Thapar Institute of Engineering & Technology – Patiala

Manufacturing Processes
UTA026

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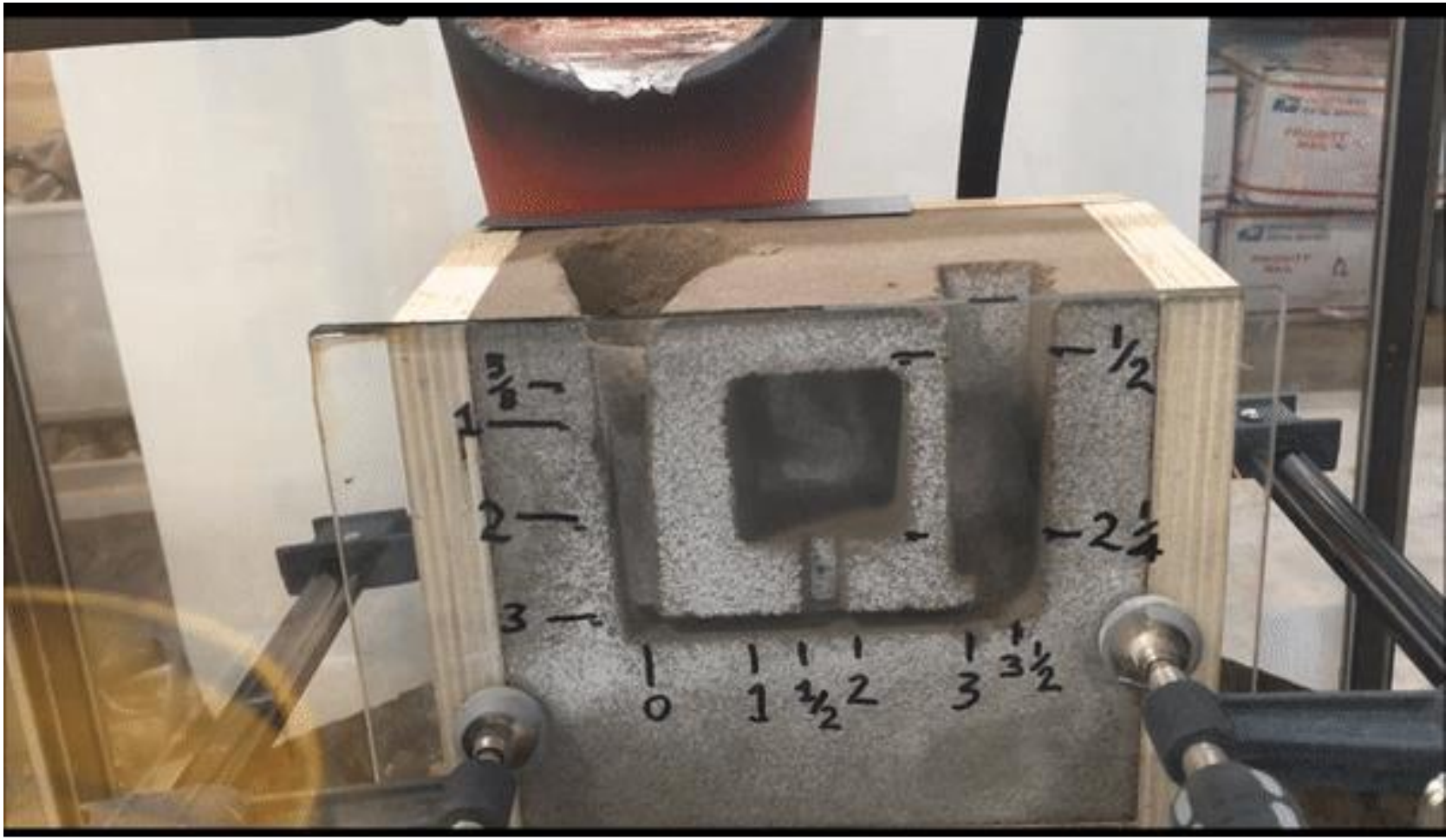
MOLD & GATING SYSTEM
Lecture - 20

The Mold in Casting

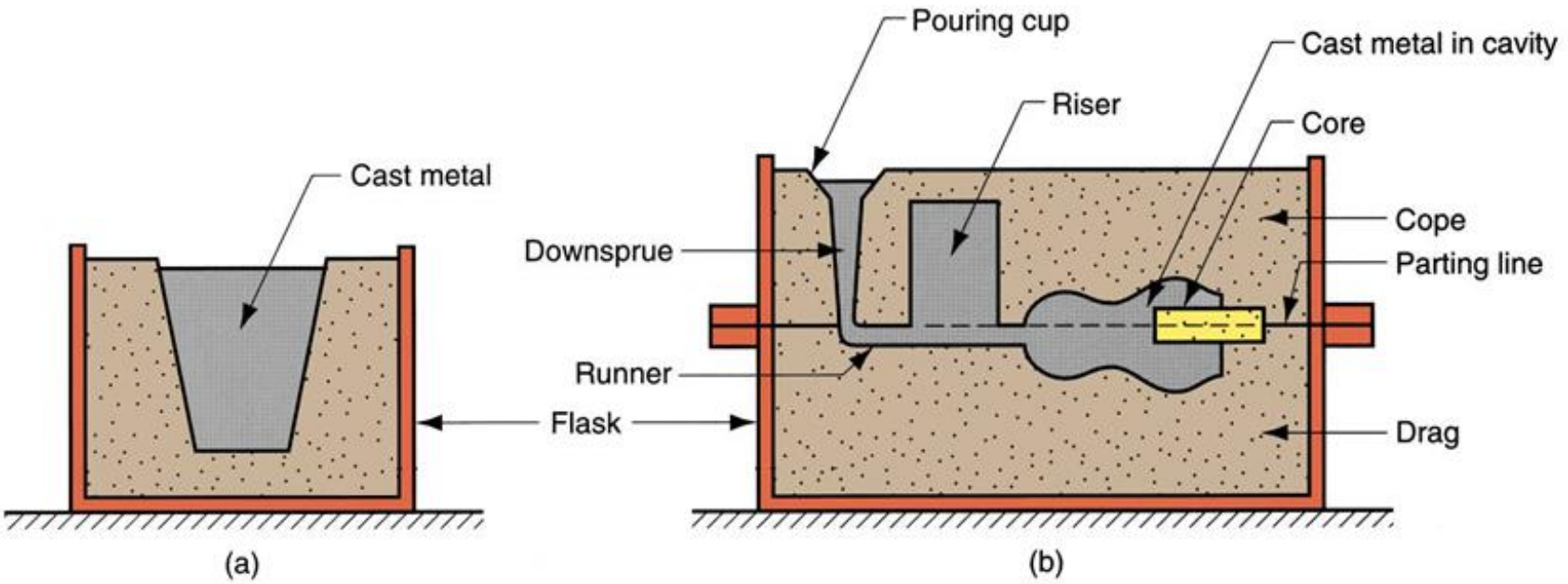
- The ***Mold*** contains a ***cavity*** whose geometry determines the shape of the cast part.

- Mold is a hollow container (***cavity***) used to give shape to ***molten*** or ***hot liquid*** material (such as wax or metal) when it cools and hardens.



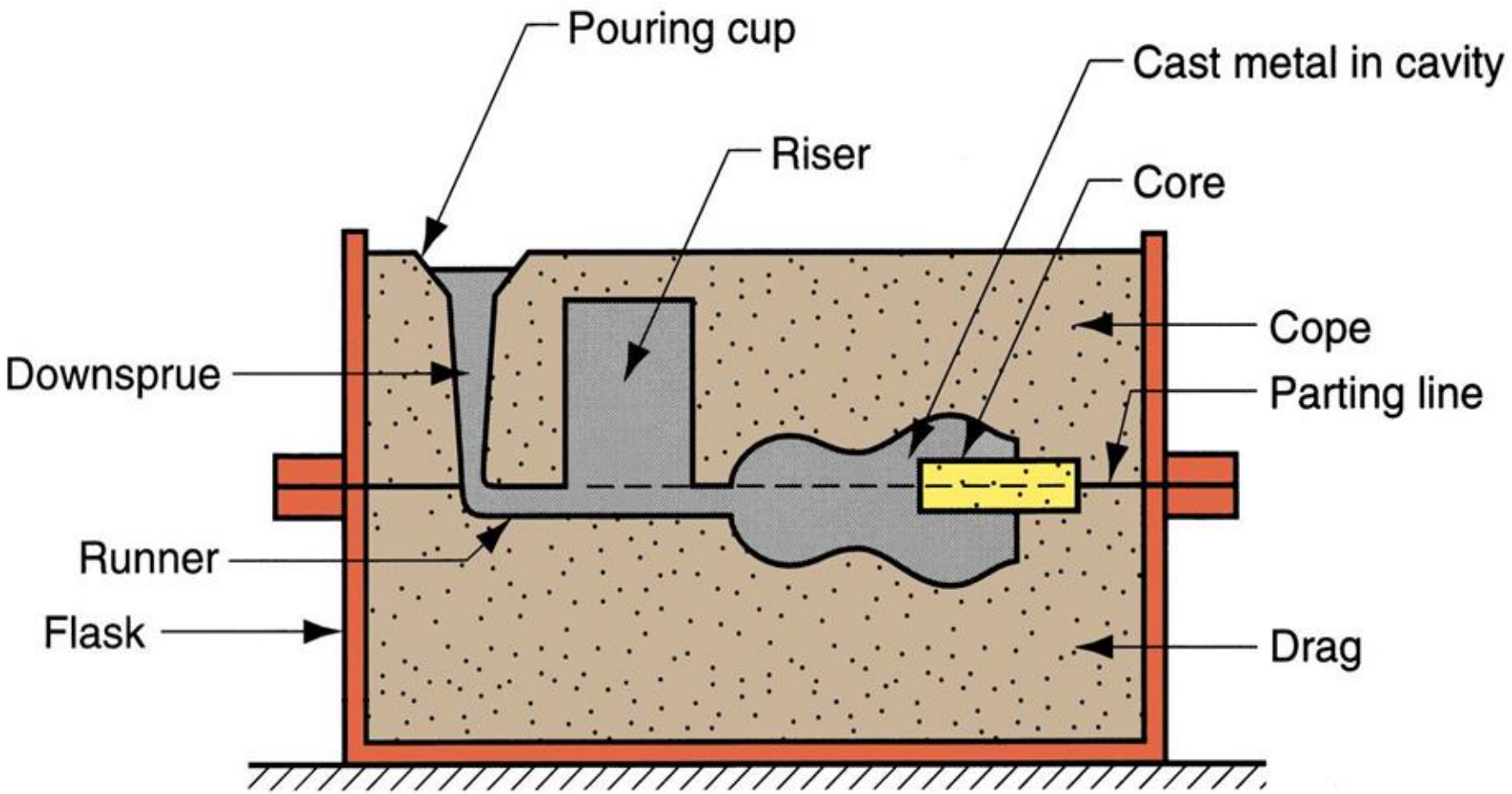
*https://www.youtube.com/watch?v=vovhaSxjIzU

Open Molds and Closed Molds



Two forms of mold: (a) open mold, simply a container in the shape of the desired part; and (b) closed mold, in which the mold geometry is more complex and requires a gating system (passageway) leading into the cavity.

