

Casting Technology

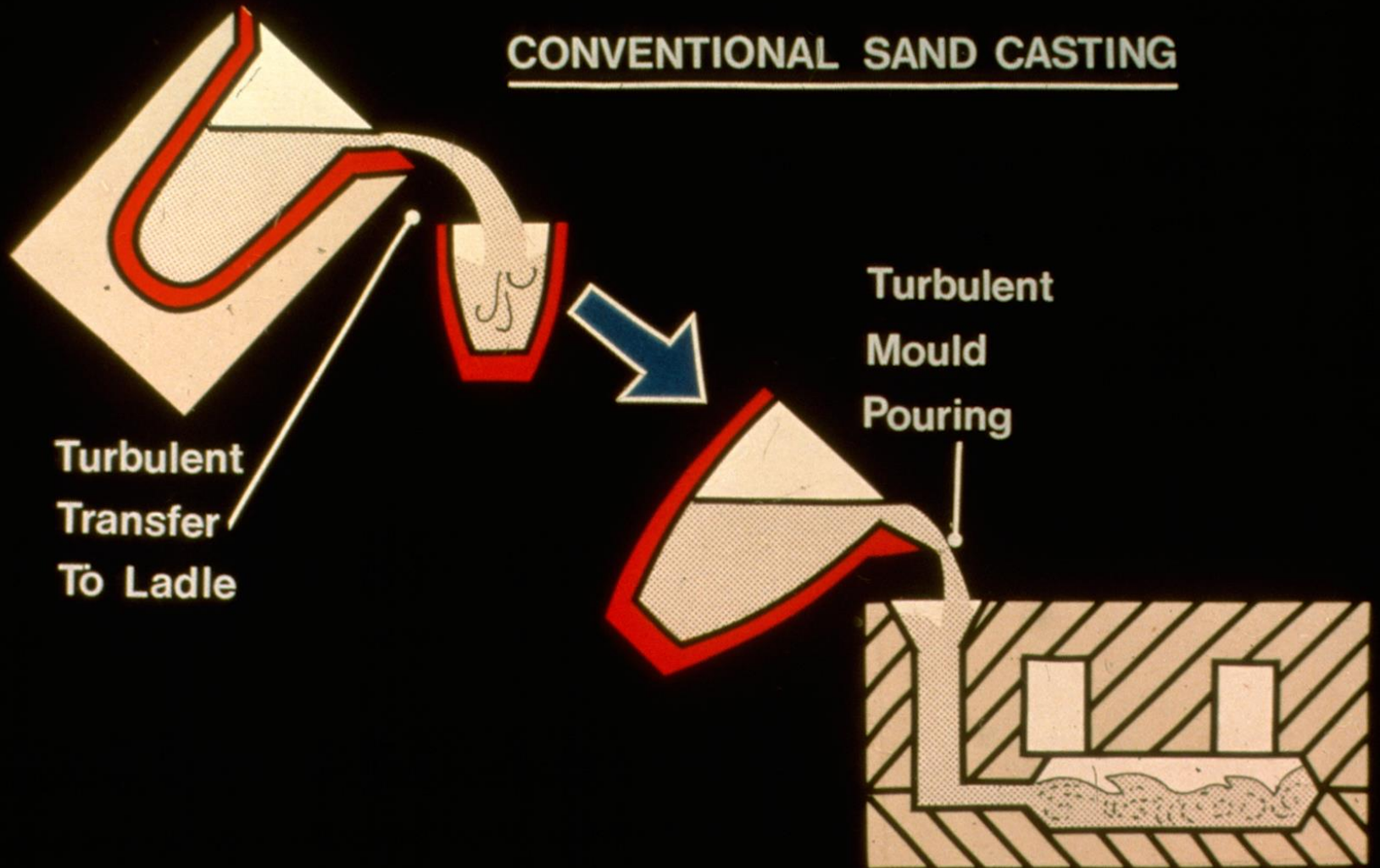
AFI Conference

2020

John Campbell

University of Birmingham UK

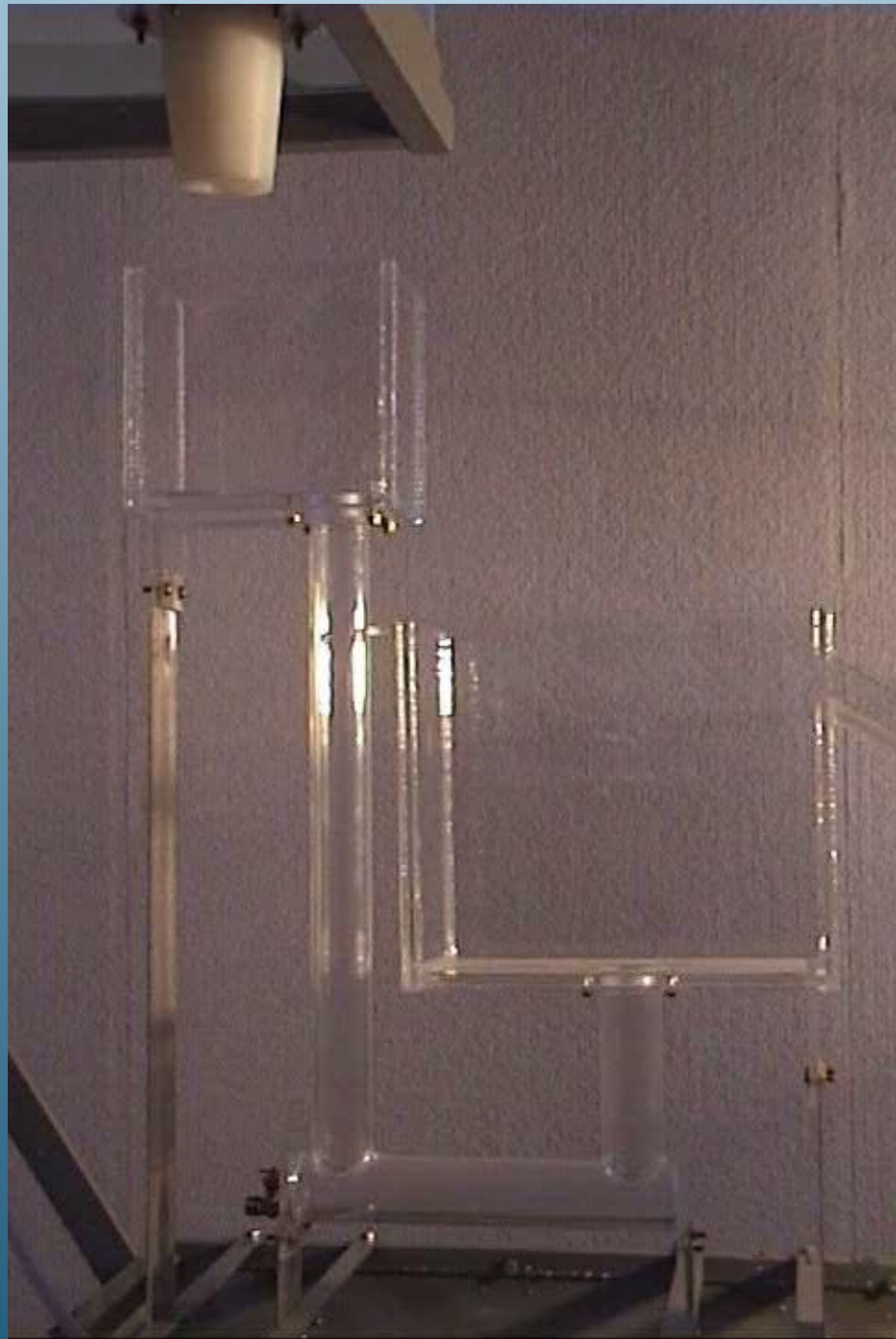
CONVENTIONAL SAND CASTING

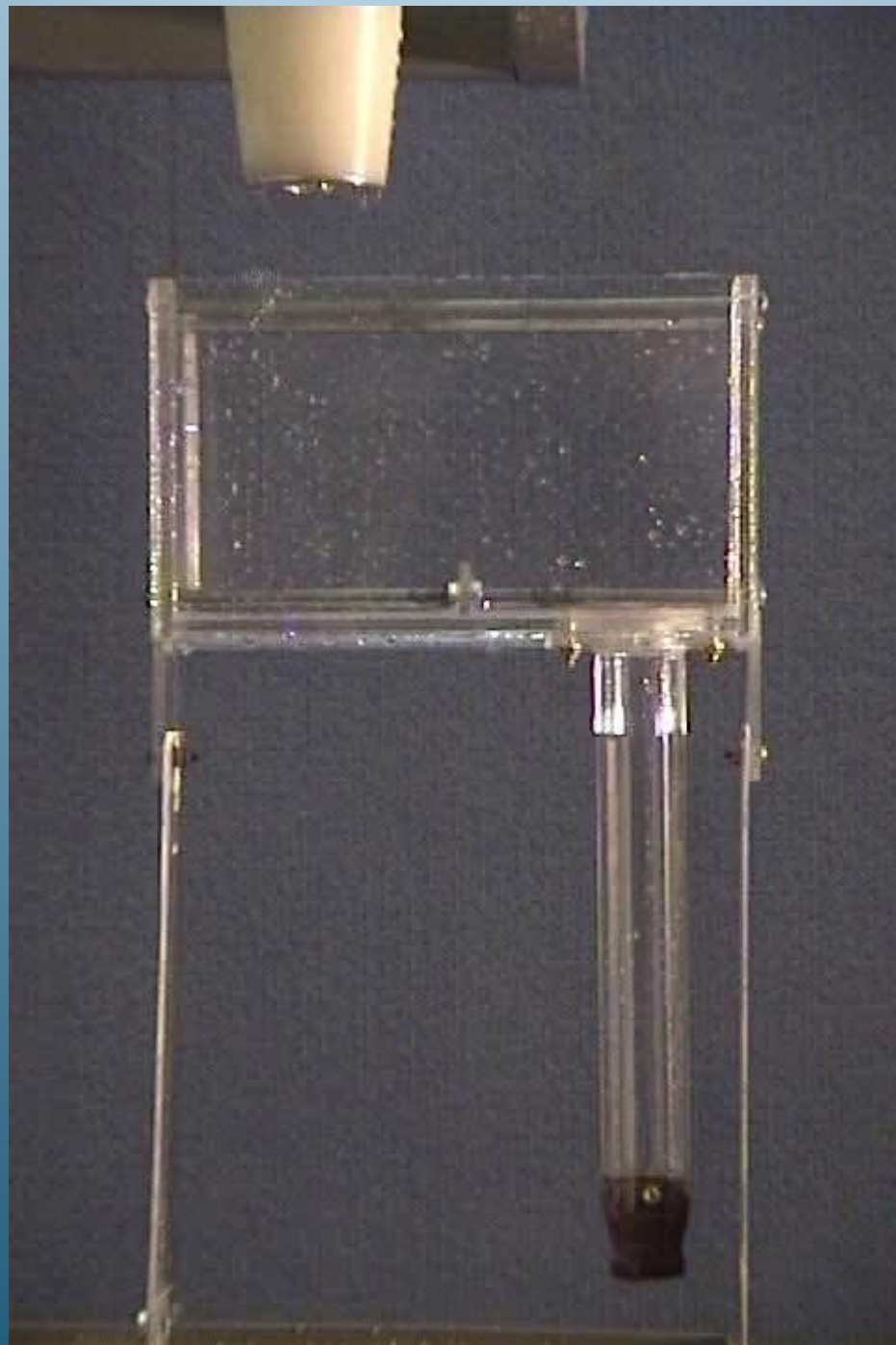


Turbulent
Transfer
To Ladle

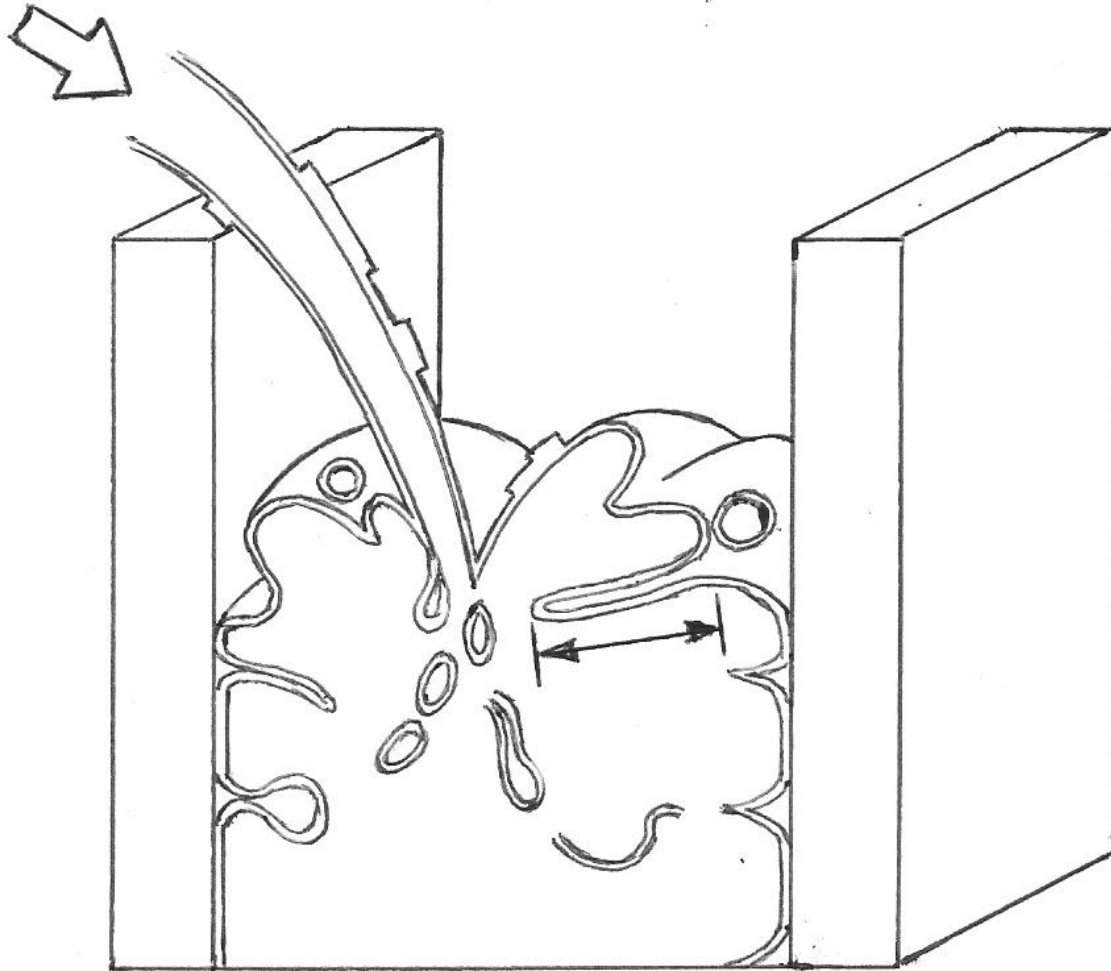
Turbulent
Mould
Pouring

Gas Entrapment due to Rolling Back Wave

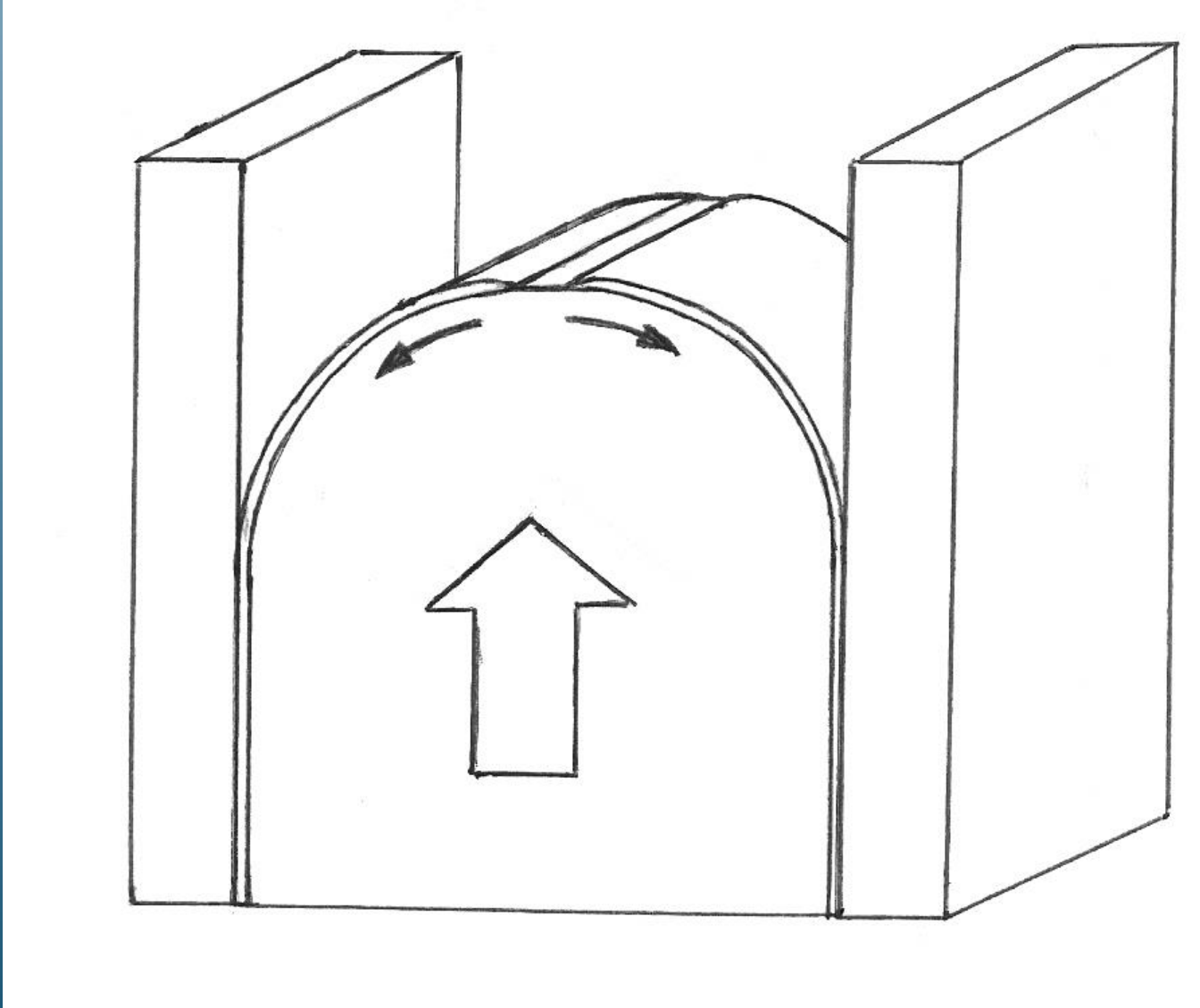




