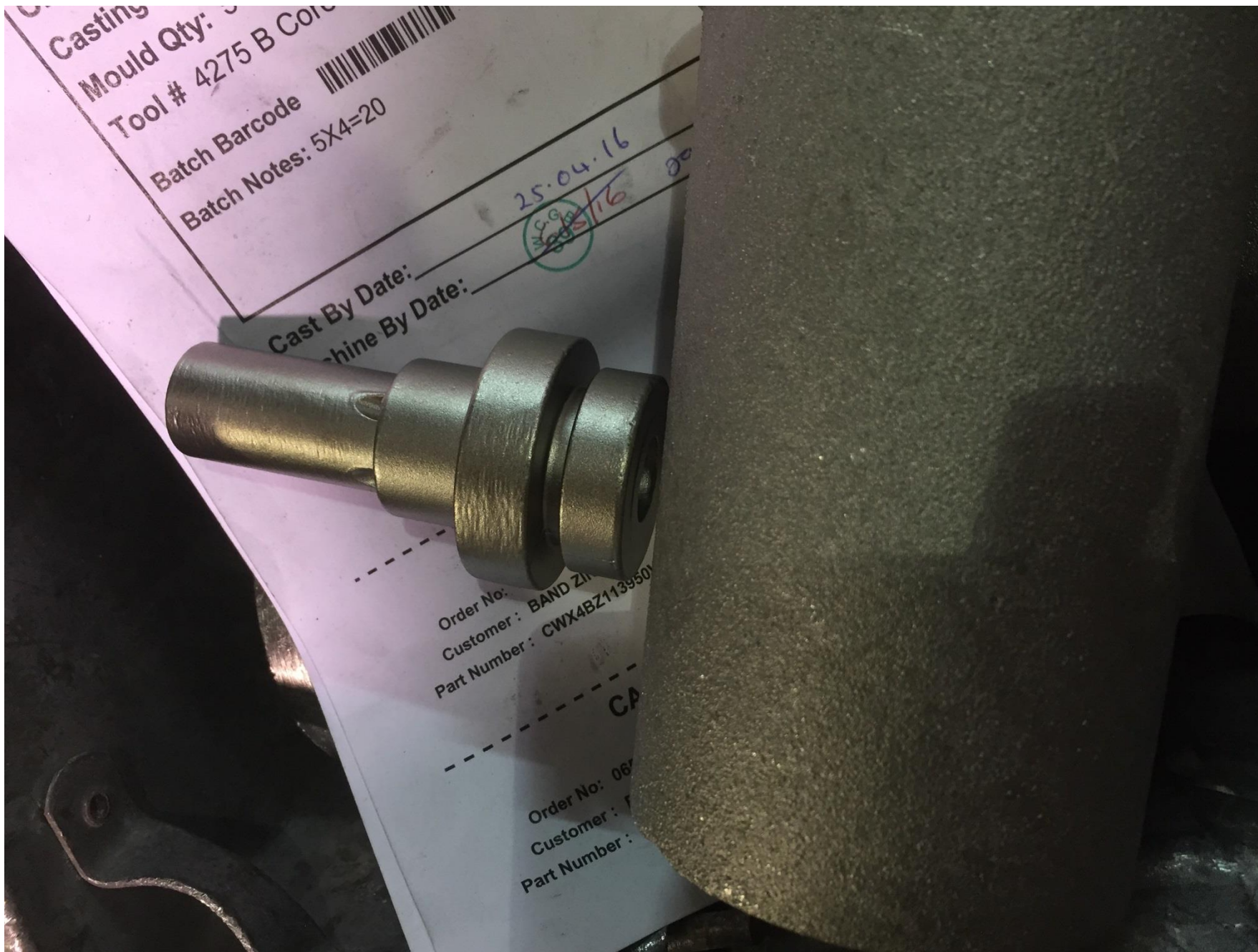




Filled and
ready – coating
knocked off to
reveal metal

Once the metal has solidified, the refractory mould is broken
revealing the cluster of cast parts

Each part is then removed from the cluster



Investment
cast cf sand
cast surface



Finished
product



Finished product art



Finished product steel
industry



Finished
product –
F1 racing



Finished product –
canning industry