Sand Casting Mold (Closed)



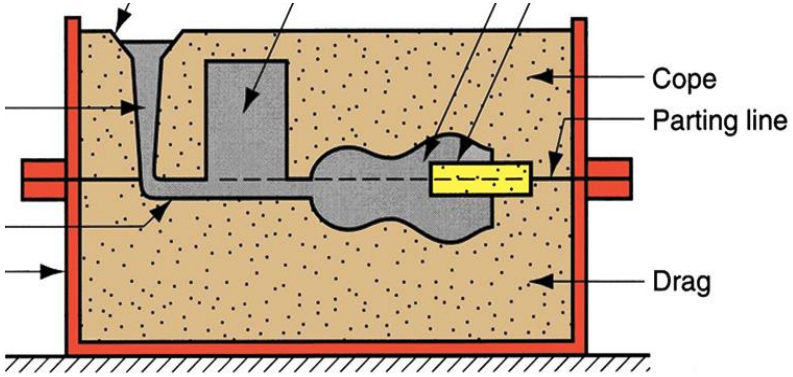
Sand Casting Mold (Closed)

- ✓ Actual size and shape of cavity must be slightly ***oversized*** to allow ***shrinkage*** of metal during ***solidification*** and ***cooling.***

- ✓ Molds are made of a variety of materials, including-
  - ***Sand,***
  - ***Plaster,***
  - ***Ceramic,***
  - ***Metals***

Mold Terms

- Mold consists of two halves:
  - ***Cope*** = upper half of mold
  - ***Drag*** = bottom half



  - ***Cheek*** = intermediate molding flask ***(optional for bigger molds)***

- The rigid metal or wood frame that holds the moulding sand together is called as ***flask***.

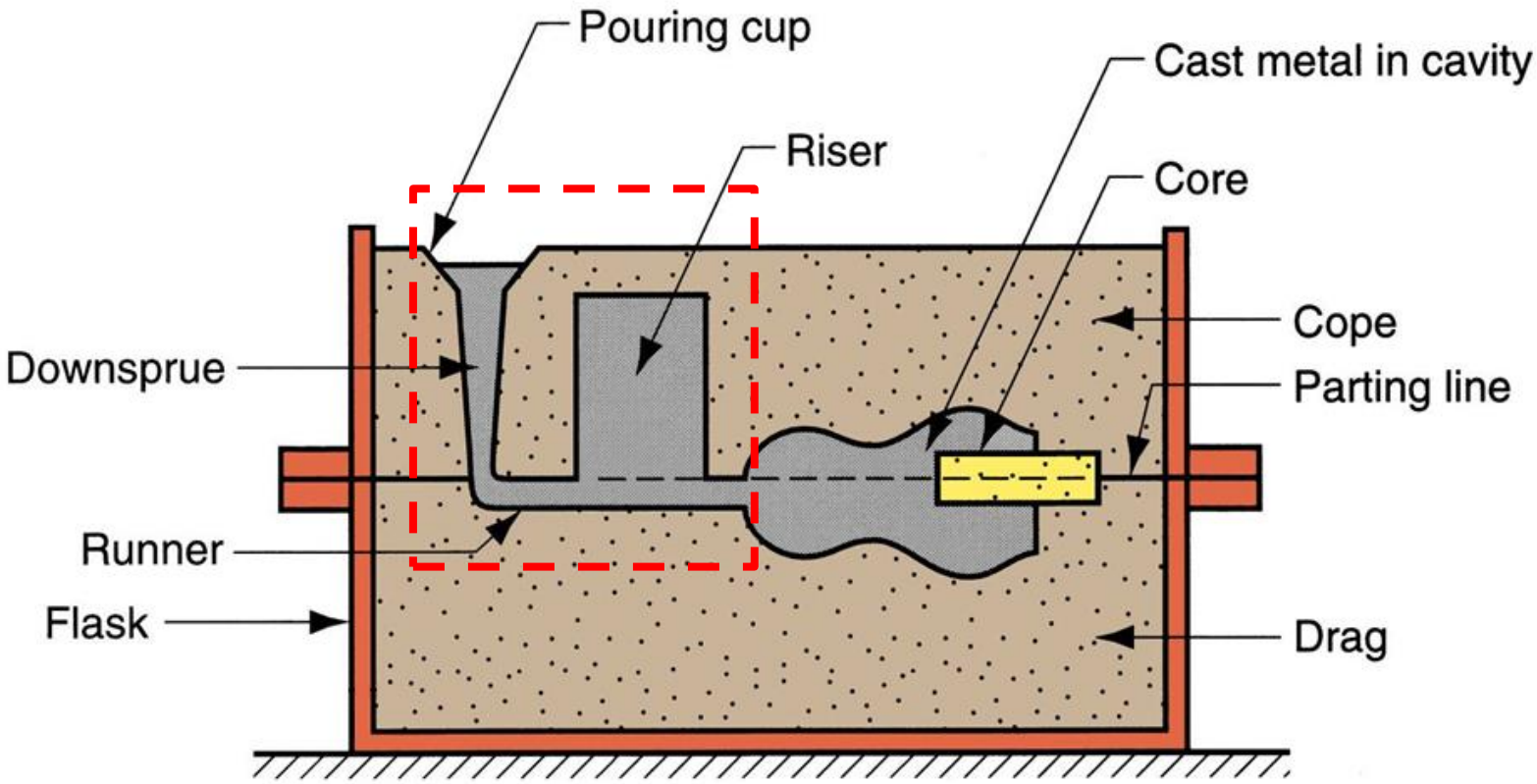
- The two halves separate at the ***parting line.***

Desirable Mold Properties

- ***Strength*** - to maintain shape and resist erosion
- ***Permeability*** - to allow hot air and gases to pass through voids in sand
- ***Thermal stability*** - non reactive with hot molten metal
- ***Collapsibility*** - allow casting to shrink without cracking the casting or mold
- ***Reusability*** - sand of broken mold can be reused to make other molds

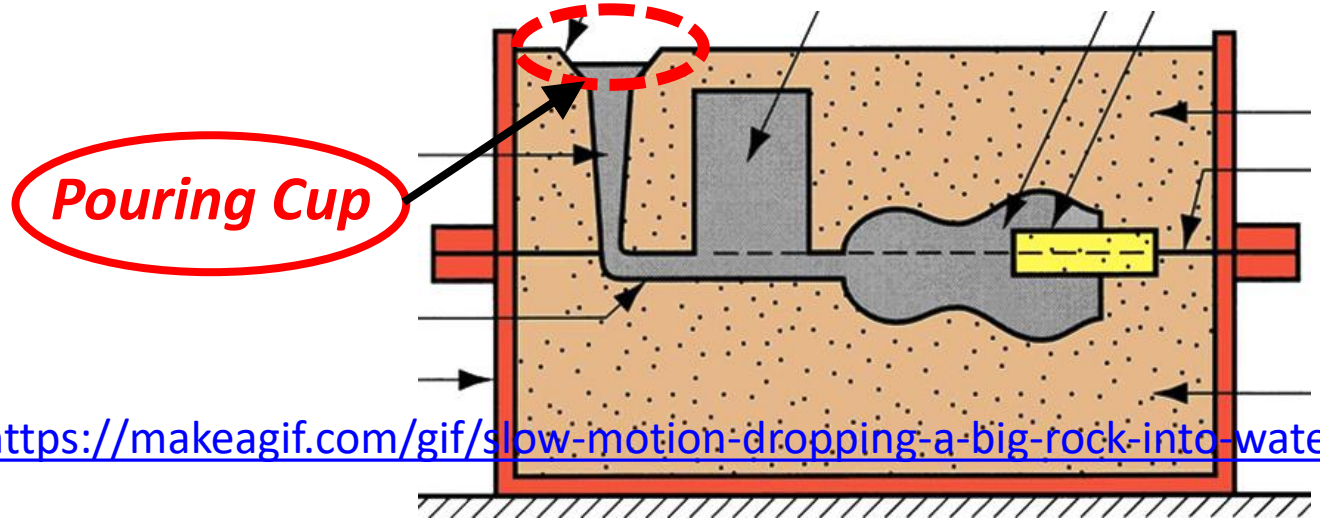
Gating System

The ***gating system*** in a casting mold is the ***channel***, or network of channels, through which ***molten metal flows*** into cavity from outside of mold.



Gating System

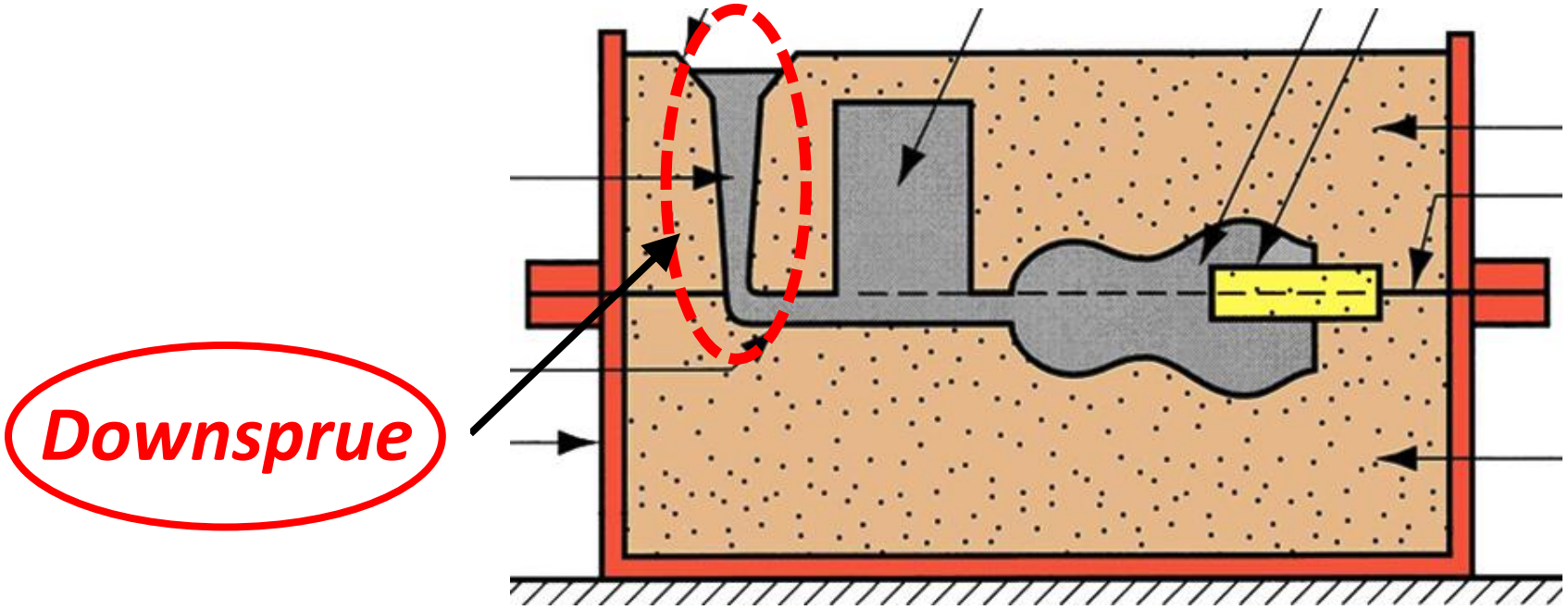
- ***The pouring cup*** (or pouring ***basin***) is the portion of the gating system that receives the molten metal from the **pouring vessel** and delivers it to the rest of the mold.
- ***Pouring cup*** is often used to minimize **splash** and **turbulence** as the metal flows into downsprue