Top gated turbulent filling



Bottom gated laminar filling

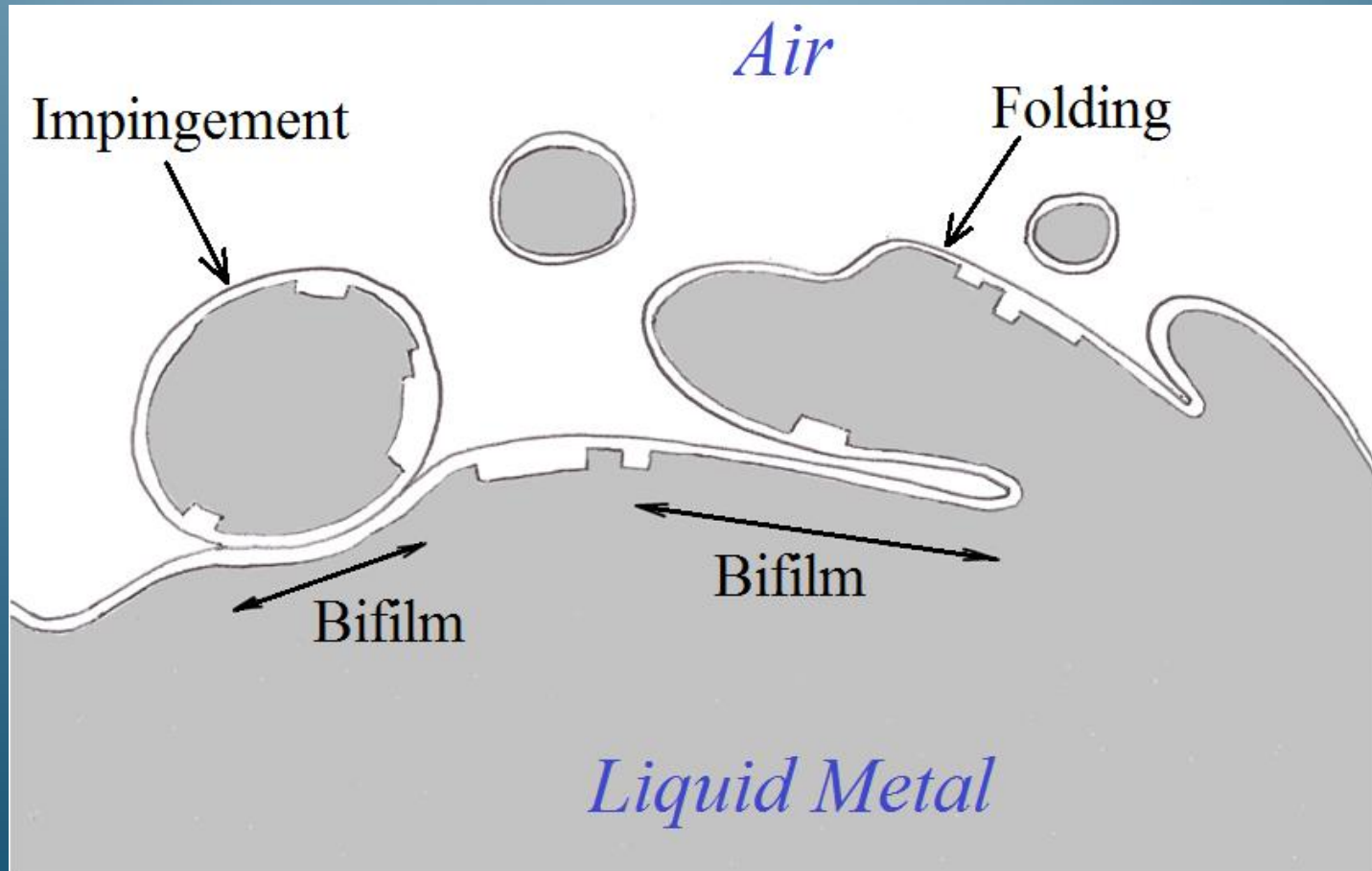


Entrainment Defects

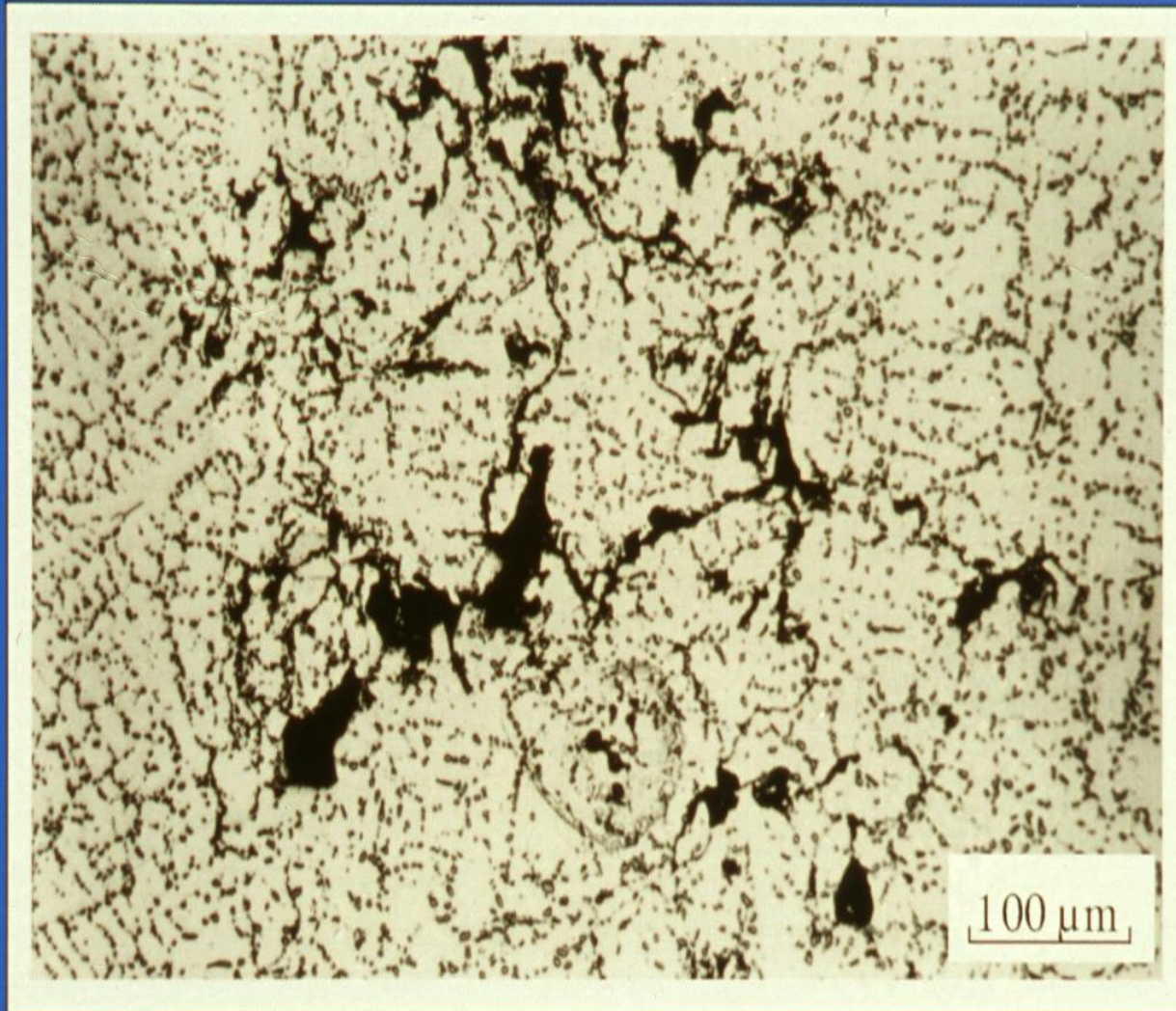
1. Bifilms

2. Bubbles

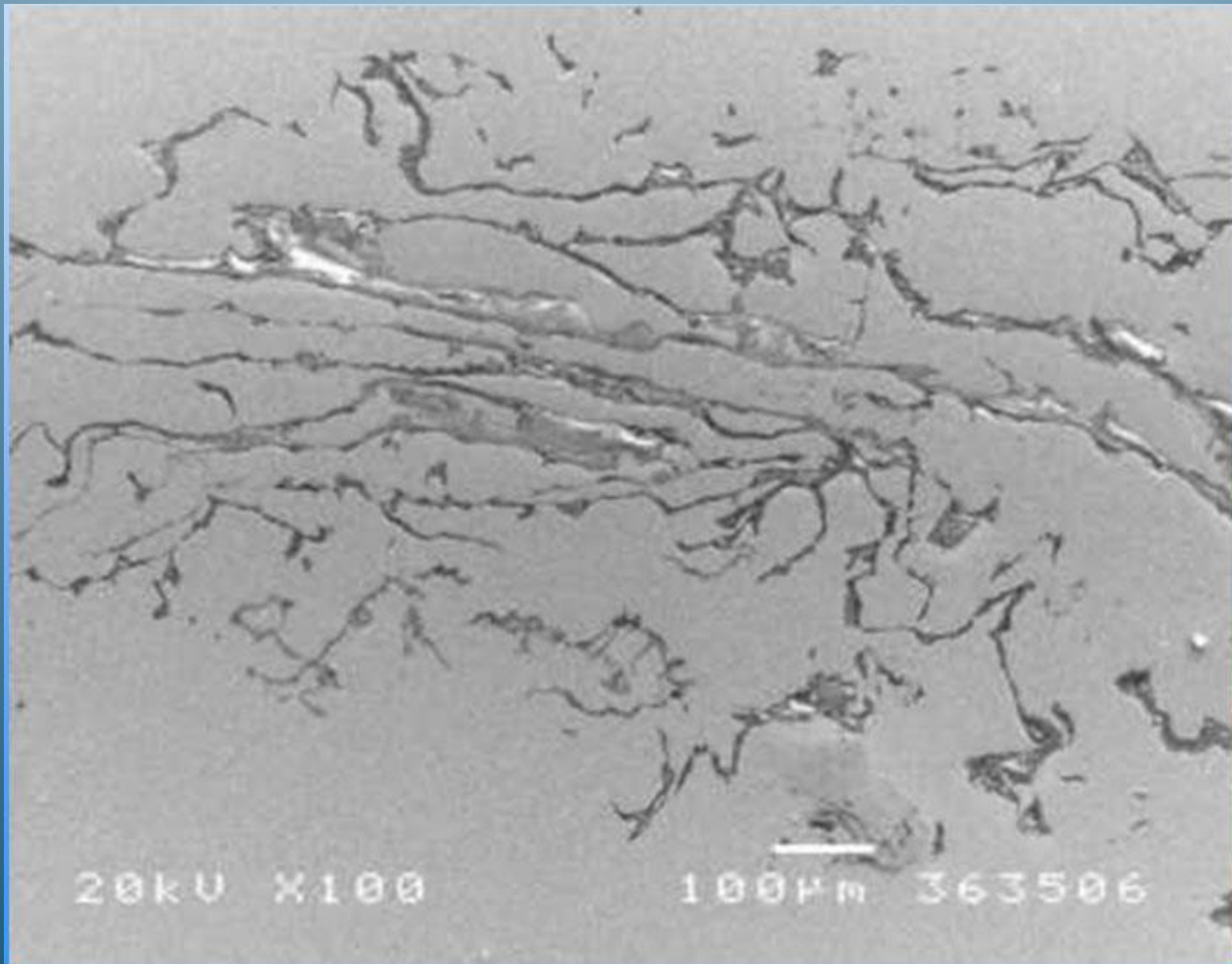
Surface Turbulence generating Bifilm Cracks in the Liquid Metal



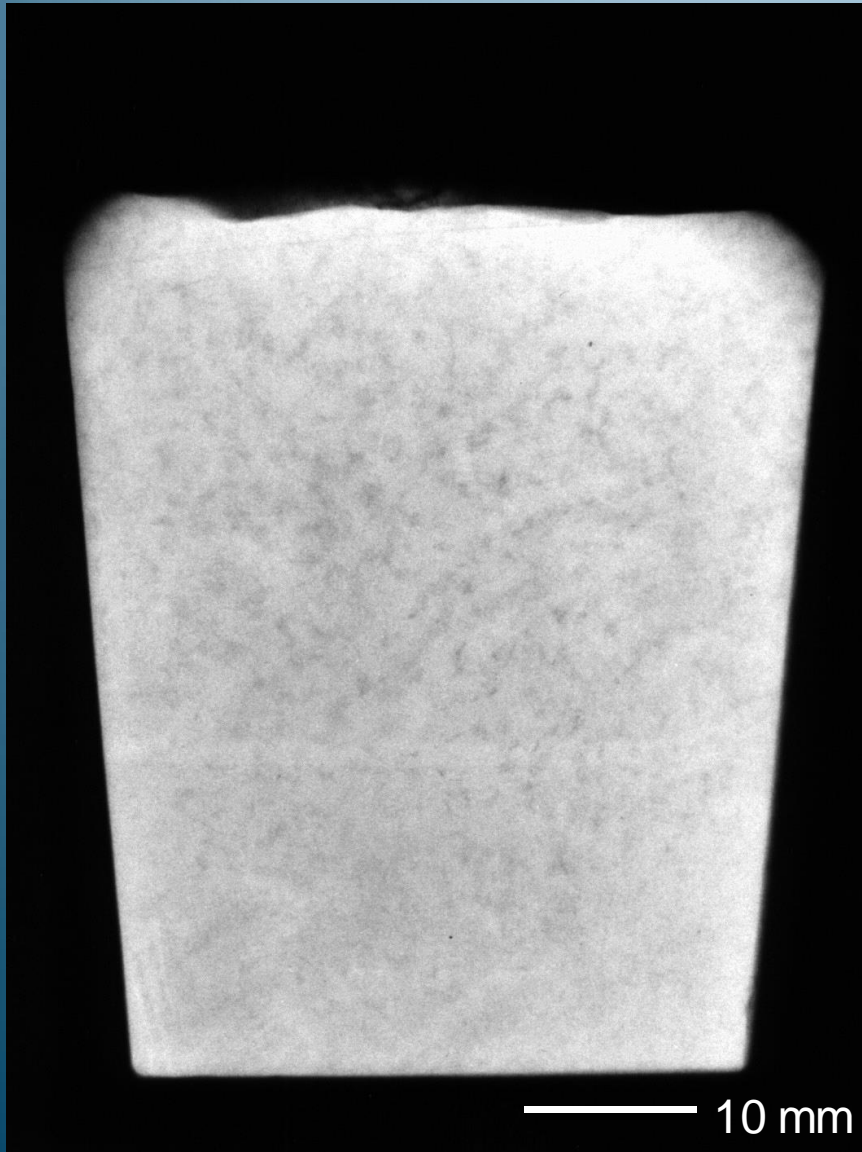
- **A tangled network of oxide films in a turbulently filled casting**