https://makeagif.com/gif/slow-motion-dropping-a-big-rock-into-water-_c8mH

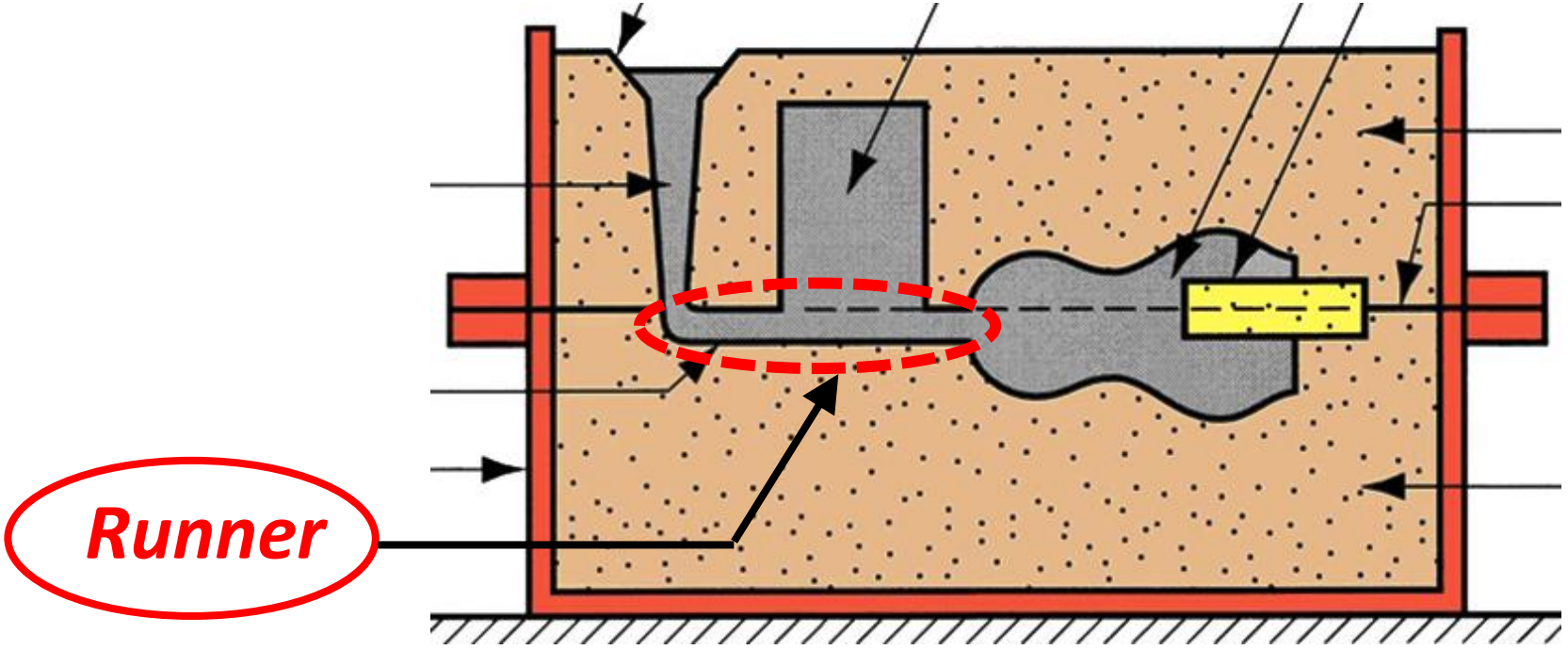
Gating System

- From the pouring cup, the metal travels down a ***downsprue*** *also called simply the* ***sprue*** (the vertical portion of the gating system).



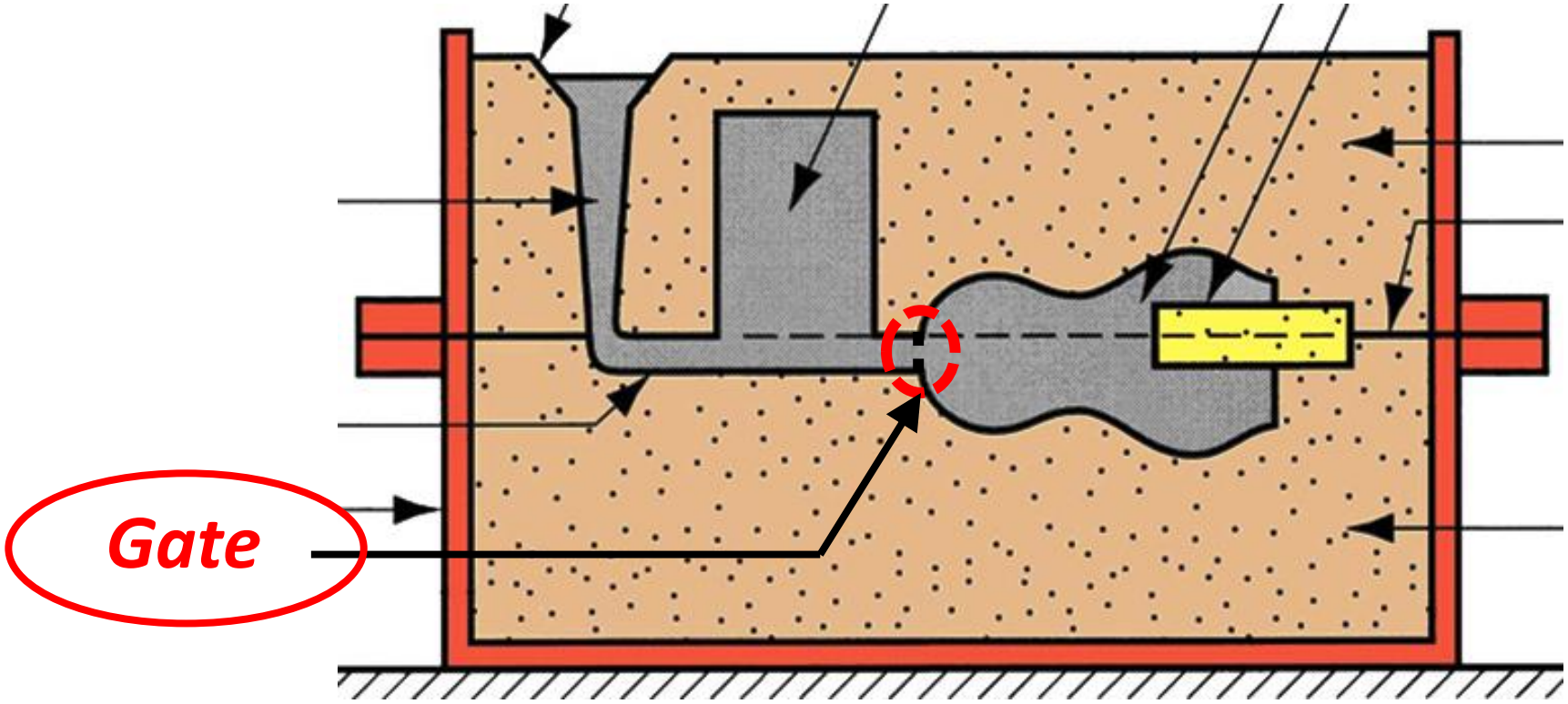
Gating System

- Then liquid metal flow along horizontal channels, called ***runners***.



Gating System

- Finally liquid metal through controlled entrances (i.e. ***gates)*** reaches into the mold cavity.



Gating System

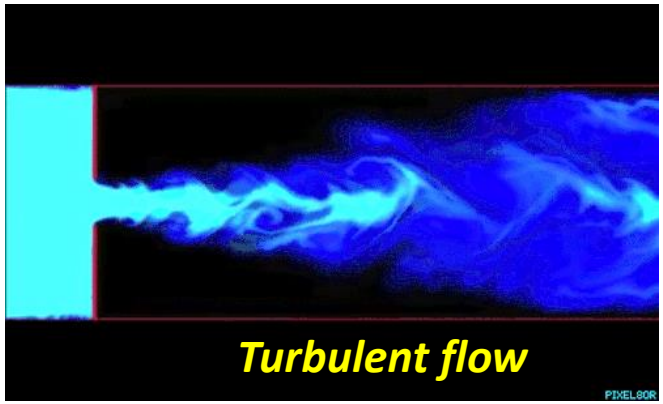
- The ***gates*** are usually ***attached*** to the

  1. ***thickest or heaviest sections*** of a casting **to control SHRINKAGE**
  2. ***to the bottom of the casting*** to **minimize TURBULENCE AND SPLASHING**.

- For large castings, ***multiple gates*** and runners is used to introduce metal at more than one point in the mold cavity.

Gating System

- ***Turbulent flow*** is generated while pouring the molten metal into the mold which causes the following problems:
  - *absorption of gases,*
  - *oxidation of the metal, and*
  - *erosion of the mold.*

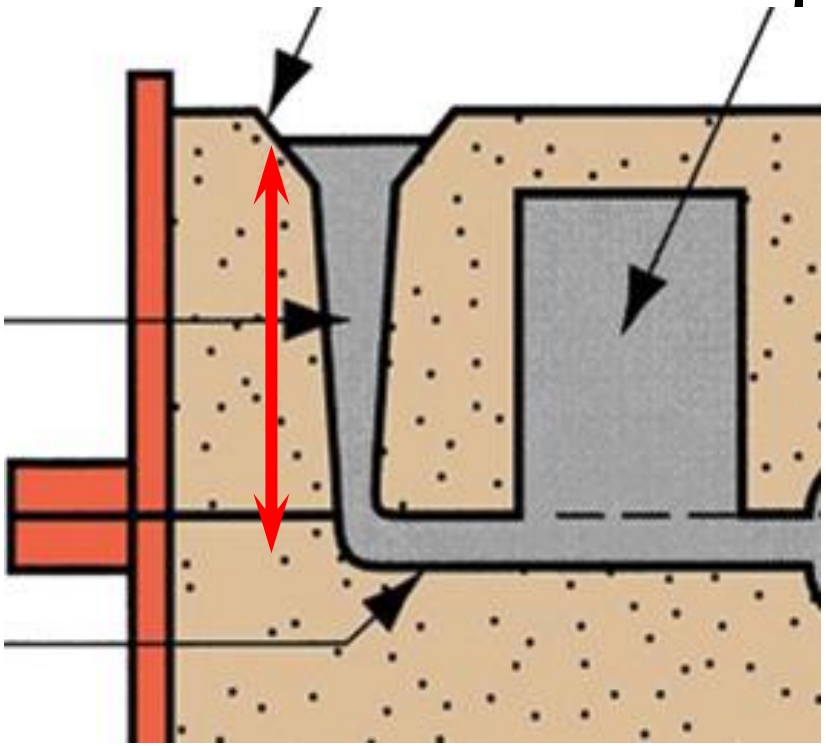


- Therefore gating systems should be designed to ***minimize turbulent flow.***

https://www.tumblr.com/tagged/dynamics

Gating System

- ***Short sprues*** are desirable, since they minimize the distance that metal falls when entering to the mold and kinetic energy acquires during that fall.



https://www.youtube.com/watch?v=vovhaSxjIzU

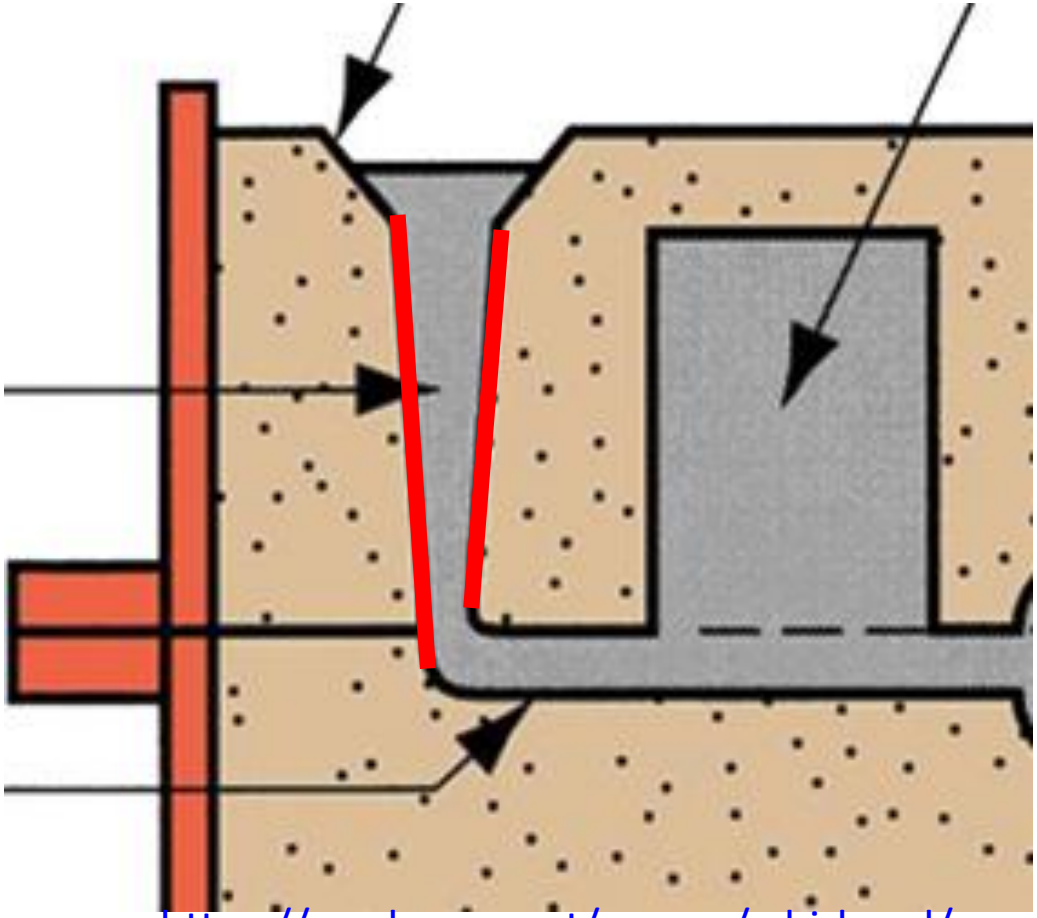
Gating System

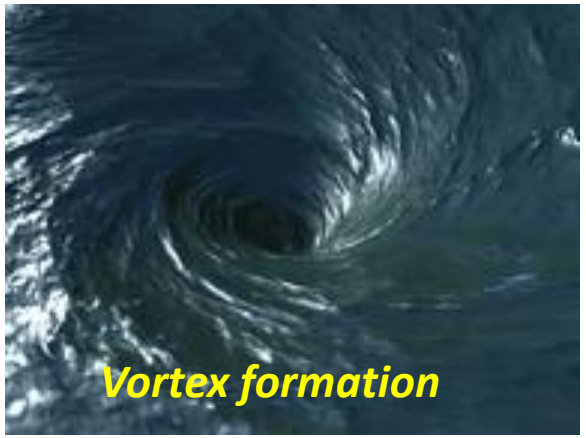
- ***Rectangular pouring cups*** prevent the formation of a ***vortex or spiralling funnel***, which tends to suck gas and oxides into the sprue.

https://forum.freecadweb.org/viewtopic.php?t=8468

Gating System

- ***Tapered sprues*** also prevent ***vortex formation***.





https://mscharrer.net/povray/whirlpool/

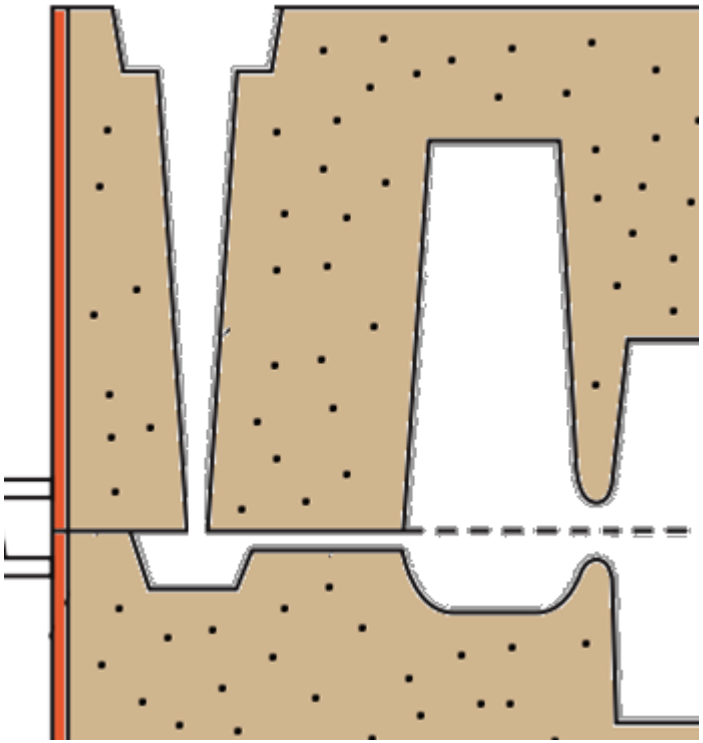
Gating System

- ***A large sprue well*** can be used to dissipate the kinetic energy of the falling stream and prevent splashing and turbulence as the metal makes the turn into the runner.

- The ***choke*** , or ***smallest cross-sectional*** area in the gating system, serves to control the rate of metal flow.

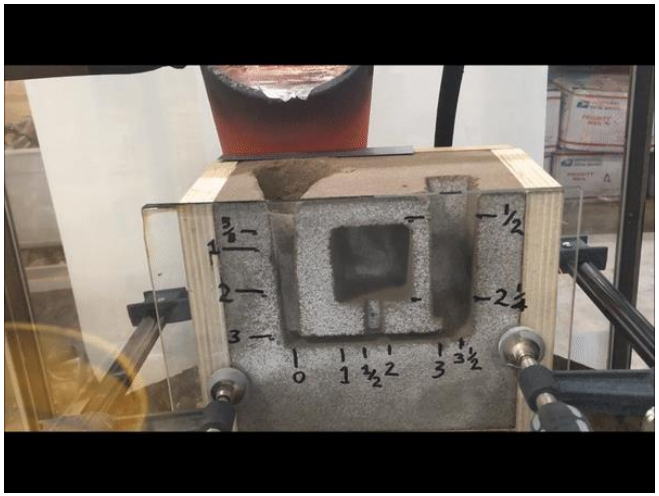
Gating System

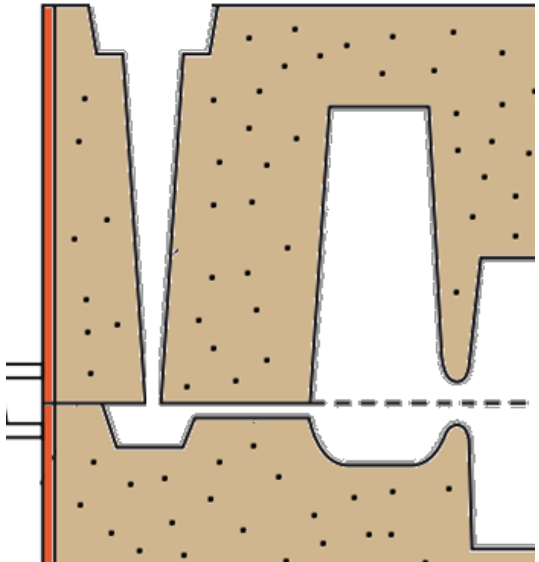
- Gating systems can also be designed to trap ***dross (slag)*** and ***sand particles*** and keep them from entering the mold cavity.