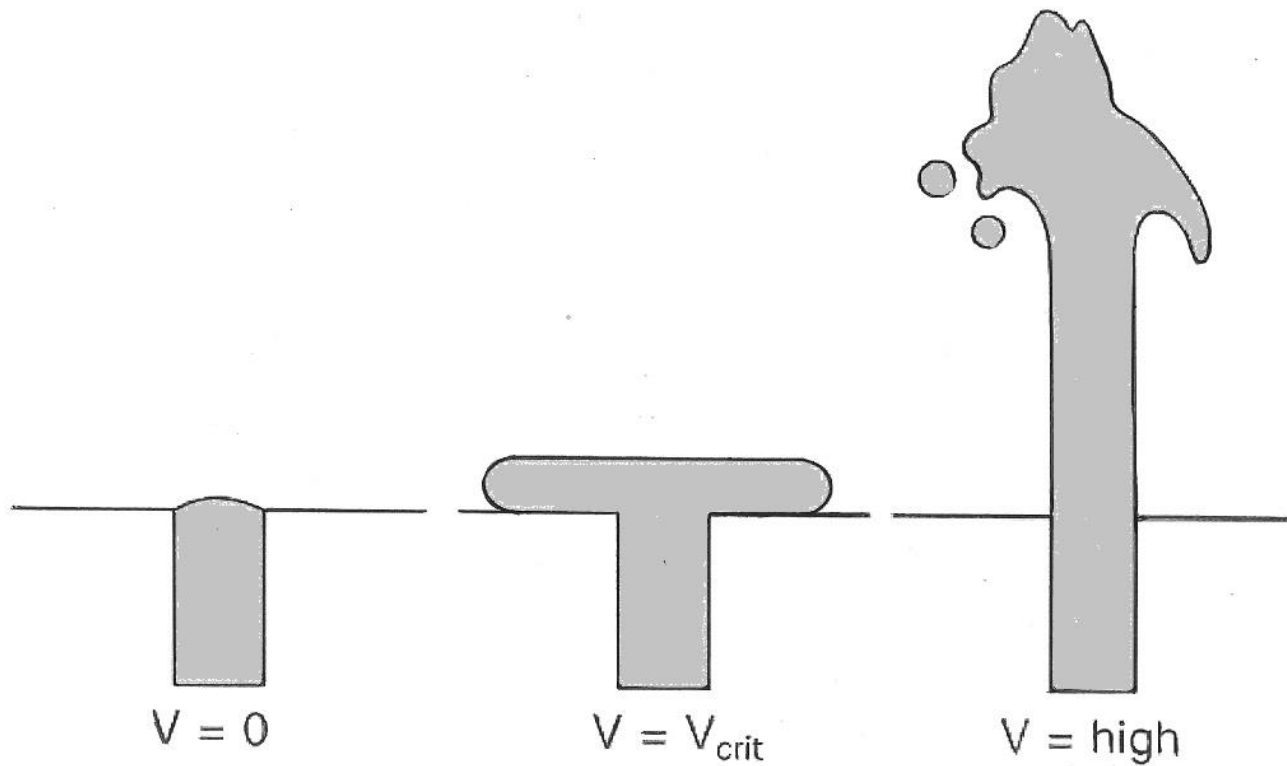
Bifilms in Al-5Mg alloy



RPT Before and After Reduced Pressure



The range of ingate velocities



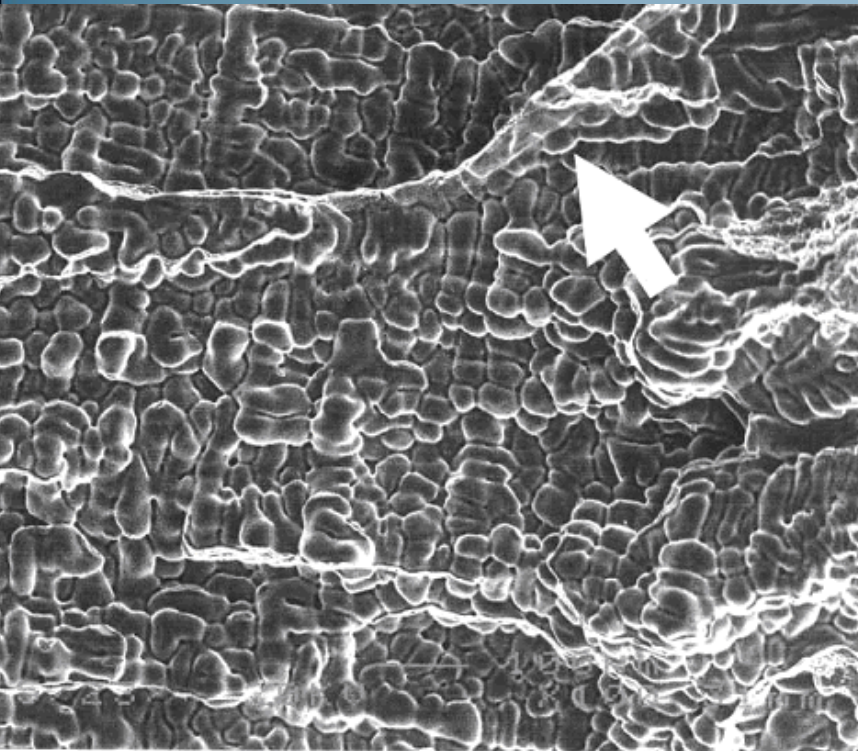
Optimum Filling Speed Range

0.5 to 1.0 m/s

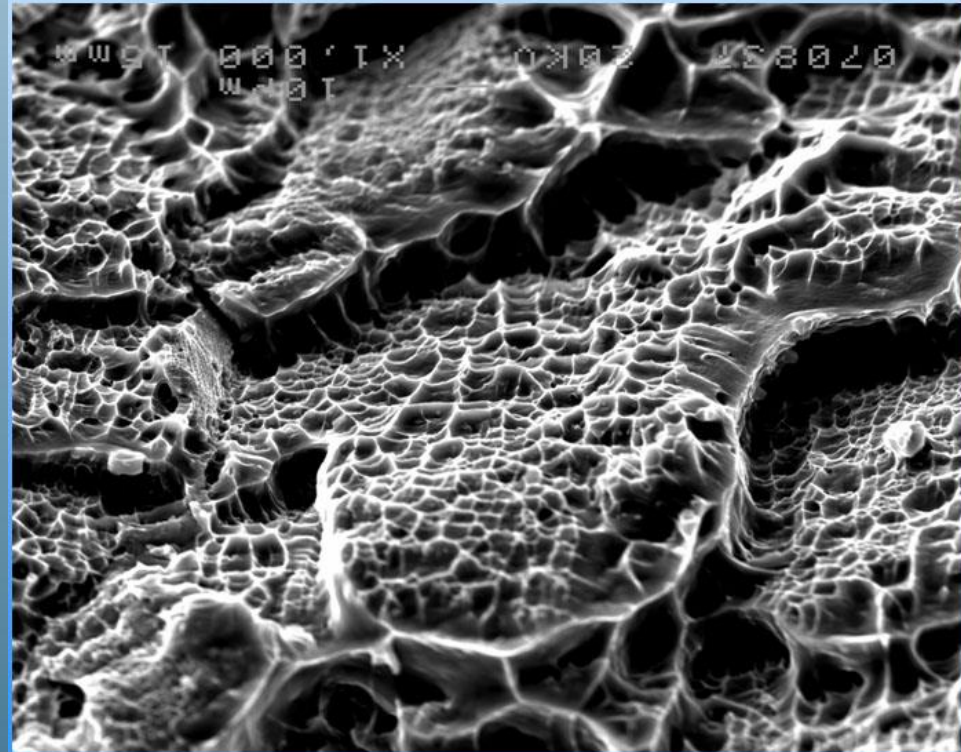
for all liquid metals

Al-4.5Cu fracture surfaces

1. Oxide covered
(0.3 % Elongation)

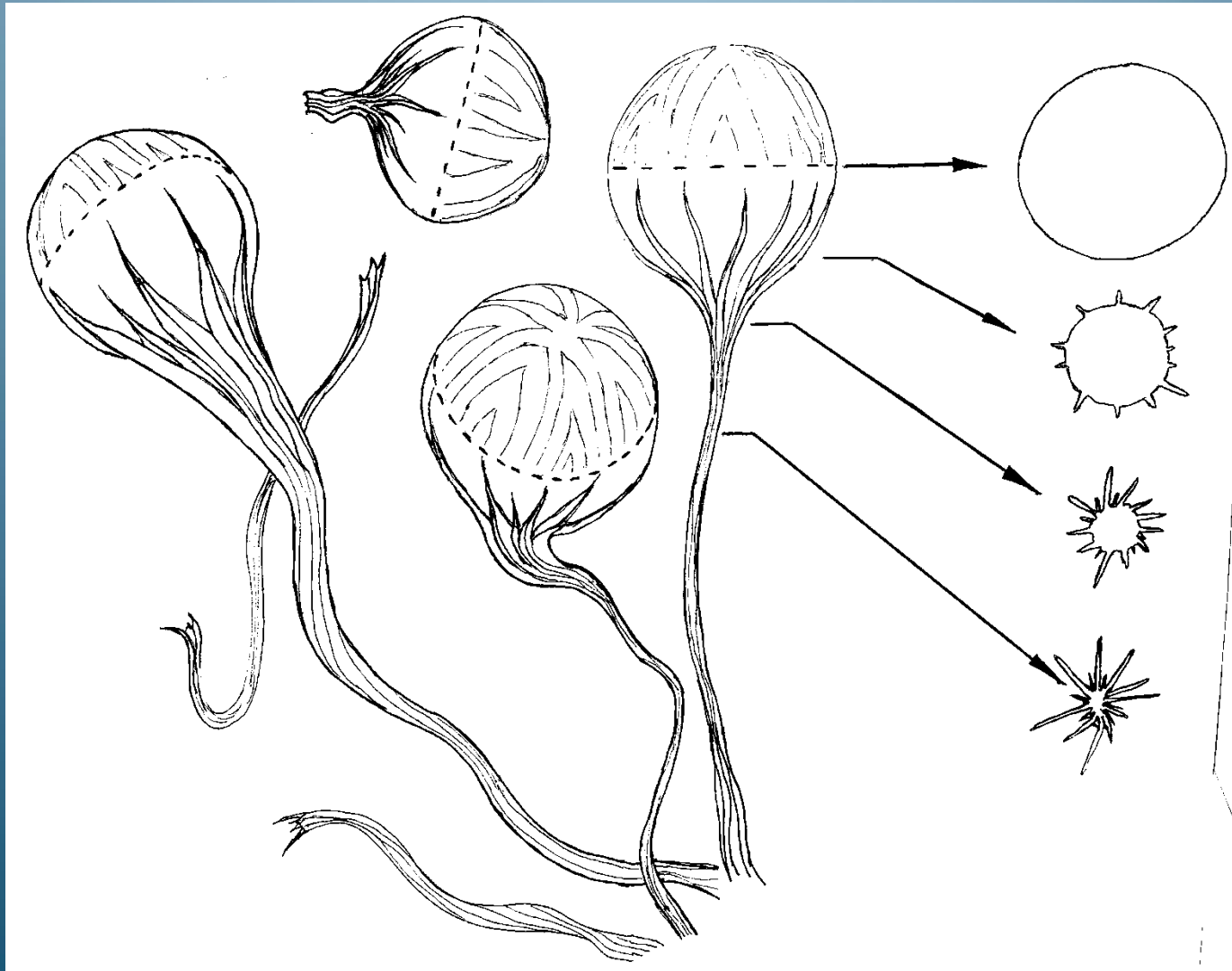


2. Ductile fracture
(3 % Elongation)



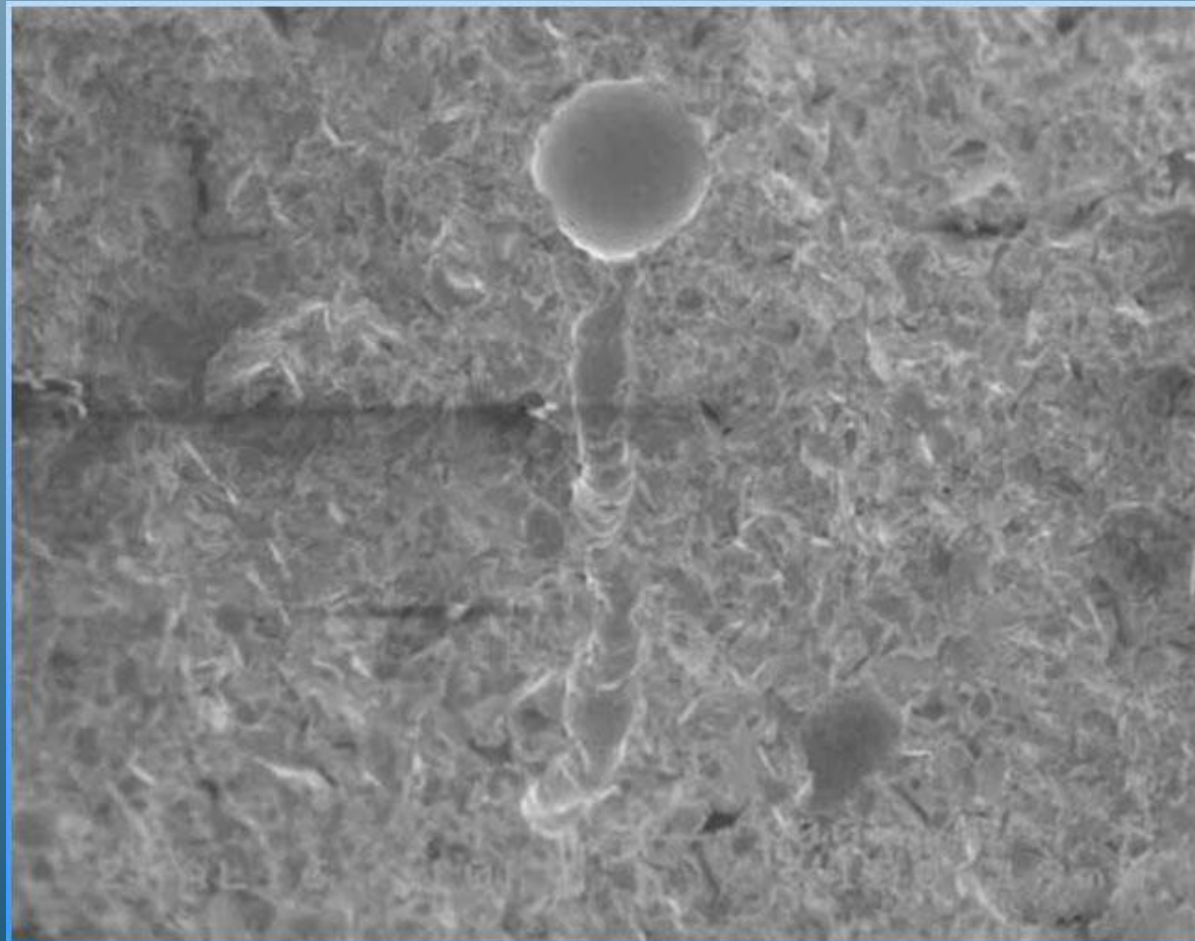
Bubble Damage

Bubbles plus Bubble Trails



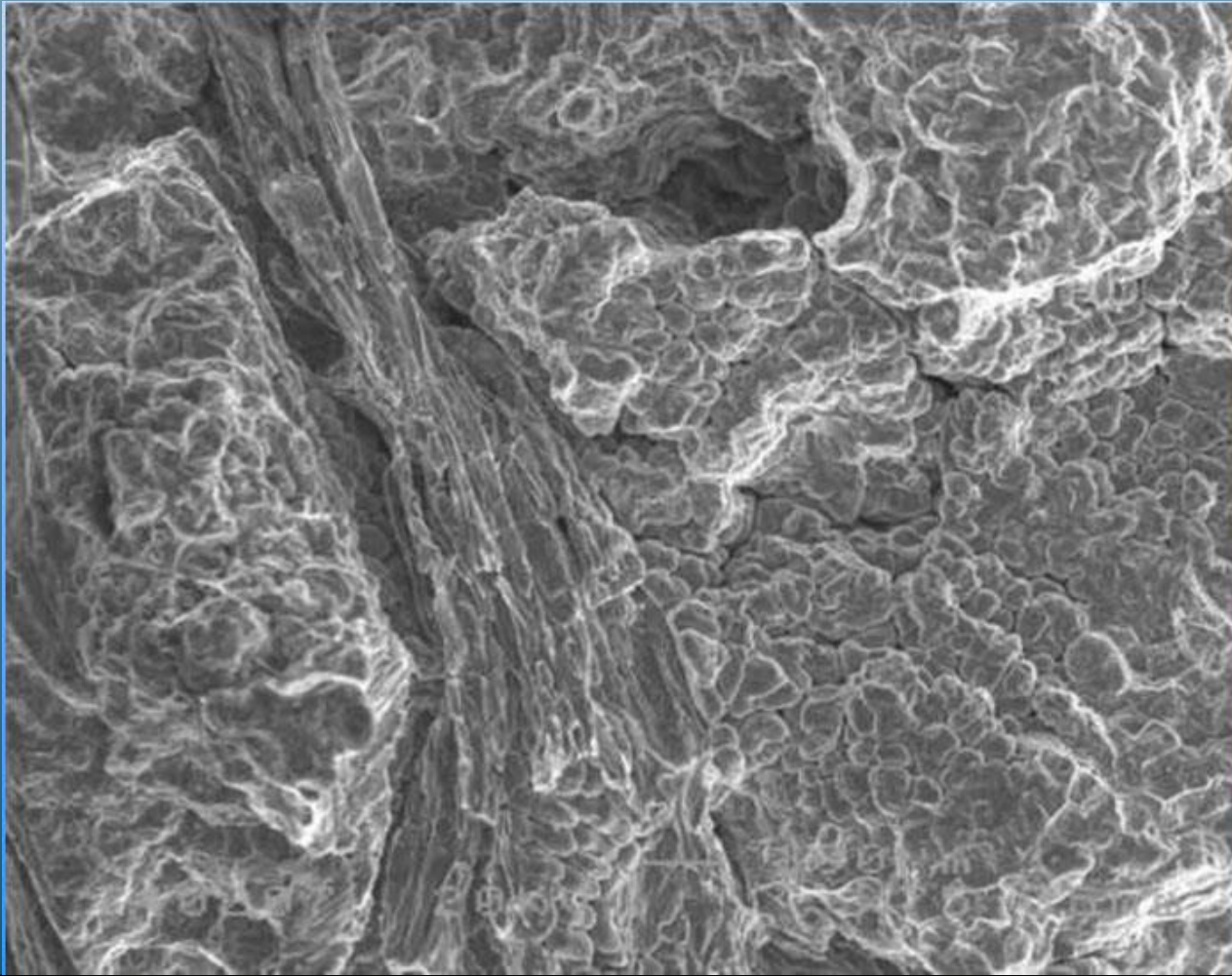


Bubble and trail in Zn alloy high pressure die casting