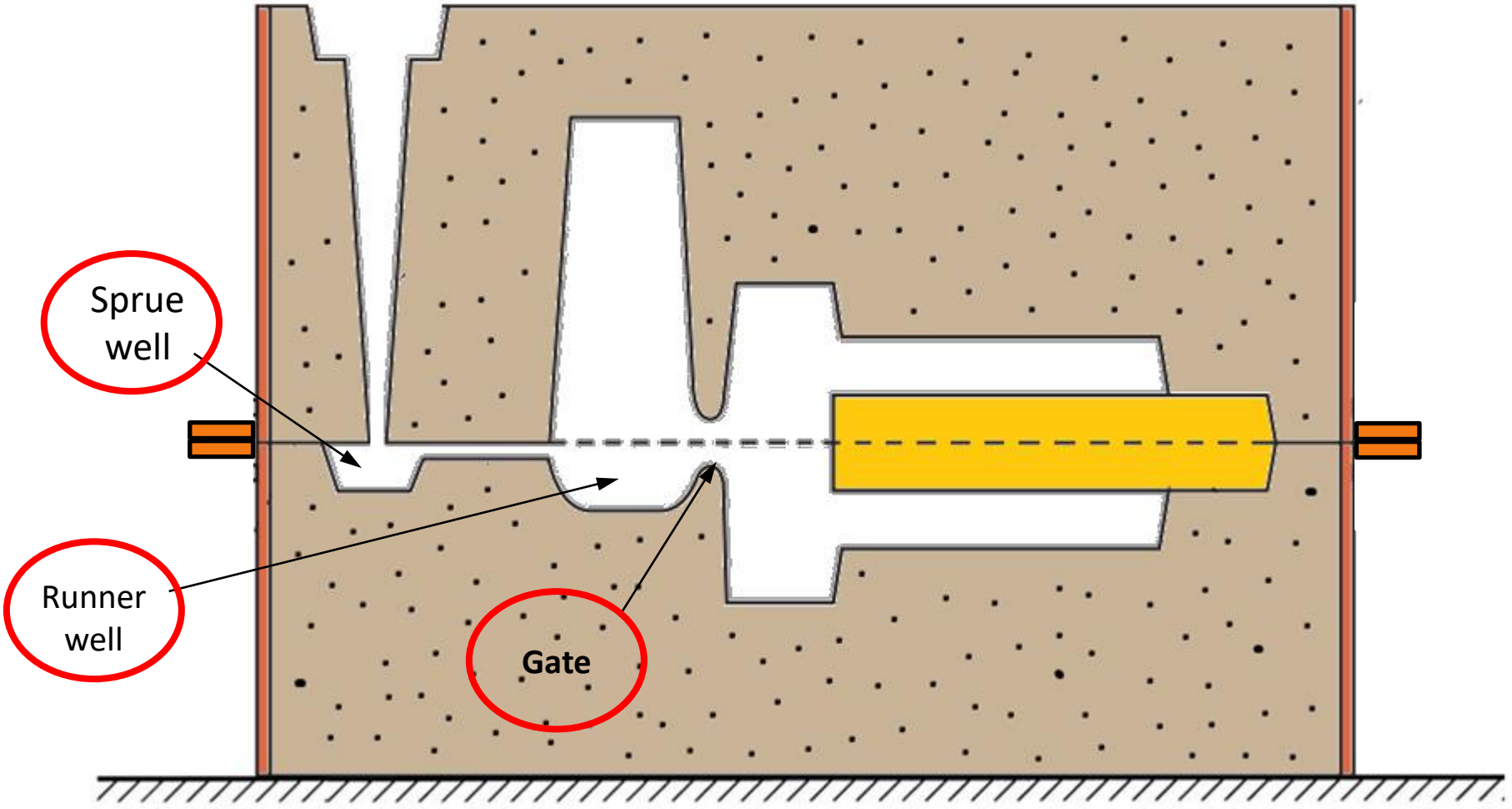
Gating System

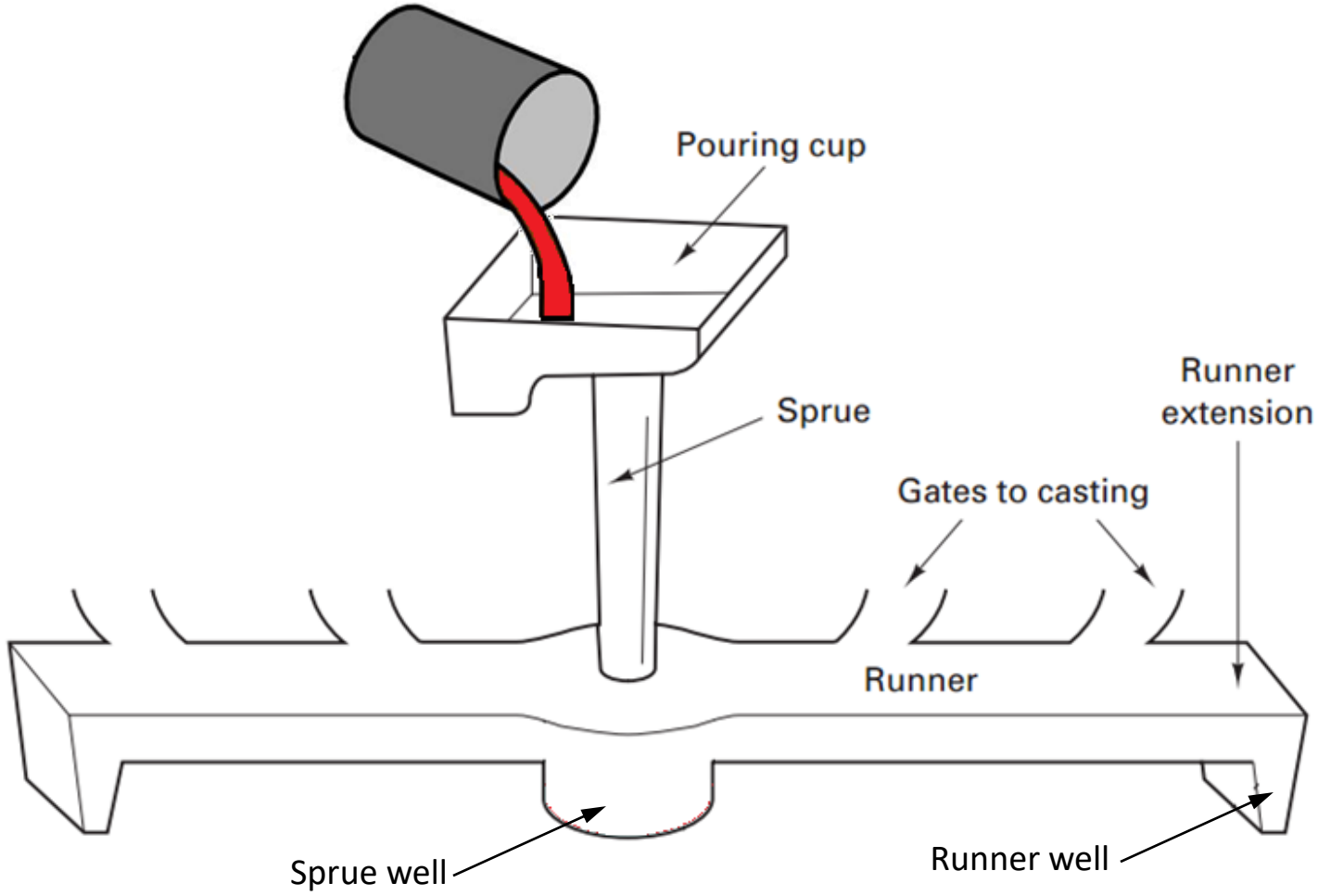
- Since the first metal to enter the mold is most likely to contain the foreign matter (dross from the top of the pouring ladle and loose particles washed from the walls of the gating system), ***RUNNER EXTENSIONS*** and ***RUNNER WELLS*** can be used to catch and trap this first metal and keep it from entering the mold cavity.

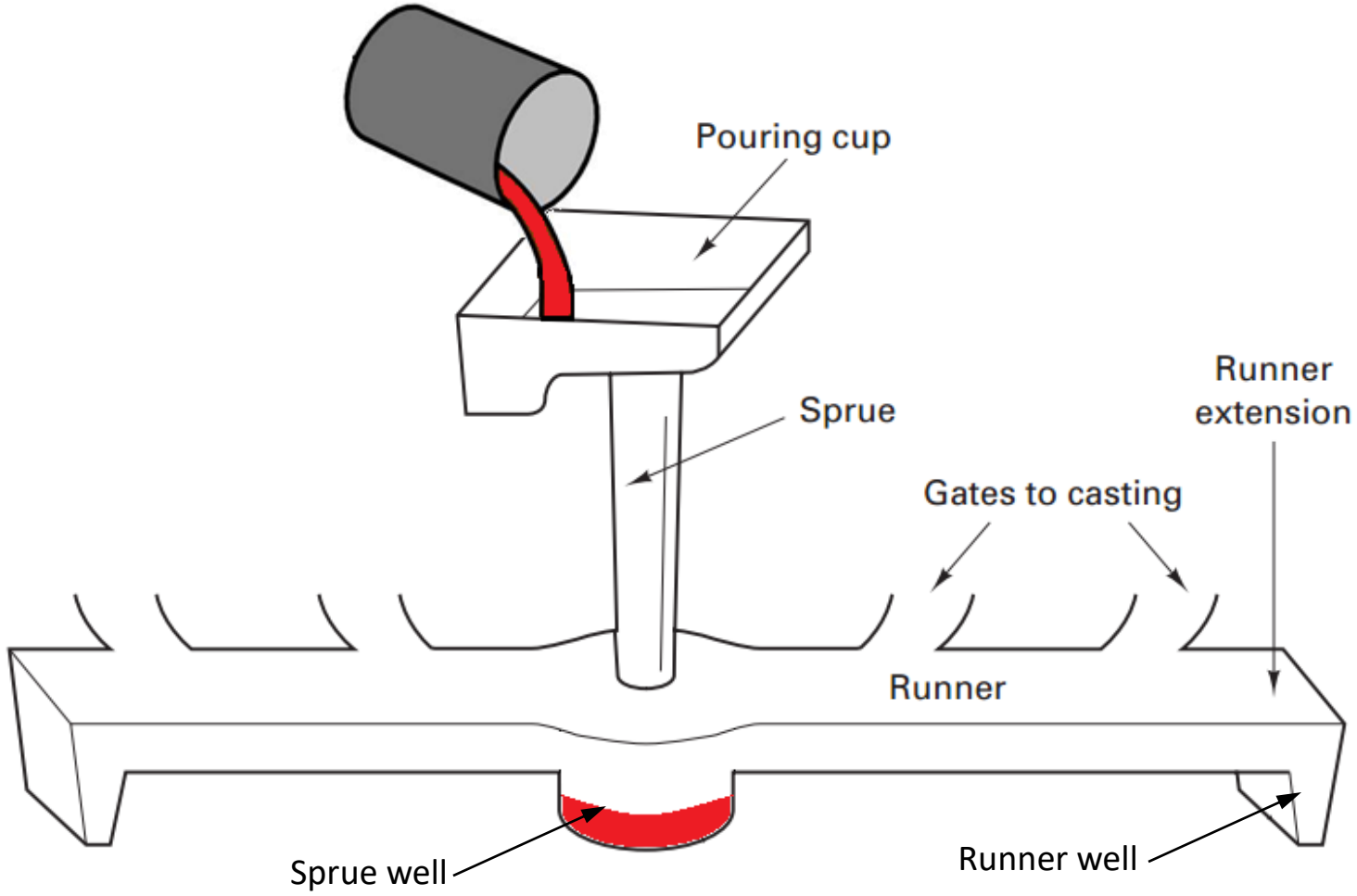




Gating System




Pouring cup
Sprue
Runner extension
Gates to casting
Runner
Sprue well
Runner well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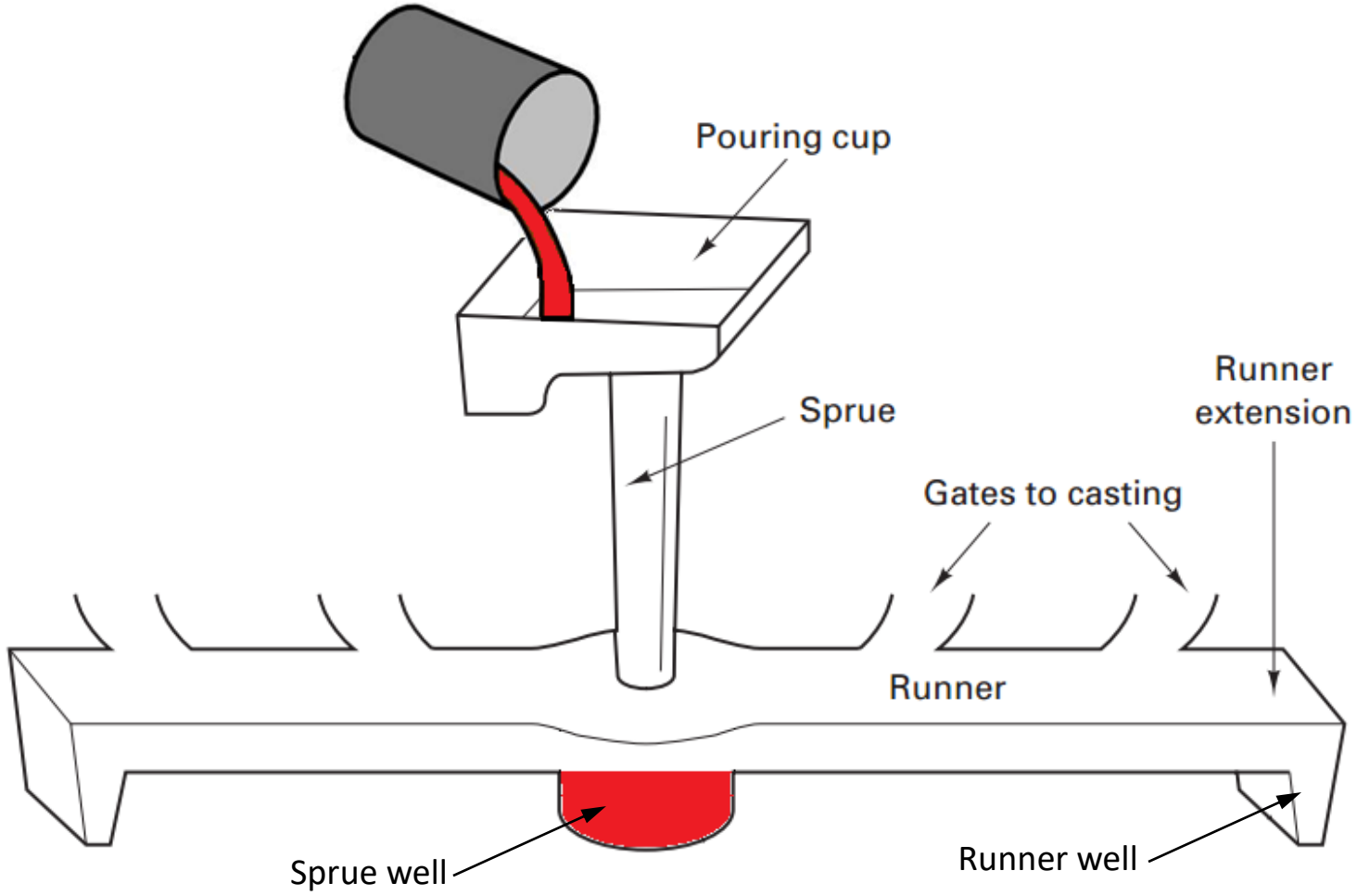
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Sprue well
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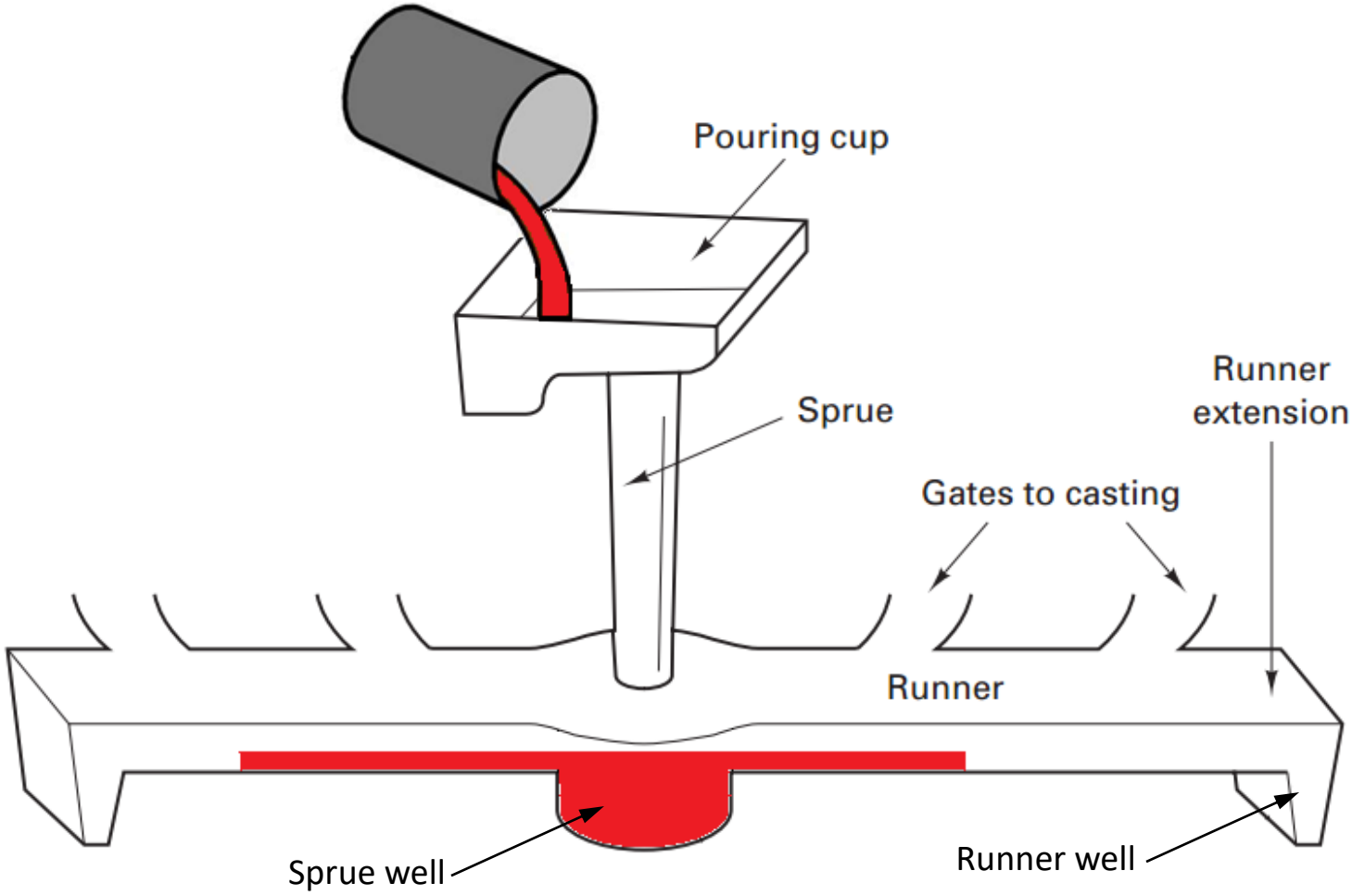
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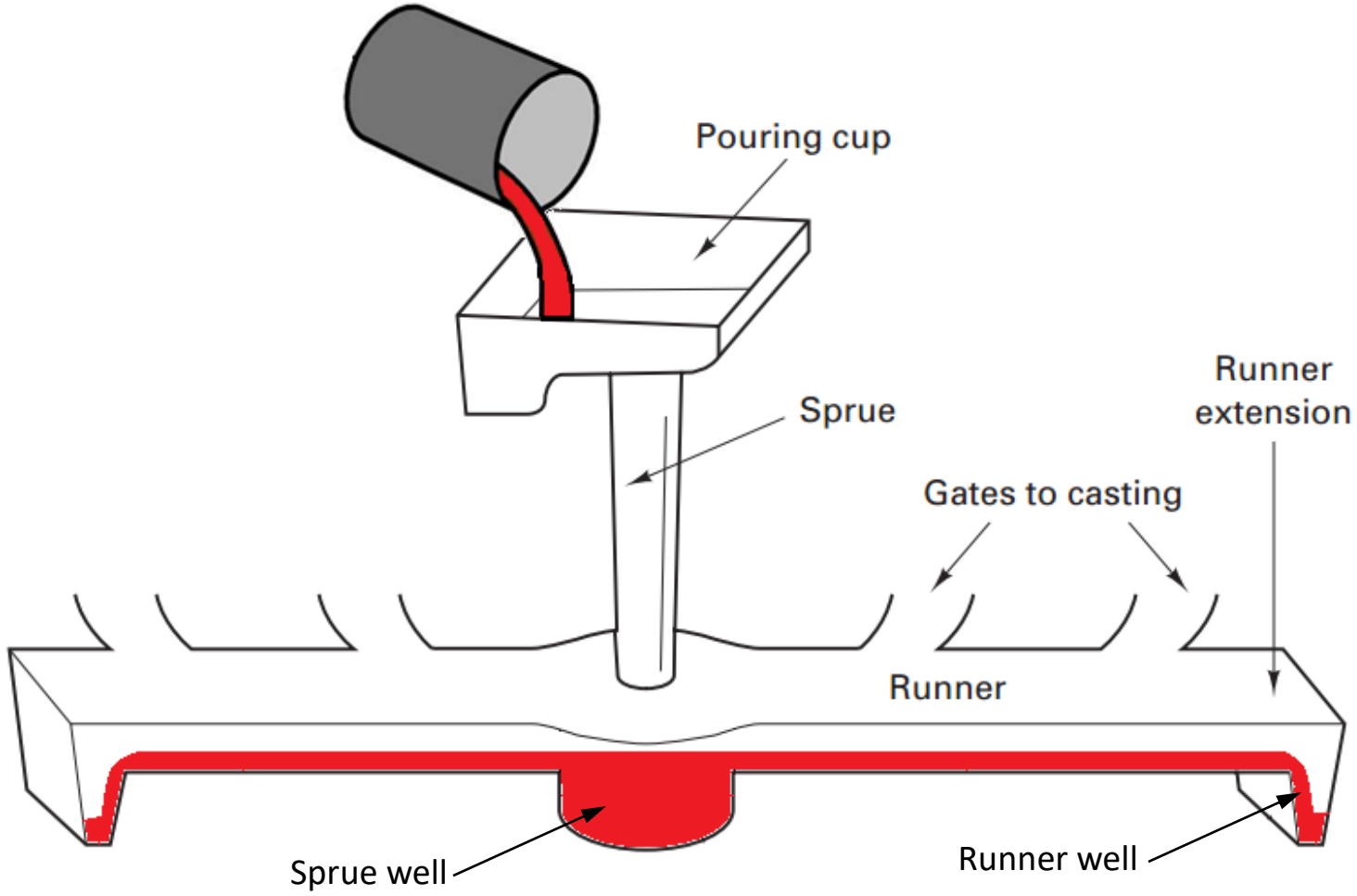
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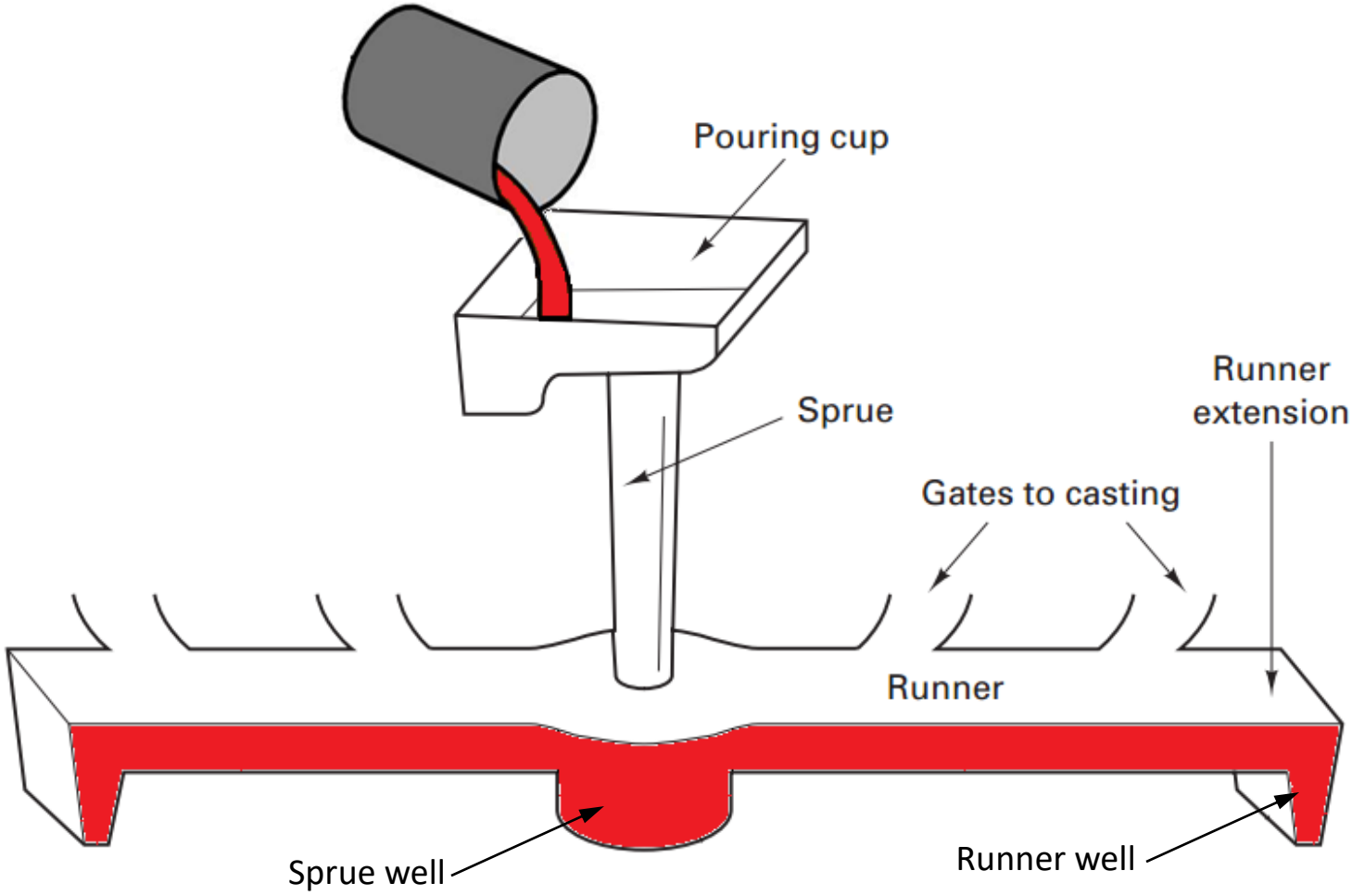
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Runner
Sprue well
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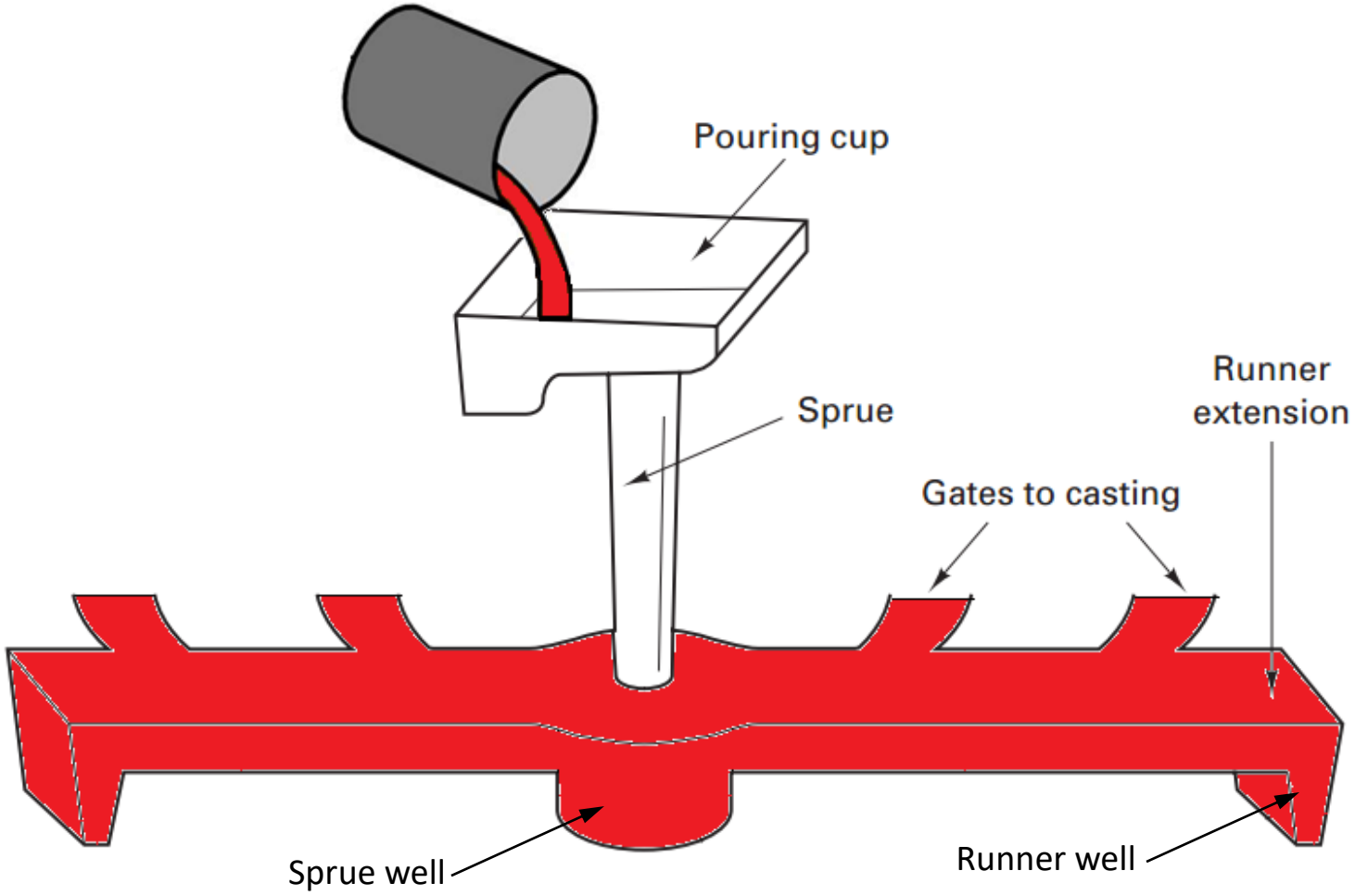
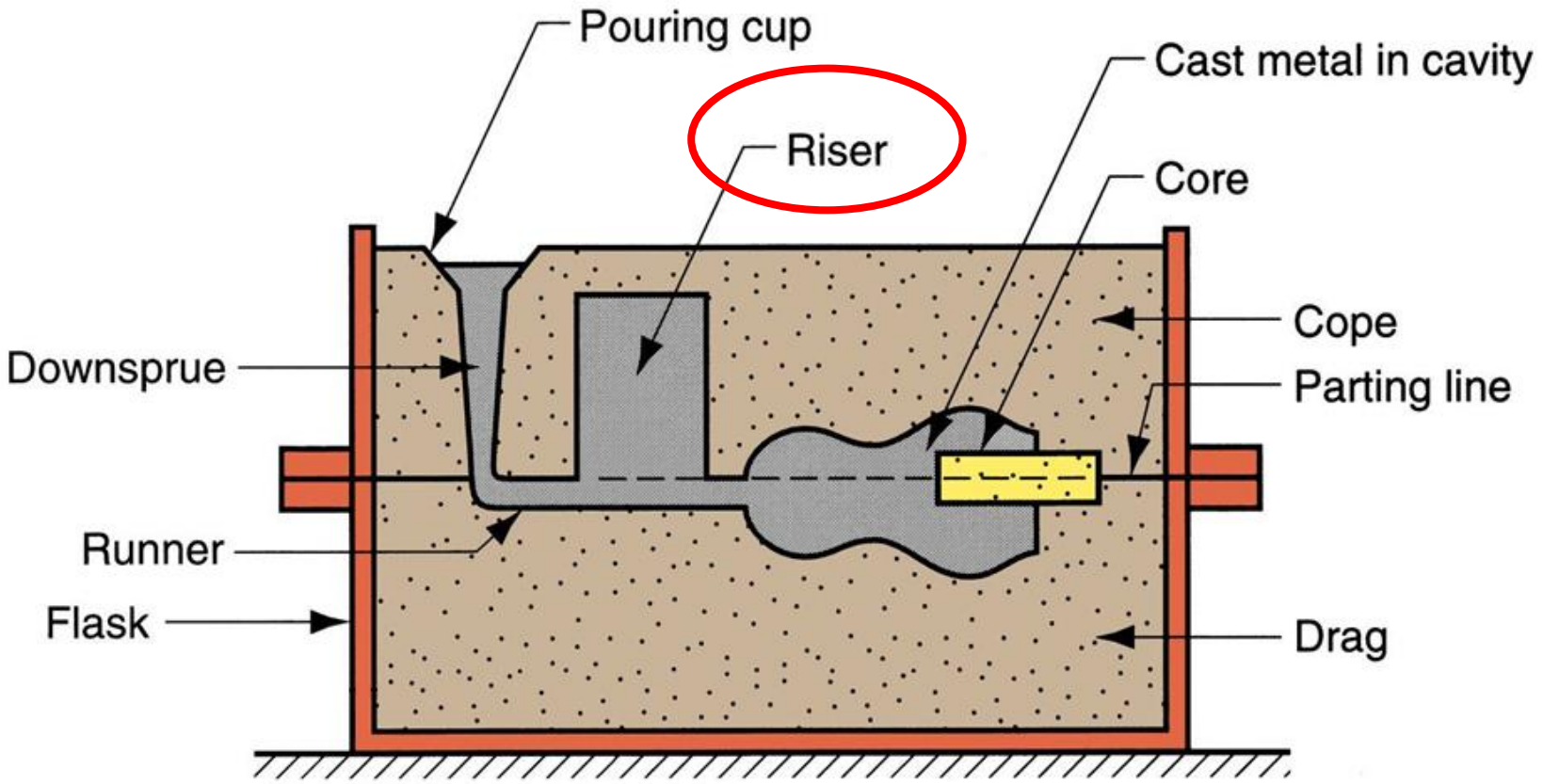