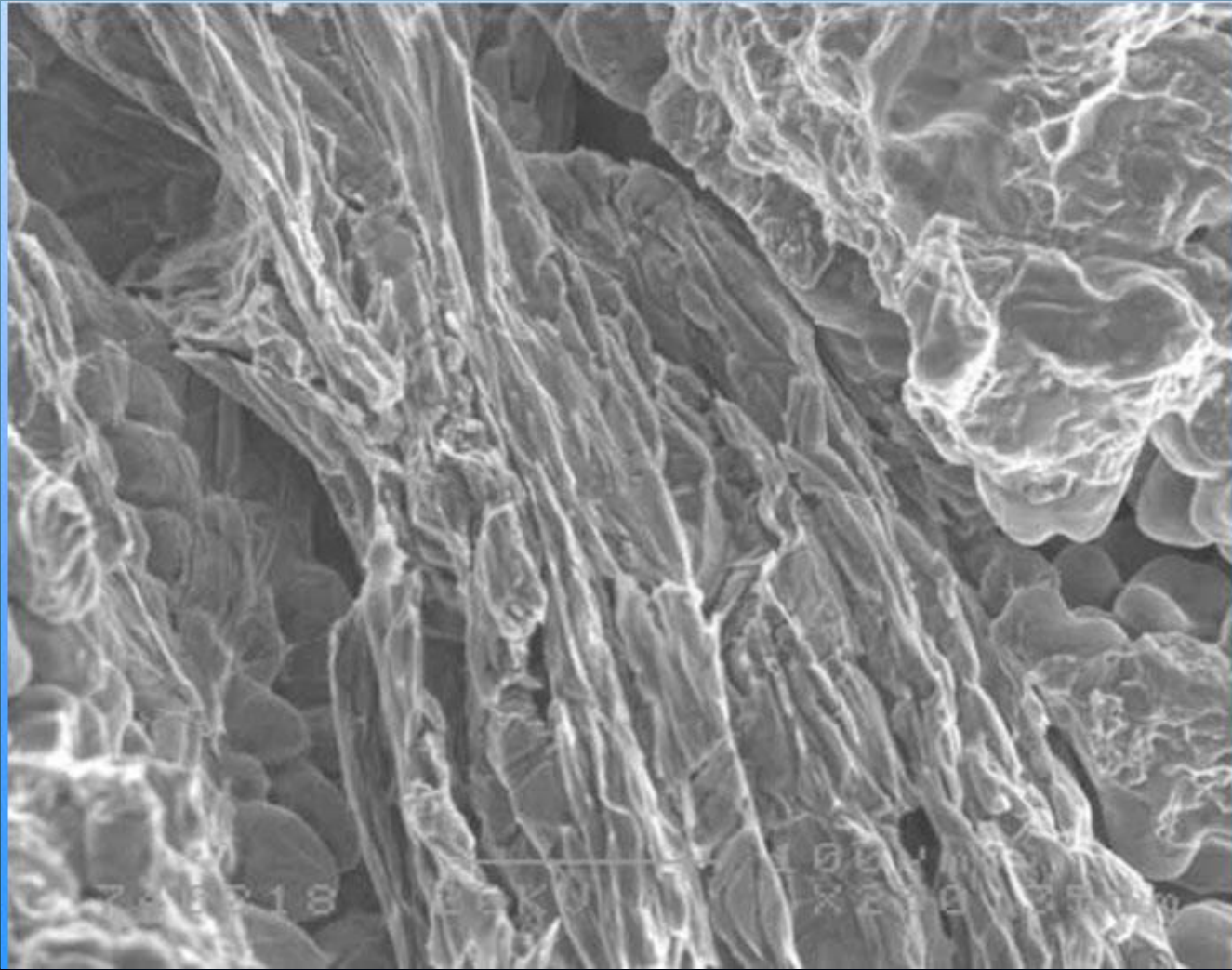




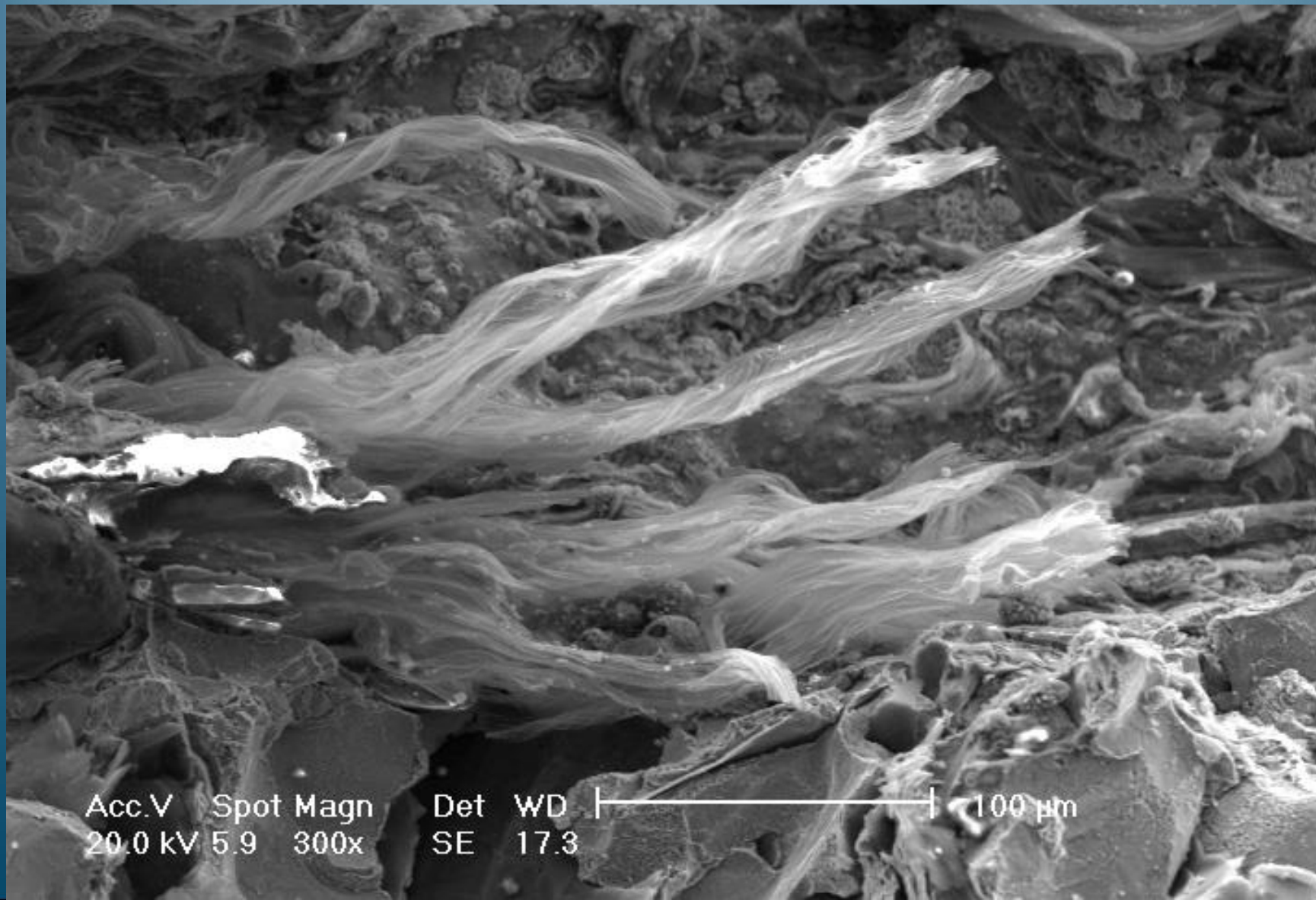
Bubble trail in Al-7Si-0.4Mg Alloy



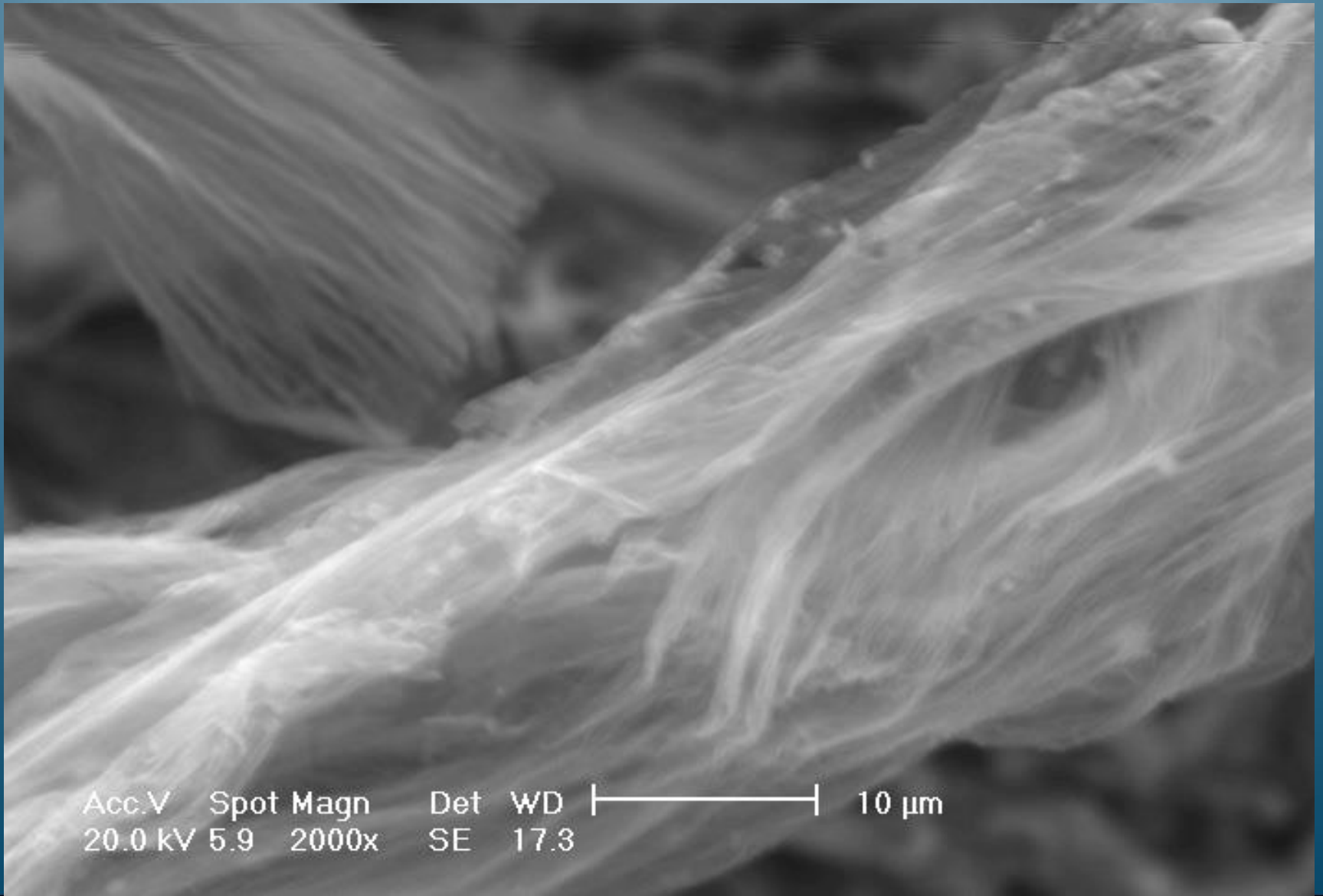
Bubble trail in Al alloy



Silicate glass bubble trails in grey iron



Silicate glass bubble trails in grey iron



Casting Technology

10 Rules

(The 10 Commandments by JC)

1. Use good metal
2. Not too fast (no turbulence)(0.5m/s)
3. Not too slow (no stopping)
4. No entrained bubbles
5. No core blows
6. Feed shrinkage if necessary
7. Avoid convection
8. Avoid segregation
9. Avoid stress
10. Provide pick-up locations



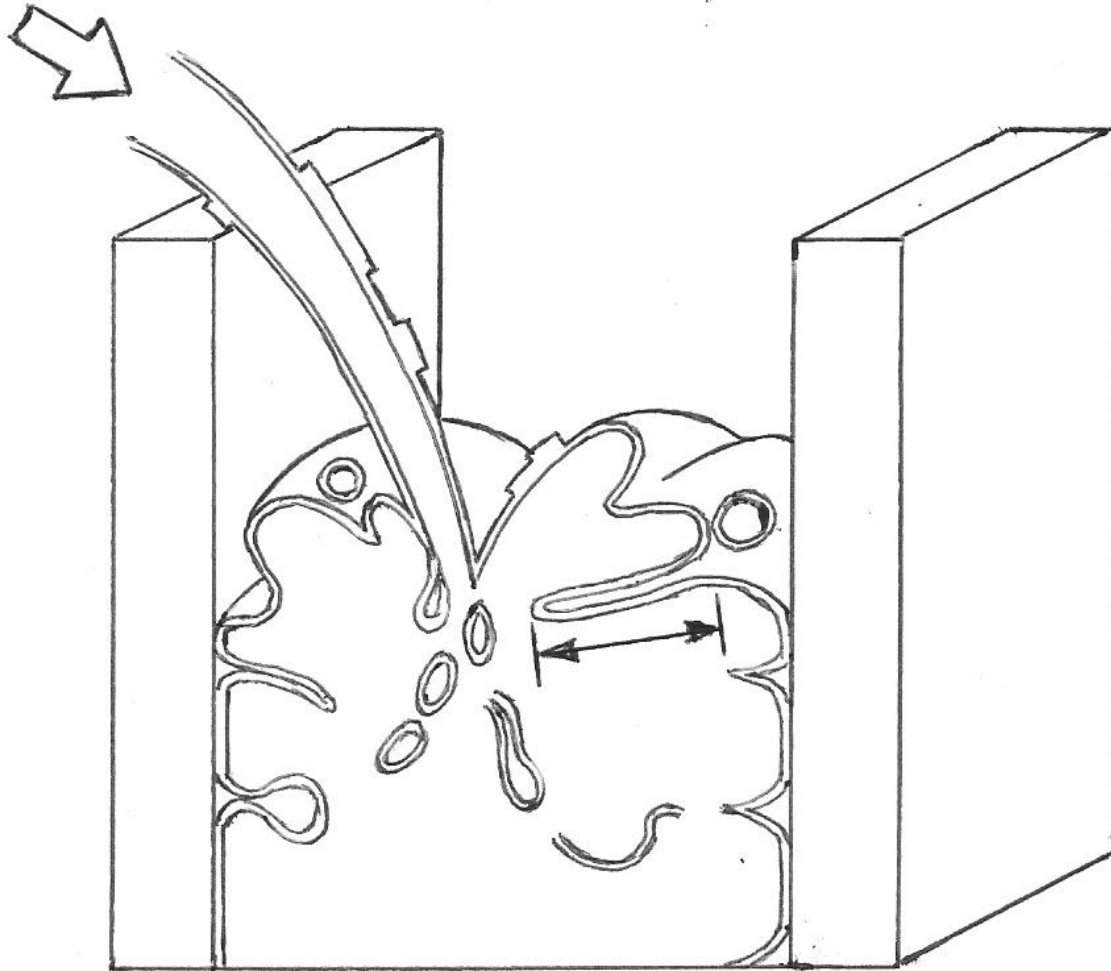
Temporary Damage



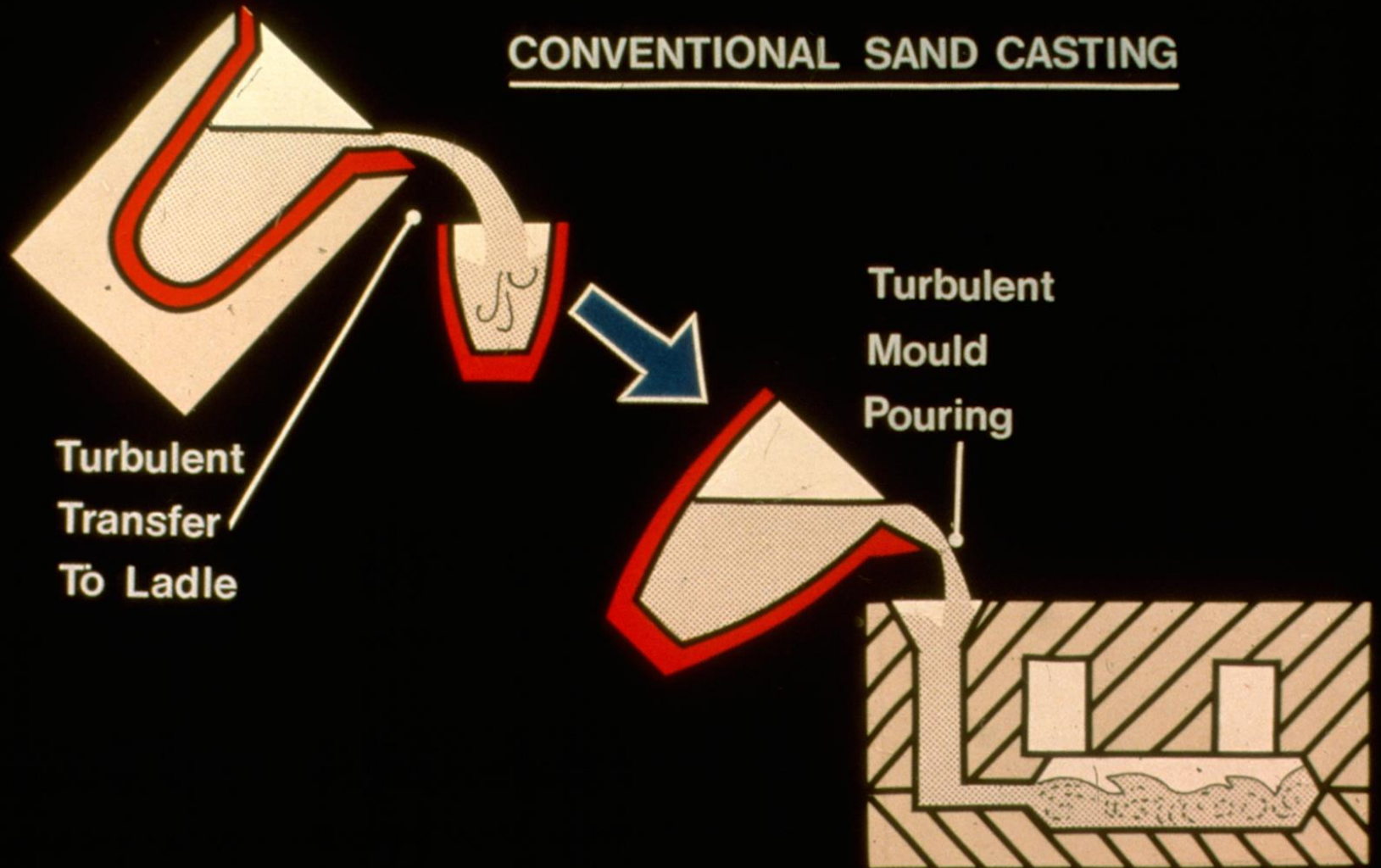
Permanent
Damage

Gravity Filling Systems

Top gated turbulent filling

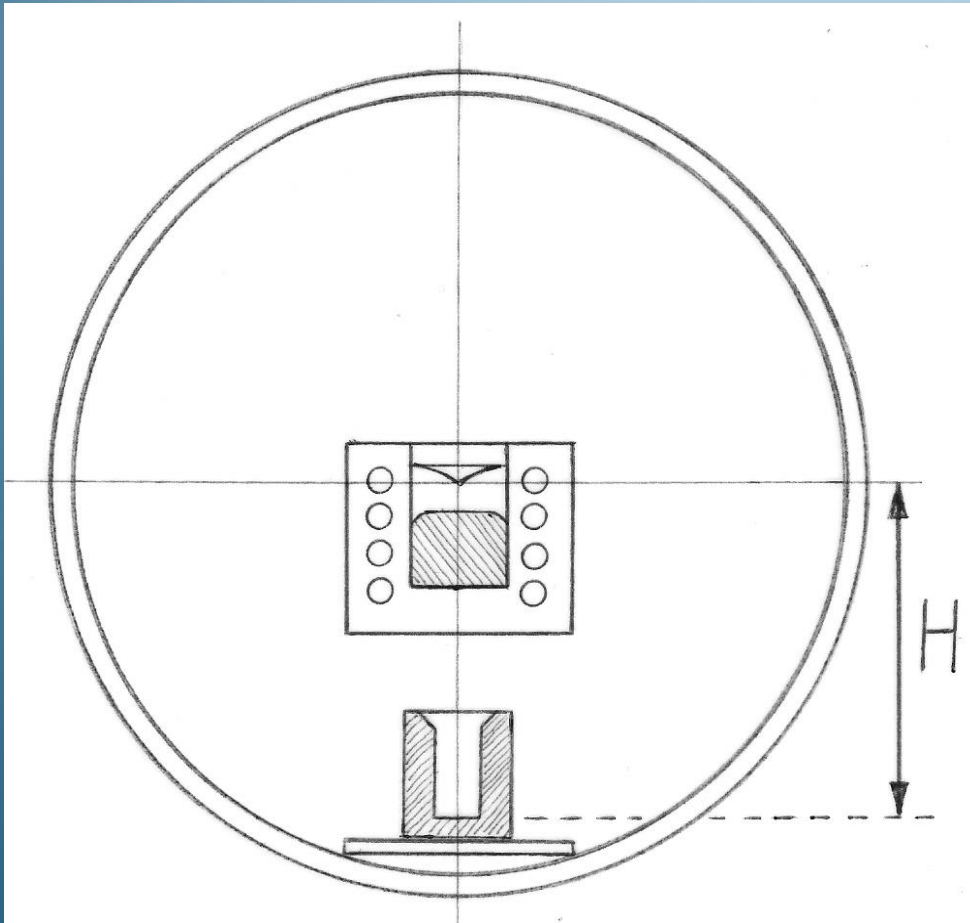


CONVENTIONAL SAND CASTING



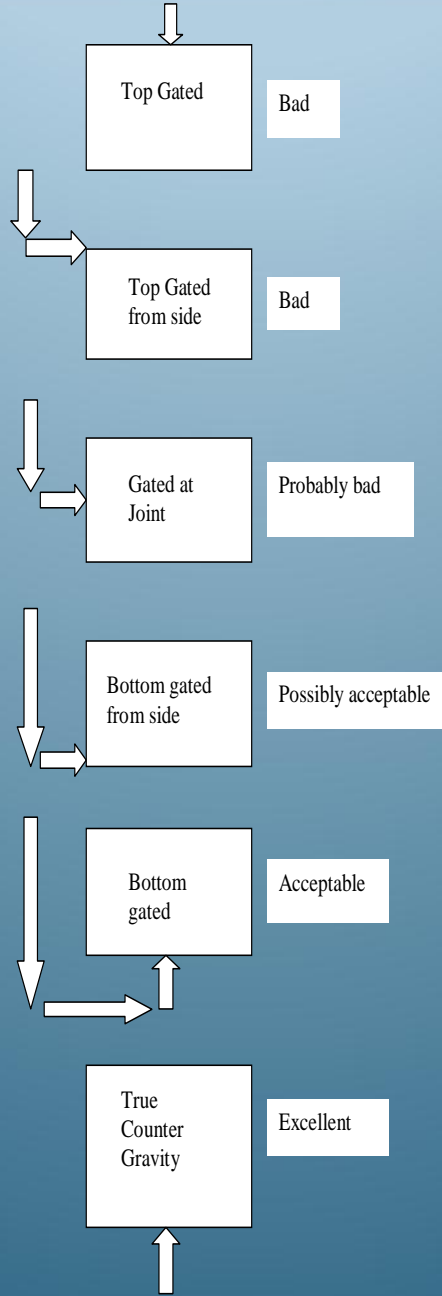
Turbulent
Transfer
To Ladle

Turbulent
Mould
Pouring

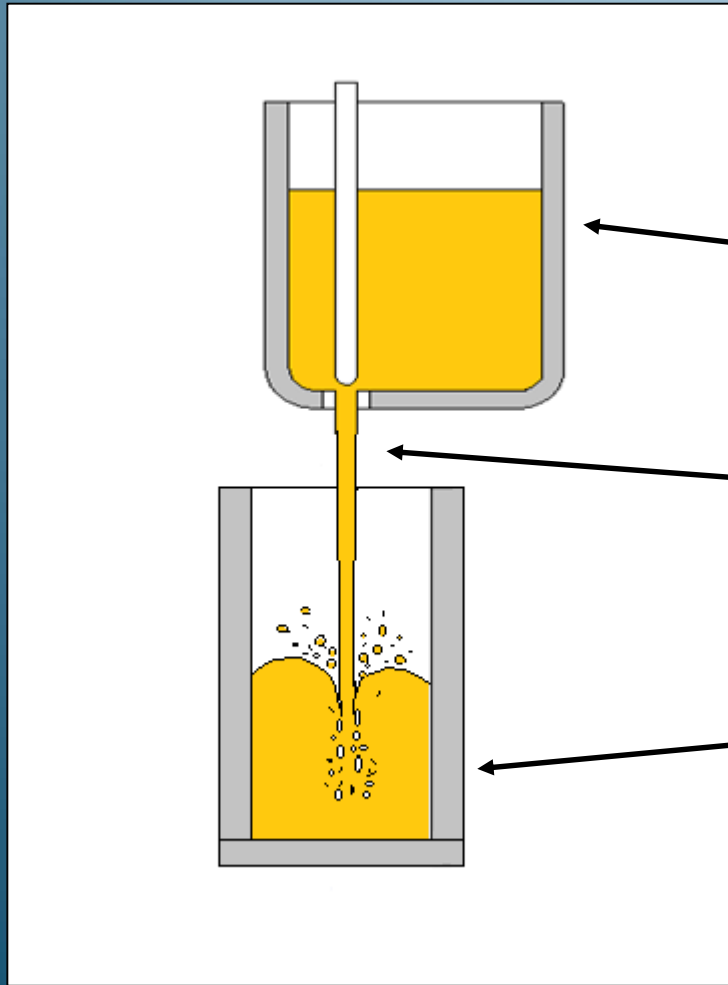


Typical
vacuum
melting
and casting
furnace

Hopeless!



Top Pour

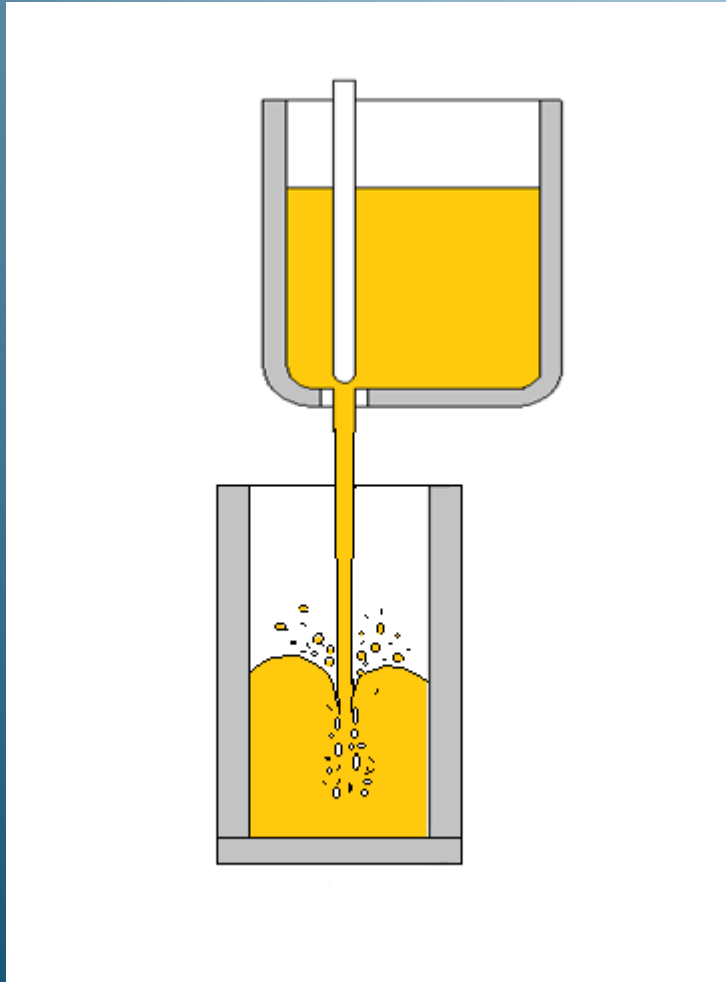


Ladle

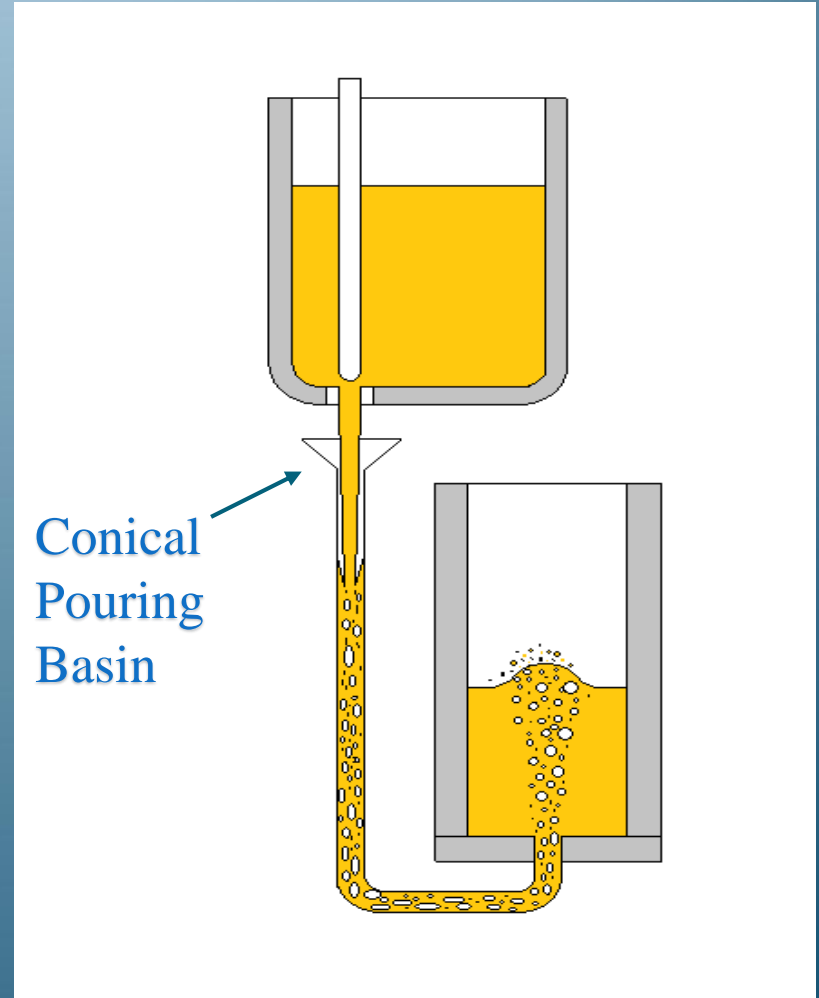
Pouring stream

Mould

Top Pour



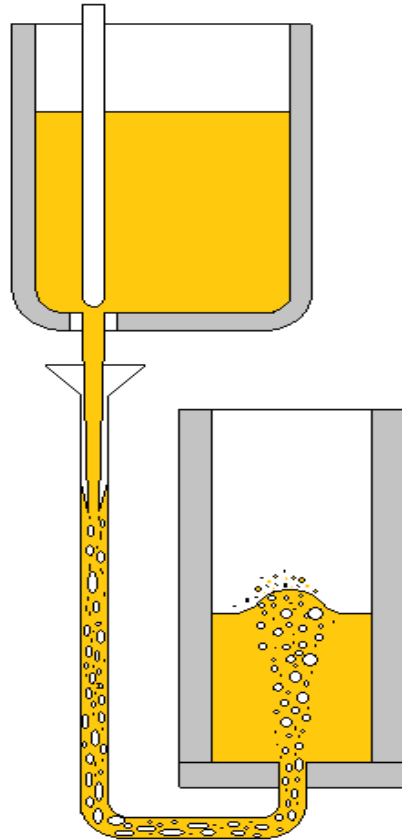
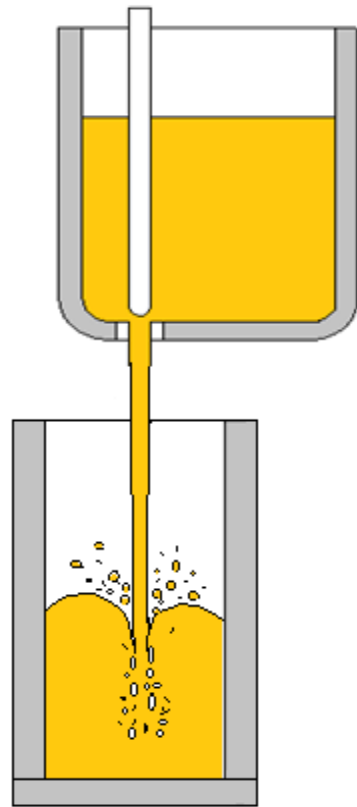
Bottom Gate