Pouring cup
Sprue
Runner extension
Gates to casting
Sprue well
Runner well

Riser

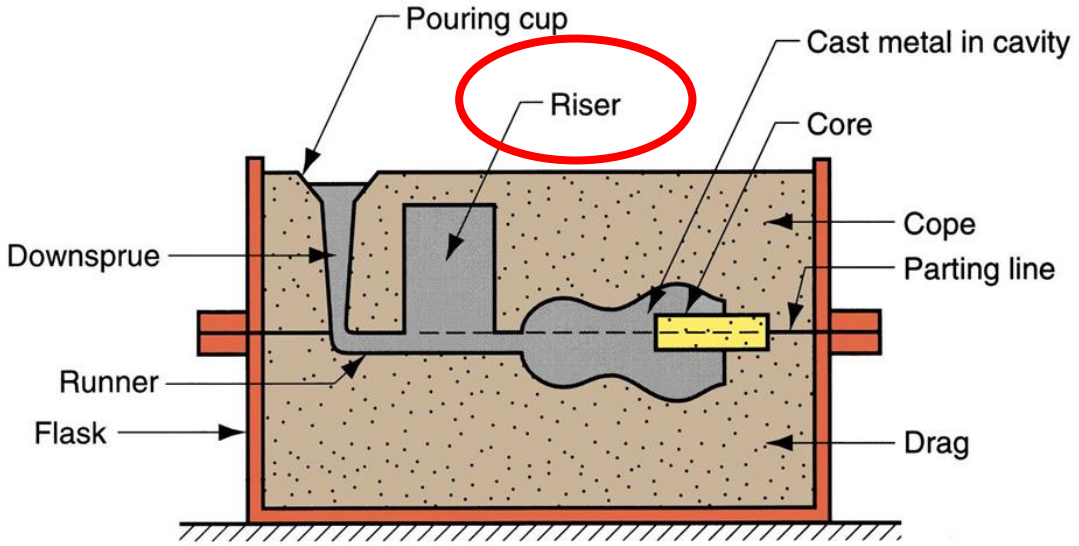
- A ***Riser*** is an additional void in the mold that also fills with molten metal.