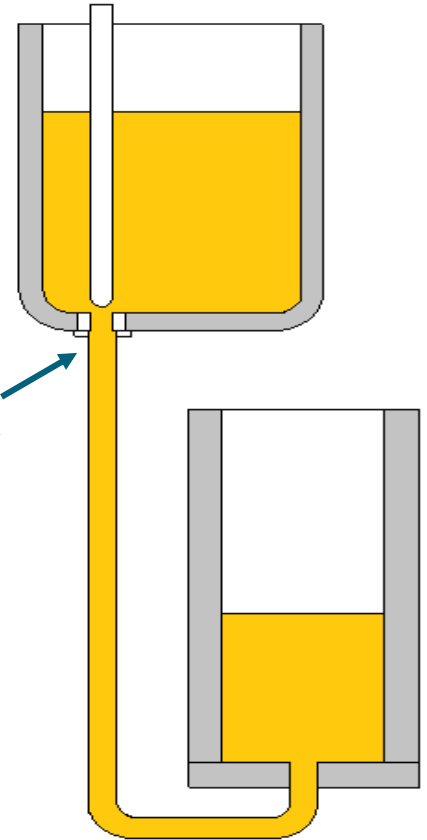
Top Pour

Bottom Gating

Contact Pour



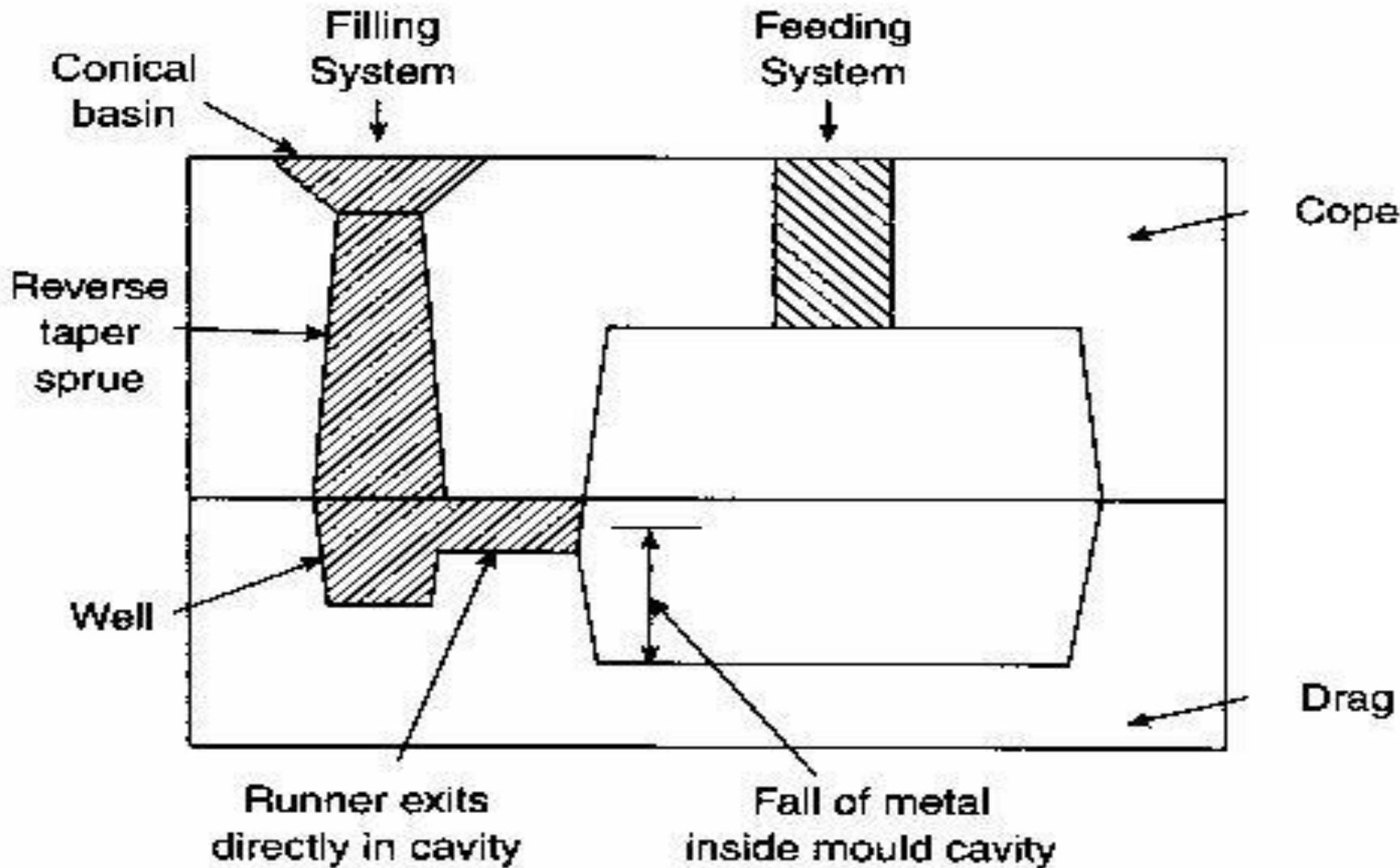
Air-sealed contact

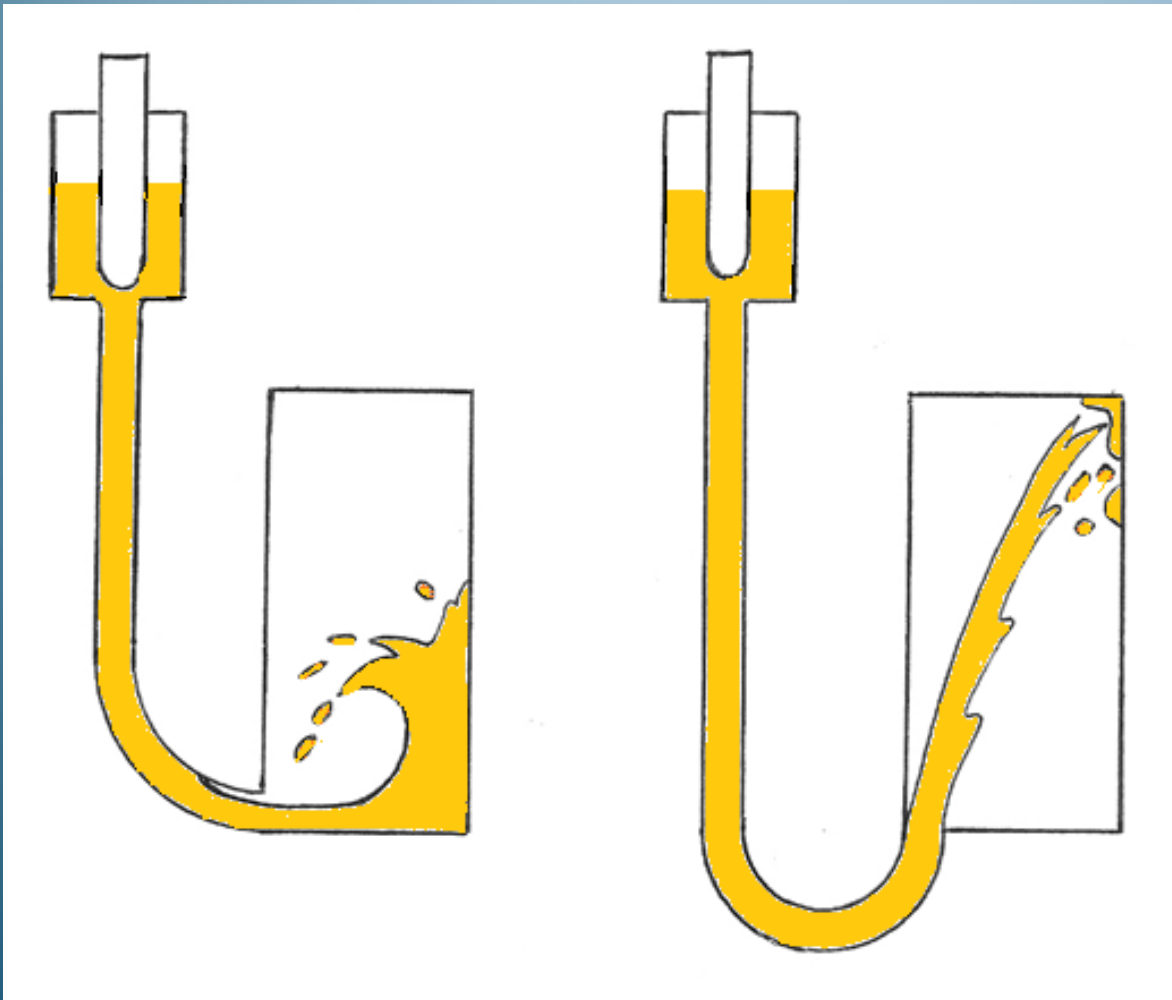




Practical Design
of
Filling and Feeding Systems

Poor filling system



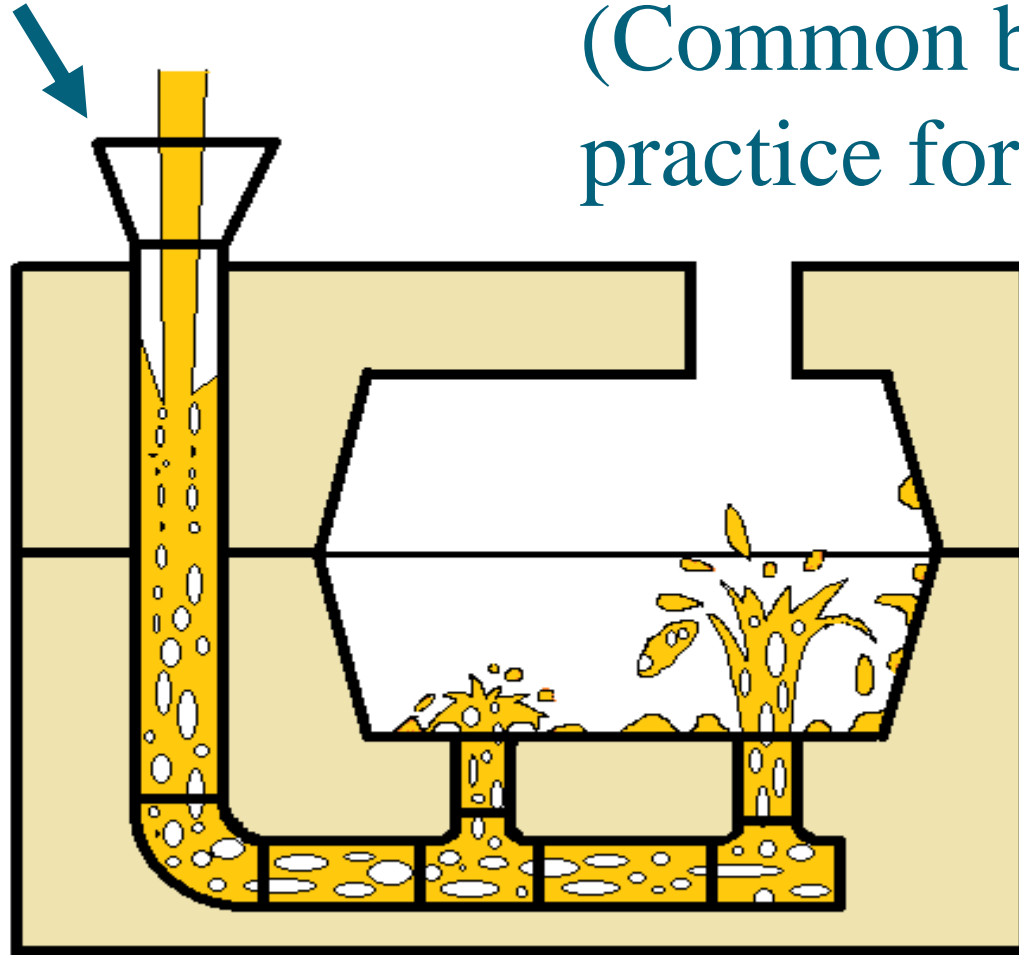


Correctly
bottom-
gated
but
awful!

No
control
of speed.

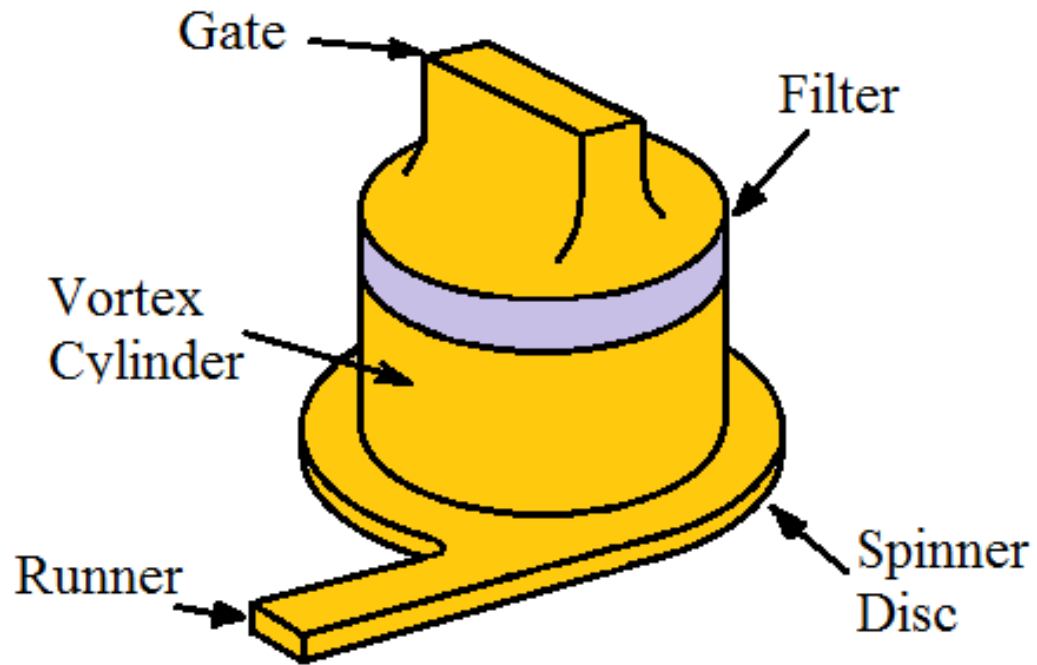
Air entrainment by a Conical Pouring Basin

(Common bad
practice for steels)