Riser

- ***Riser*** is a ***reservoir*** of additional molten metal that can flow into the mold to ***compensate*** for ***shrinkage*** of the part ***during solidification .***

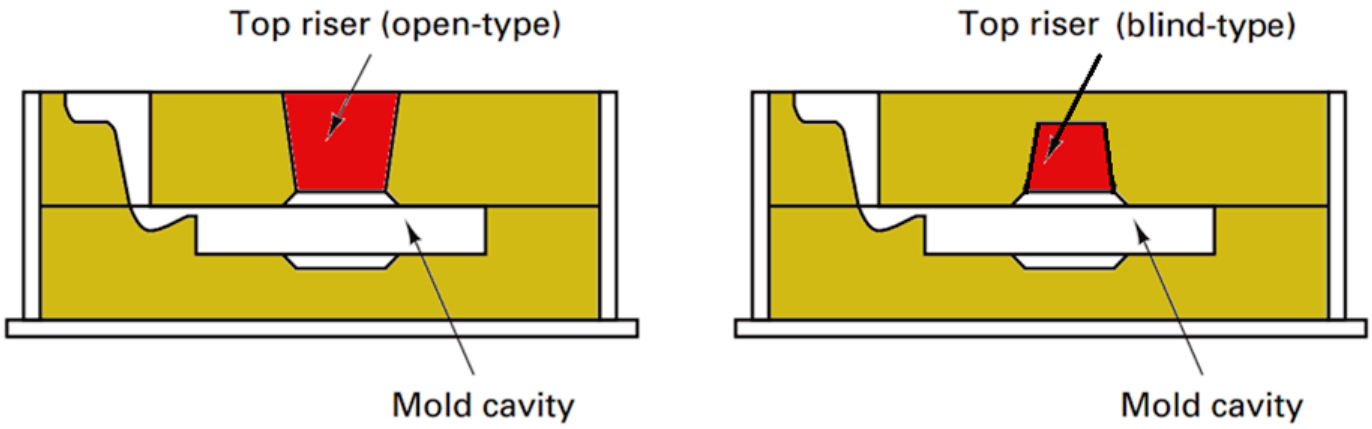
- The ***riser must*** be designed to ***freeze after*** the main ***casting*** in order to satisfy its function i.e. it should have a **larger volume-to-area ratio** so that the main casting solidifies first.



Riser

- ***Dead (or cold)*** ***risers*** fill with metal which already flowed through the mold cavity.
- As shown in Figure, ***top risers*** are almost always dead risers.

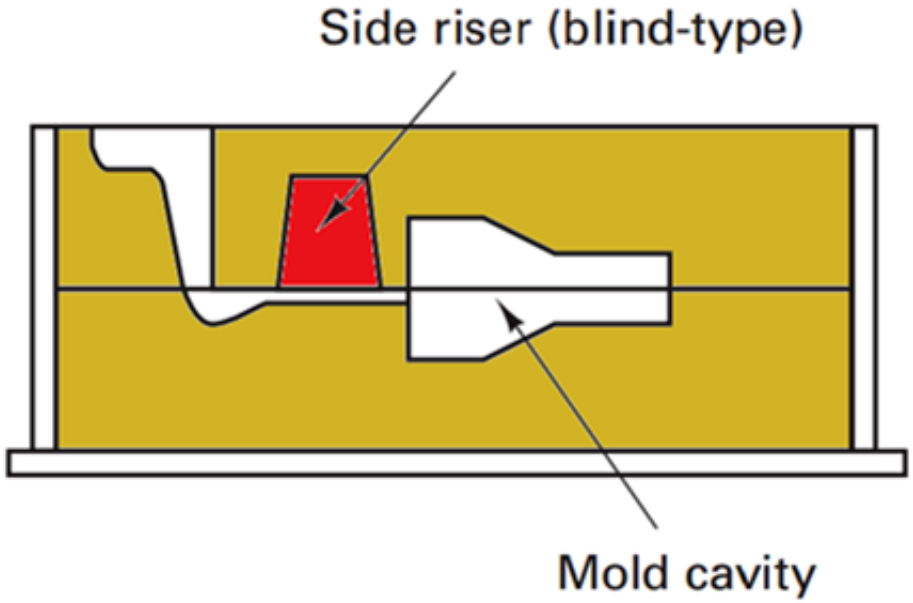
Dead Riser



Riser

- ***Live risers*** (also known as ***hot risers***) receive the last hot metal that enters the mold.
- Risers that are part of the gating system generally ***live risers***.

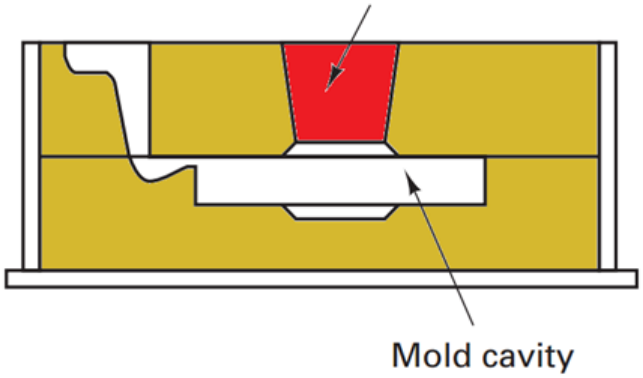
Live Riser



Riser

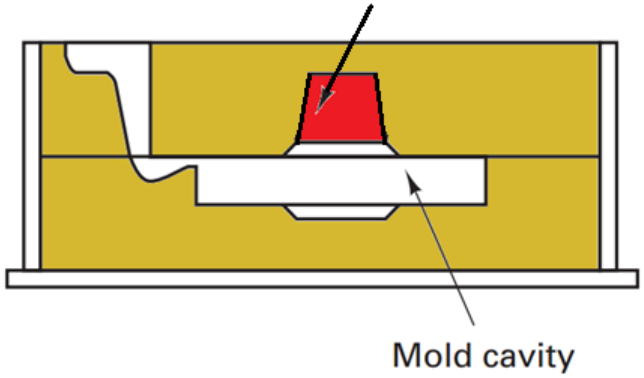
Dead

Top riser (open-type)



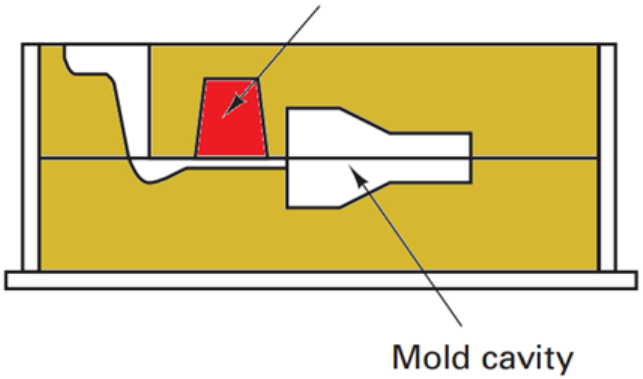
Dead

Top riser (blind-type)



Live

Side riser (blind-type)



Riser Location

- A riser should be located in such a way that directional solidification is obtained.
- Since the heaviest section of the casting solidifies last, the riser should be located to feed this section.
- The heaviest section will now act as a riser for other sections which are not so heavy or thick.
- For small castings, a single riser can feed the entire casting, but more than one riser is required for large castings.

Riser Location

- The number of risers and their locations depend on the casting configuration.
- The risers are generally located at a short distance from the casting since they are ultimate separated from the final casting.
- The connecting channel between the casting and the riser should be large enough (Diameter) to ensure that this link does not freeze before the casting.

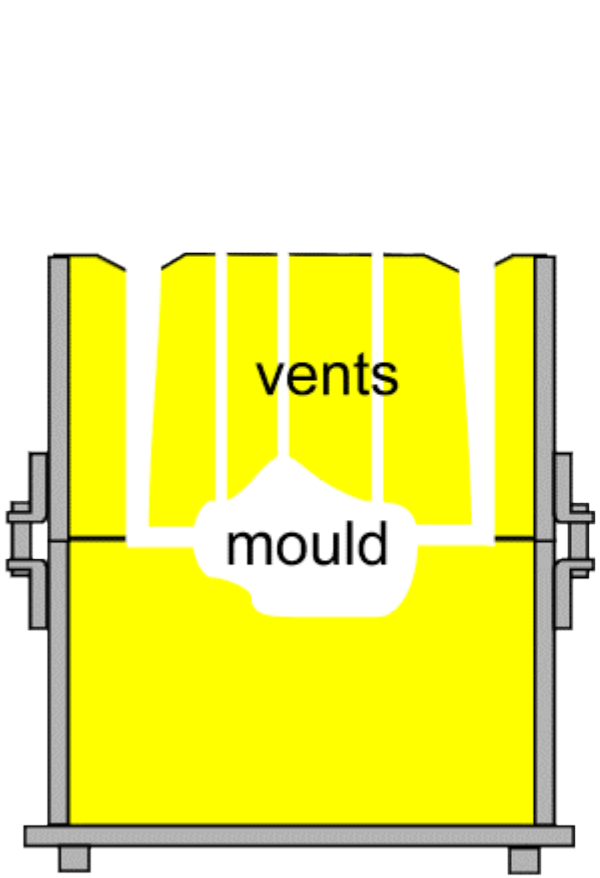
Vent holes

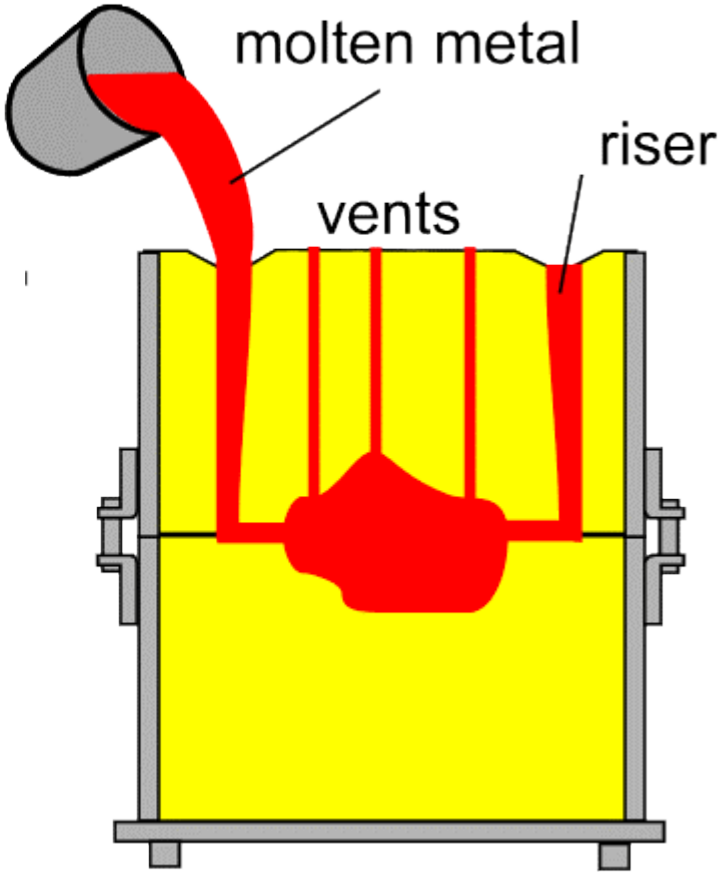
- As the metal flows into the mould, the air that previously occupied the cavity, as well as hot gases formed by reactions of the molten metal, must be evacuated so that the metal will completely fill the empty space.

- In sand casting, for example, the natural porosity of the sand mould permits the air and gases to escape through the walls of the cavity.

- In permanent-metal mould, small vent holes are drilled into the mould or machined into the parting line to permit removal of air and gases.

Vent holes





*https://www.the-warren.org/GCSERevision/engineering/casting.htm

References:

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- Degarmo, E. P., Kohser, Ronald A. and Black, J. T., Materials and Processes in Manufacturing, Prentice Hall of India (2008) 8th ed.
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