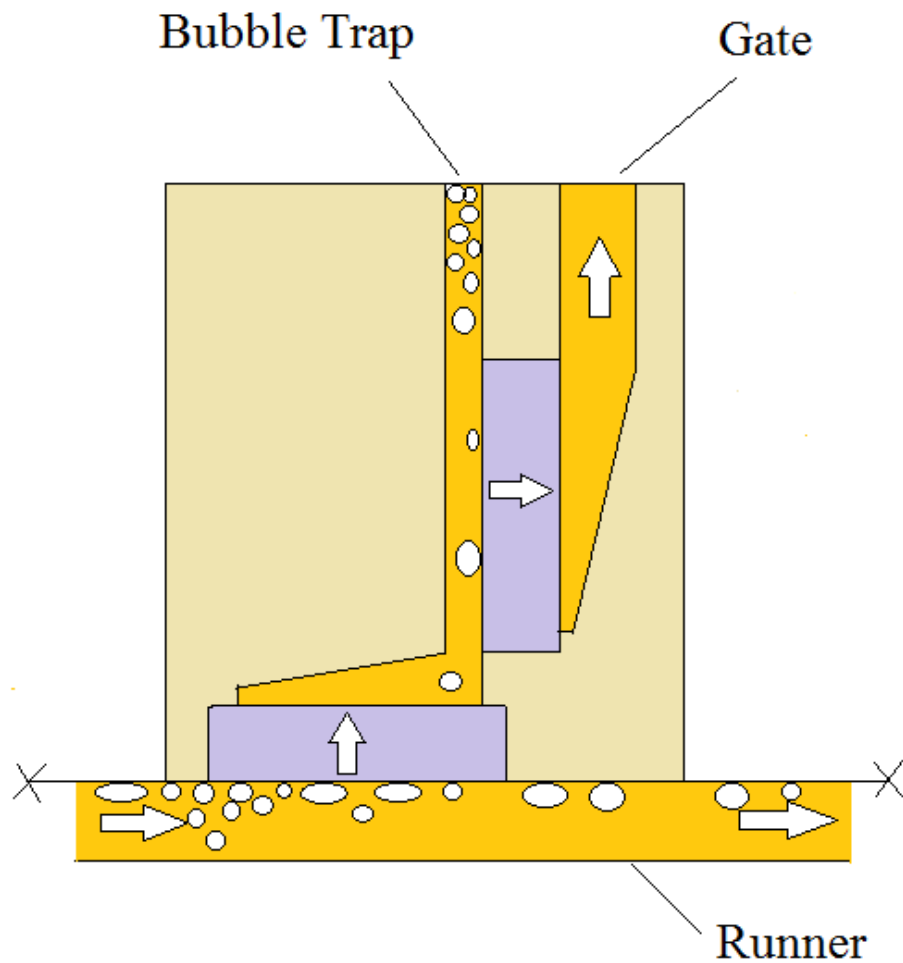
We need to control

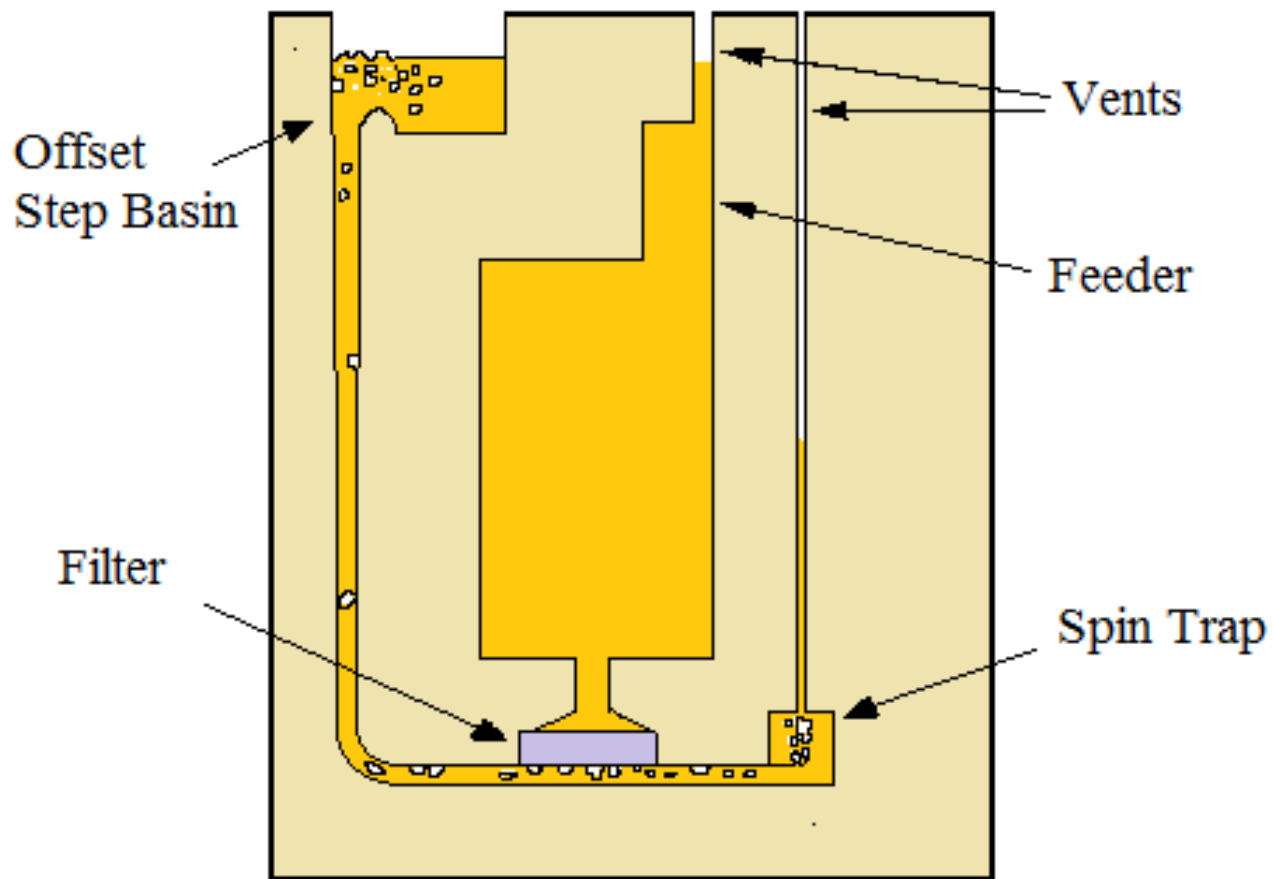
1. Speed (less than 1 m/s)
2. Air entrainment

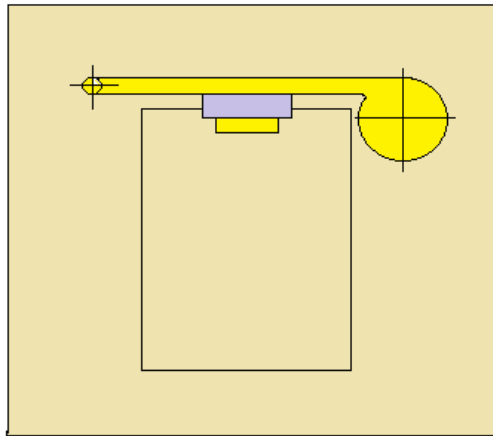
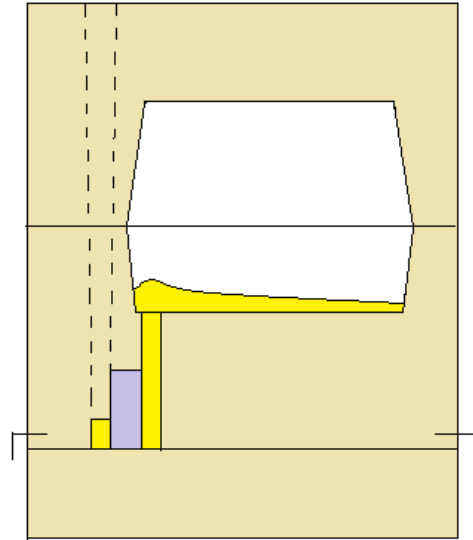
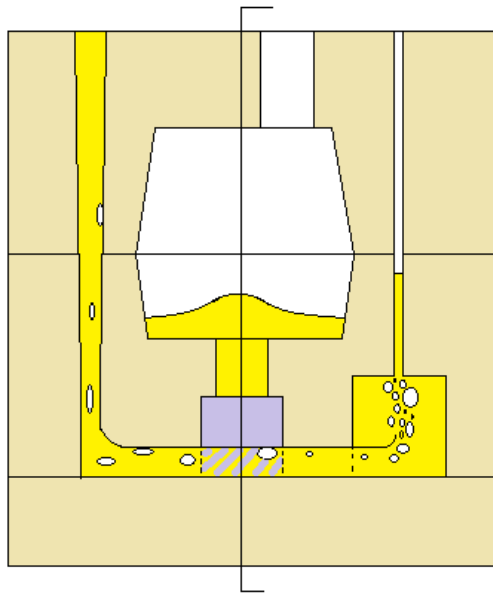


Vortex Gate

Trident Gate

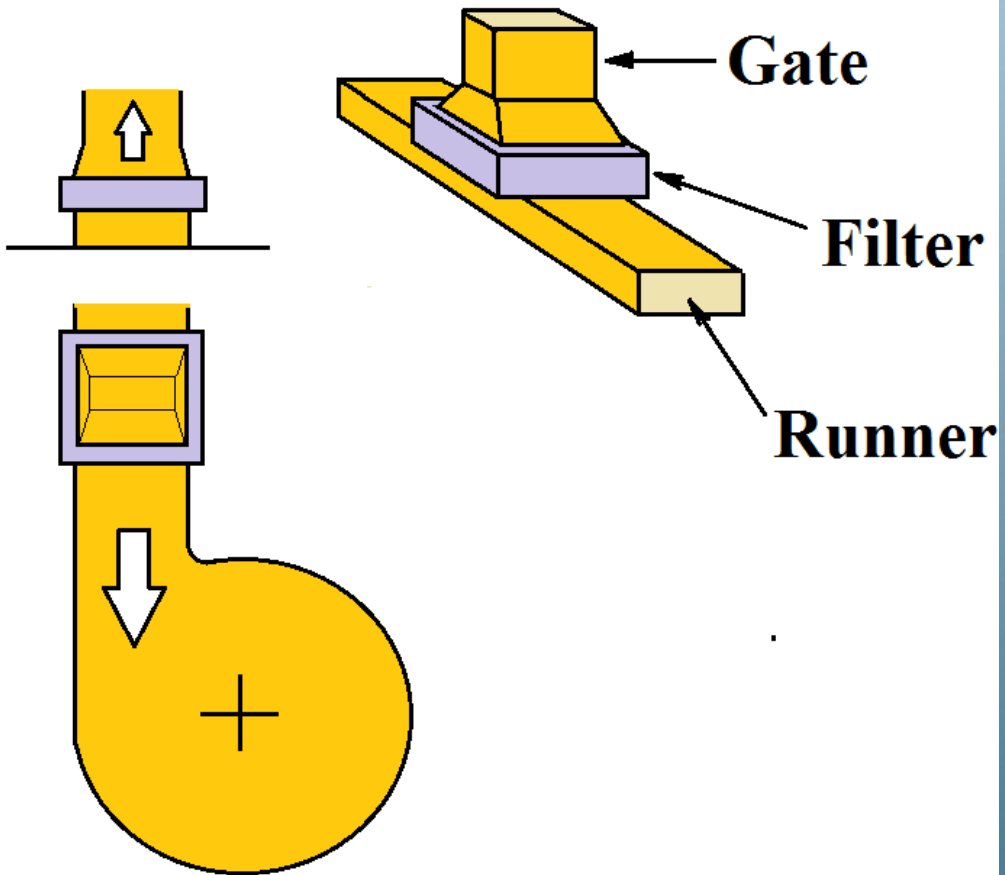


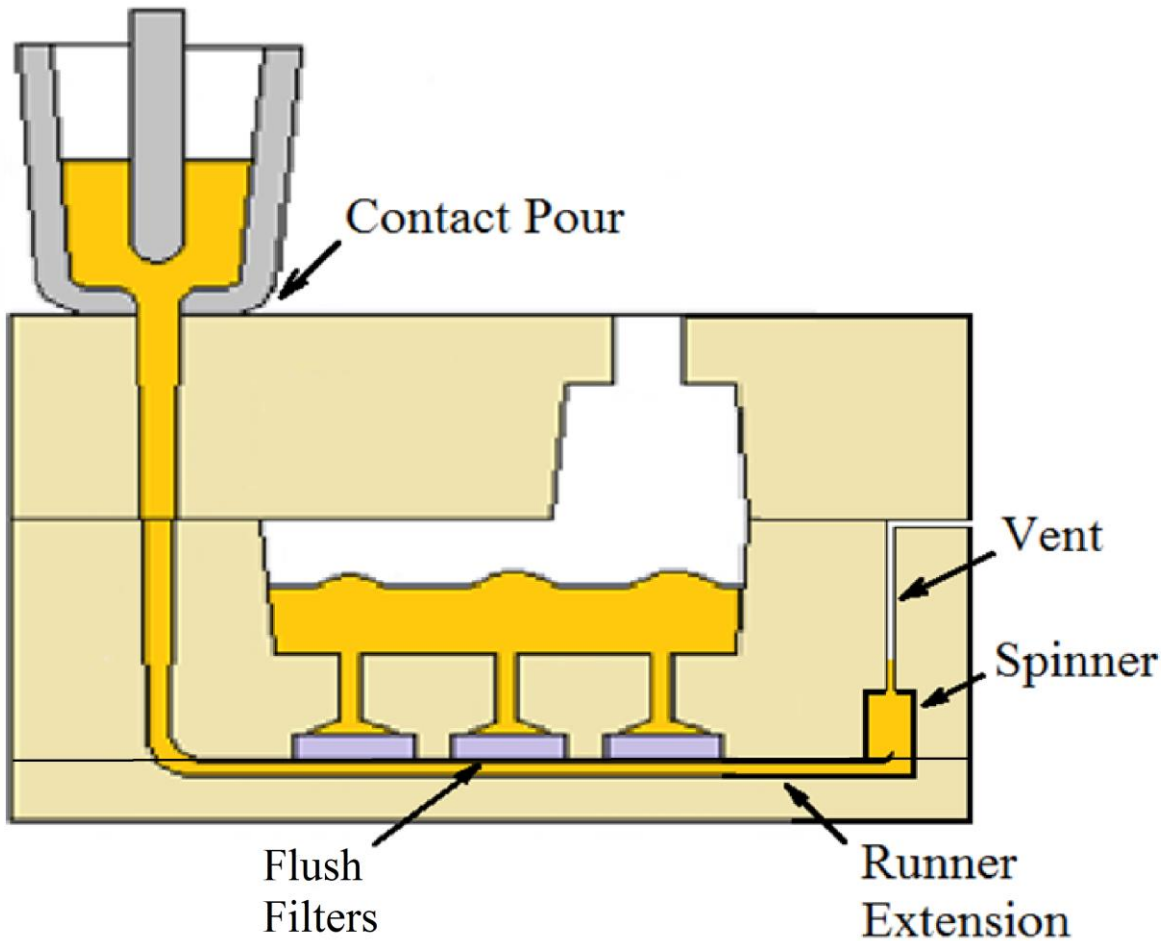




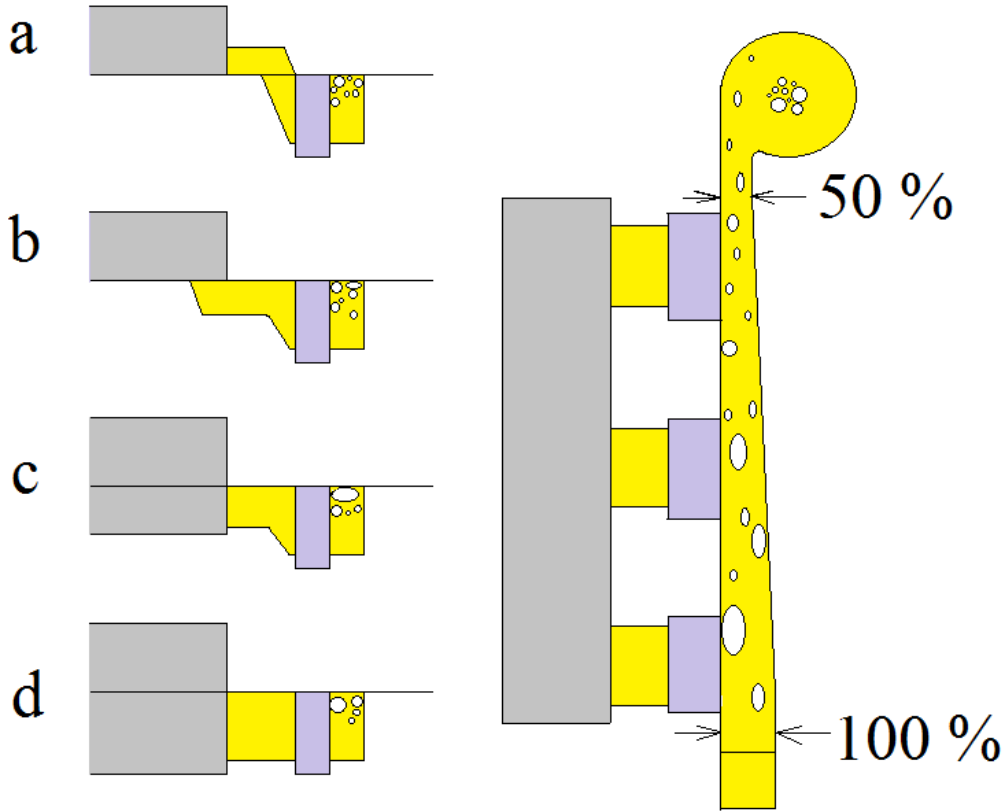
Side Filter
Sholes system

(3 or 4-part mould)





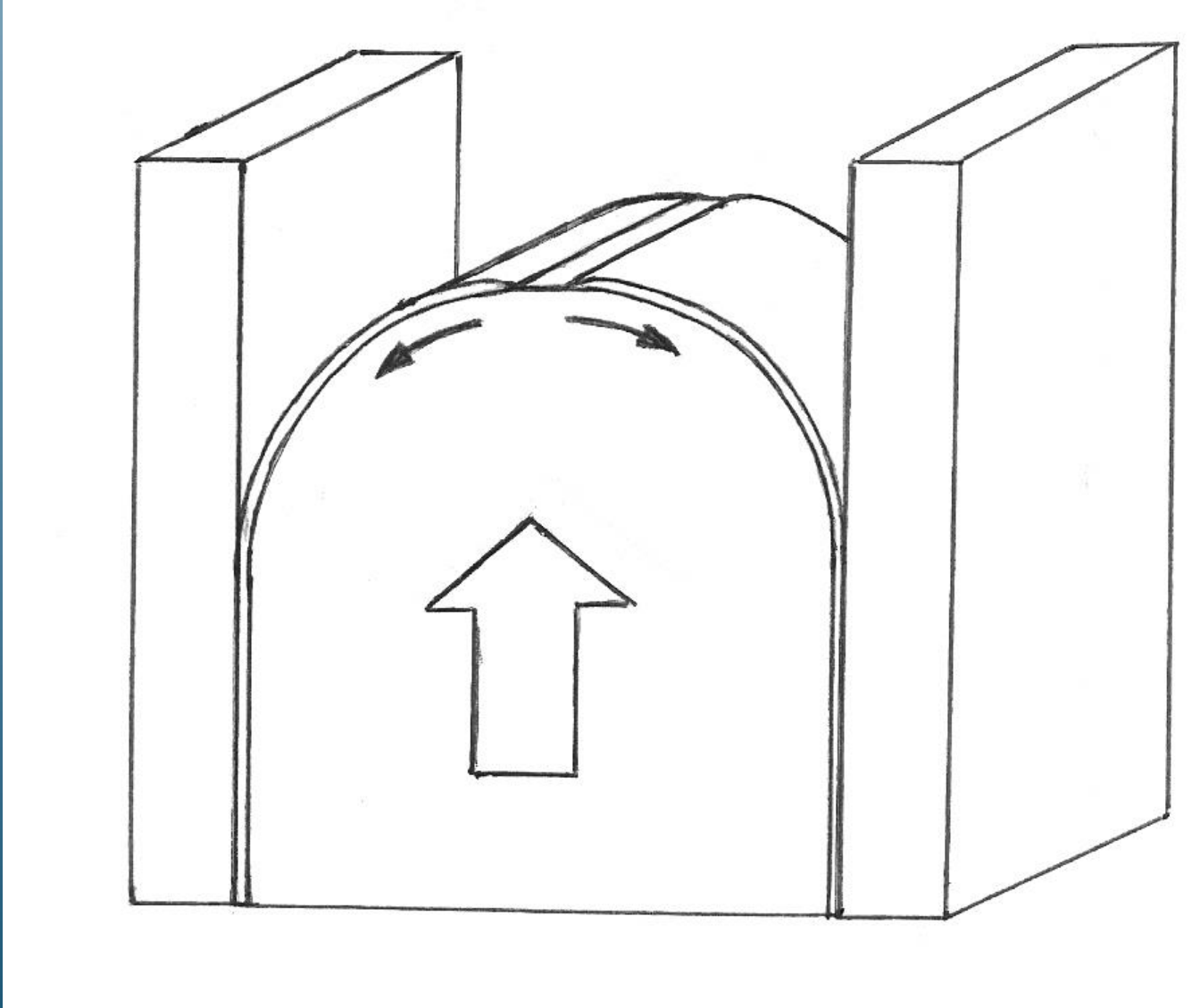
The latest development in gravity pouring to achieve a defect-free casting

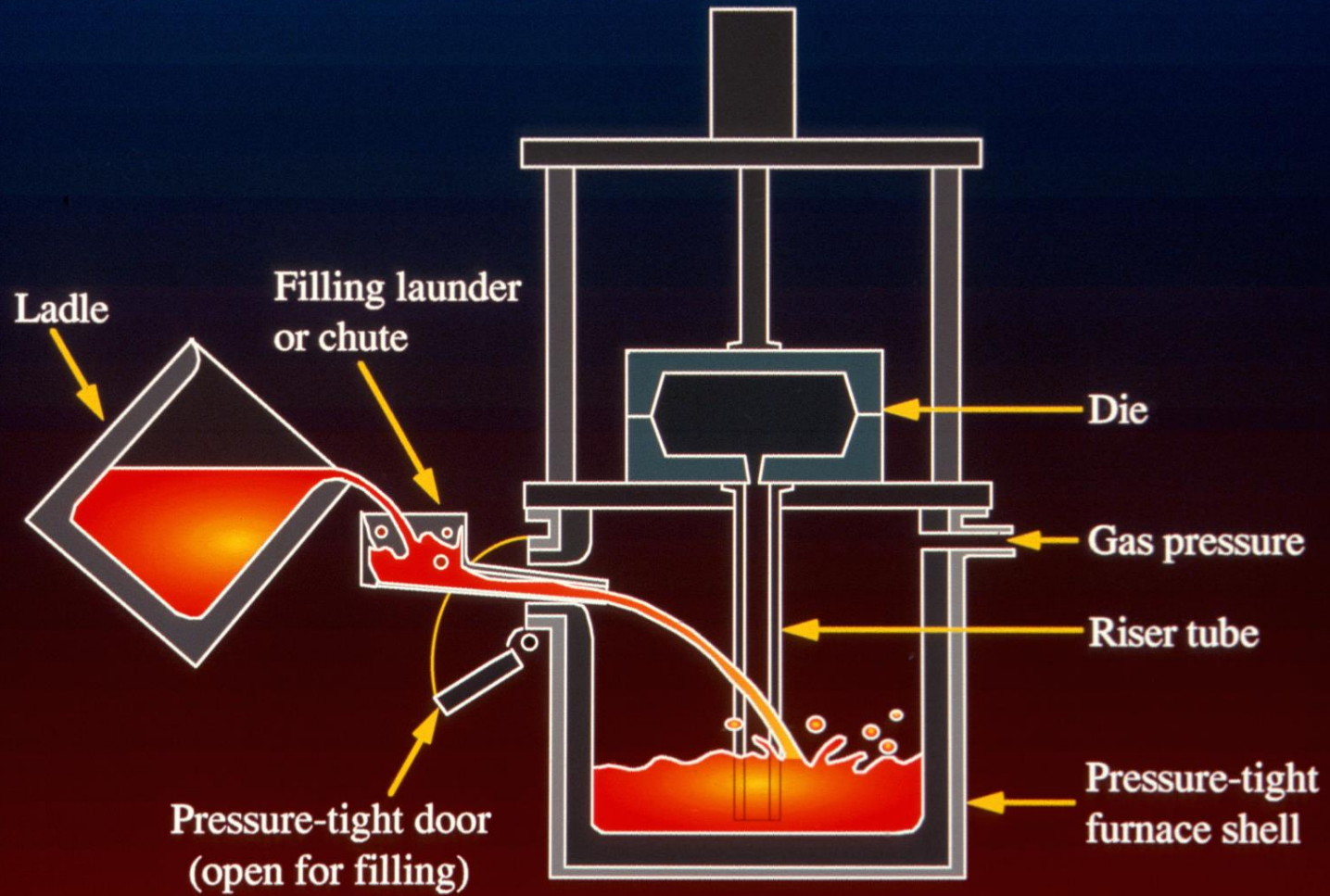


Side Filters 2-part mould

Counter-Gravity

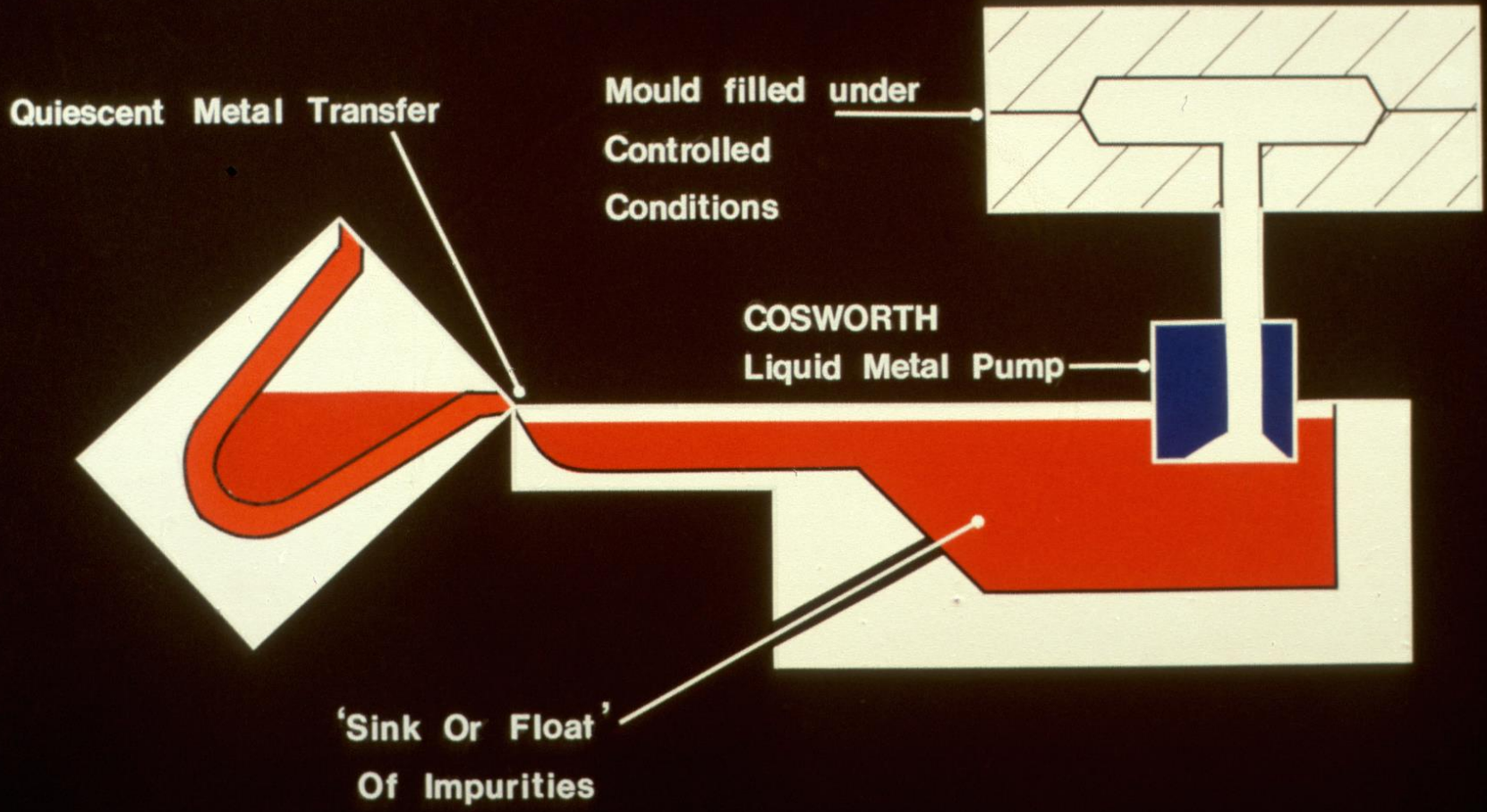
Bottom gated laminar filling



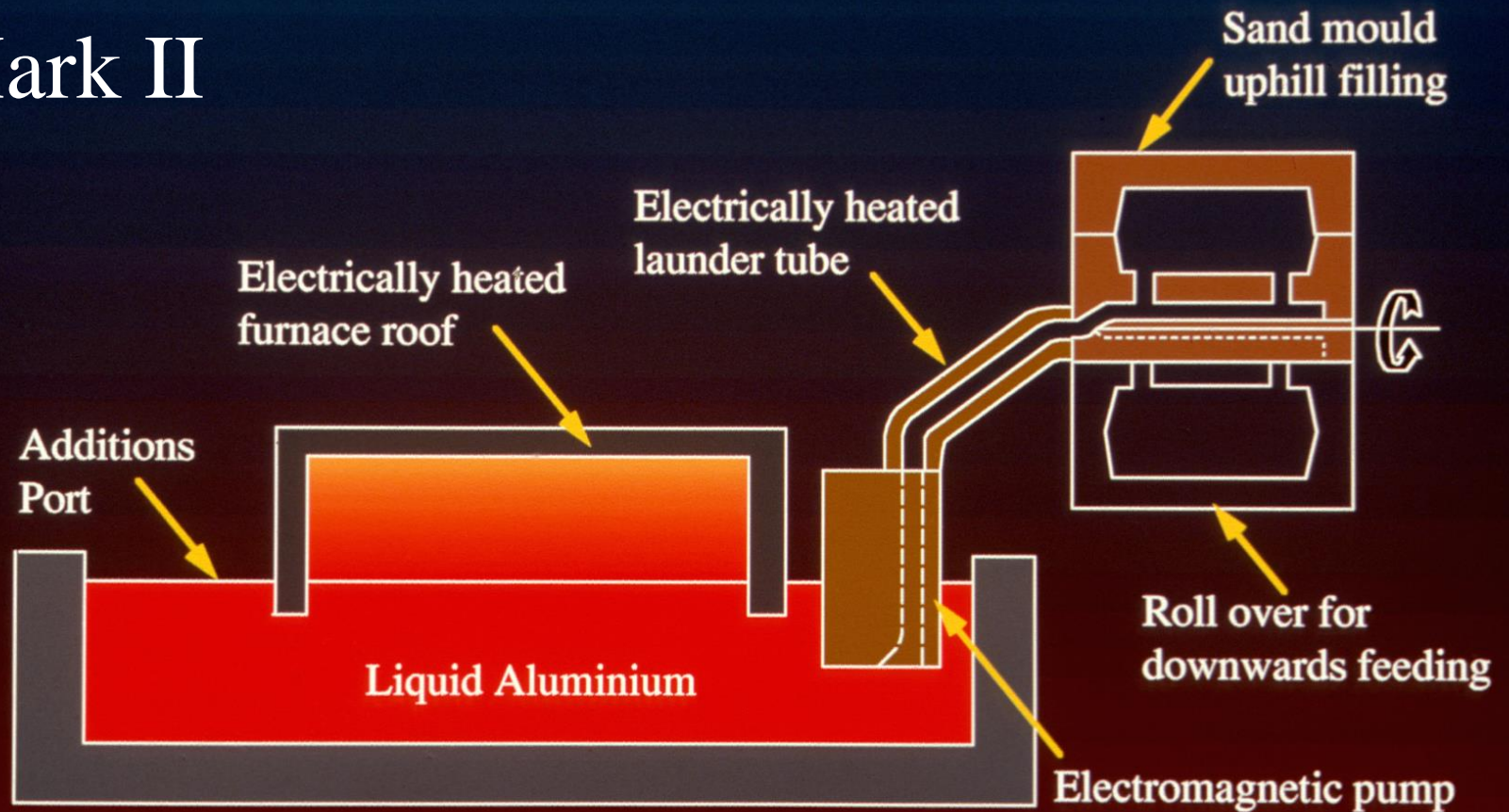


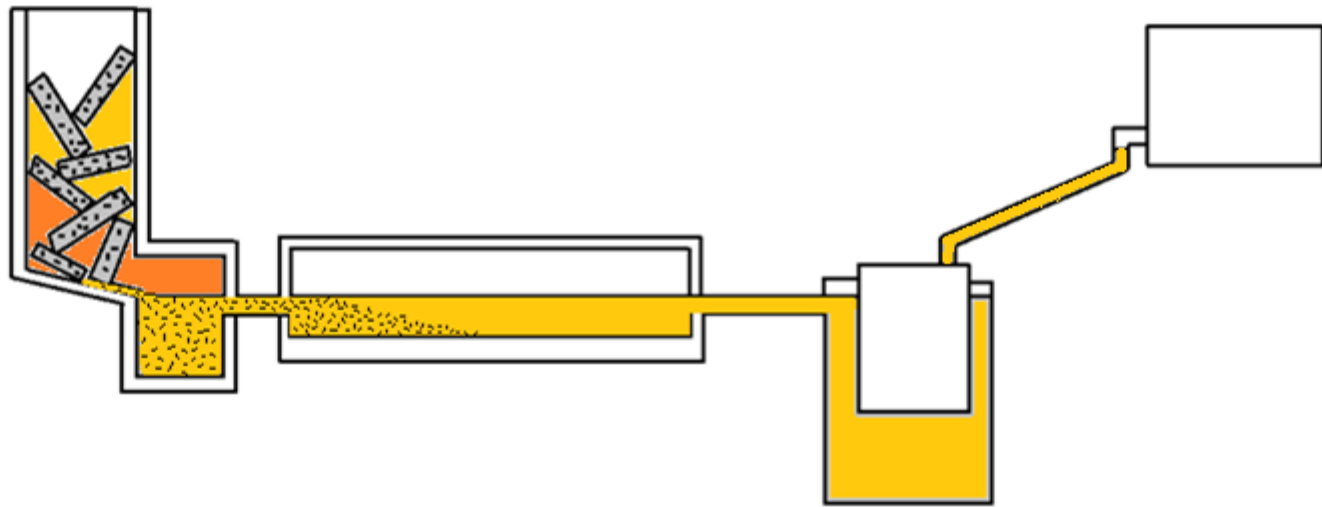
Low Pressure Die Casting

THE COSWORTH PROCESS



Cosworth Mark II





Al Alloy Continuous Production of Castings using Sedimentation

The End

