Rao Badhur Y Mahabaleshwarappa Engineering College (RYMEC)

(Formerly , Vijayanagara Engineering College (VEC), Ballari)

Welcome to 3 Sem Mechanical Engineering, RYMEC Family.

Rao Badhur Y Mahabaleshwarappa Engineering College (RYMEC), BALLARI.

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QUALIFICATION:

BE (Mech) 1991 - (Gulbarga University)

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EXPERIENCE : 26 yrs Teaching, 1 yr Industry, 8 yrs Research.

PRESENTATION

Metal Casting and Welding : (18ME35B)

By

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Syllabus
Includes (Foundry/Casting & Welding)

Module-1
Introduction & basic materials used in foundry: **Introduction:** Definition, Classification of manufacturing processes. Metals cast in the foundry-classification, factors that determine the selection of a casting alloy. **Introduction to casting process & steps involved:** **Patterns:** Definition, classification, materials used for pattern, various pattern allowances and their importance. **Sand moulding:** Types of base sand, requirement of base sand. Binder, Additives definition, need and types; preparation of sand moulds. Melding machines- Jolt type, squeeze type and Sand slinger. **Study of important moulding process:** Green sand, core sand, dry sand, sweep mould, CO_2mould, shell mould, investment mould, plaster mould, cement bonded mould. **Cores:** Definition, need, types. Method of making cores, **Concept of gating** (top, bottom, parting line, horn gate) and risers (open, blind) Functions and types.
Module-2
MELTING & METAL MOLD CASTING METHODS: **Melting furnaces:** Classification of furnaces, Gas fired pit furnace, Resistance furnace, Coreless induction furnace, electric arc furnace, constructional features & working principle of cupola furnace. **Casting using metal moulds:** Gravity die casting, pressure die casting, centrifugal casting, squeeze casting, slush casting, thixocasting, and continuous casting processes.

GATING SYSTEM

Always Good Gating system

– Leads to good and sound castings

(Produces defect free castings)

&

Bad Gating system

– Leads to Defective castings

So, It is very important to Design a Good Gating system

Concept of Gating system

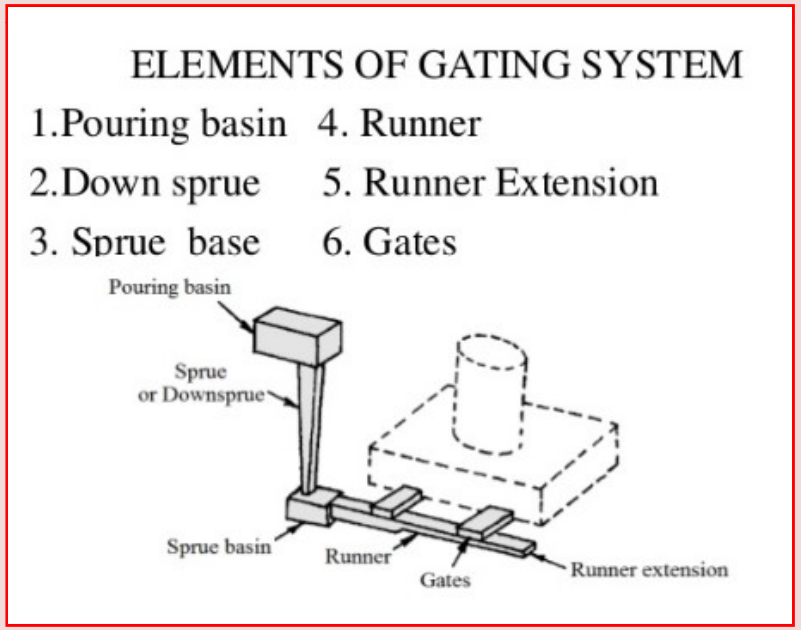
Gating System: In sand moulding / casting, Gating system refers to all the passages / Channels / network of channels through which the molten metal flows and enters into the mould cavity from outside of the mould.

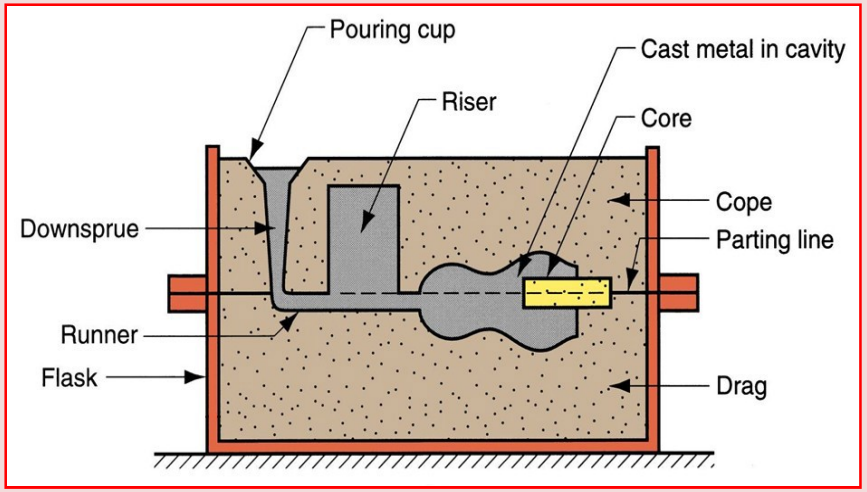
(Eg. Water distribution system)

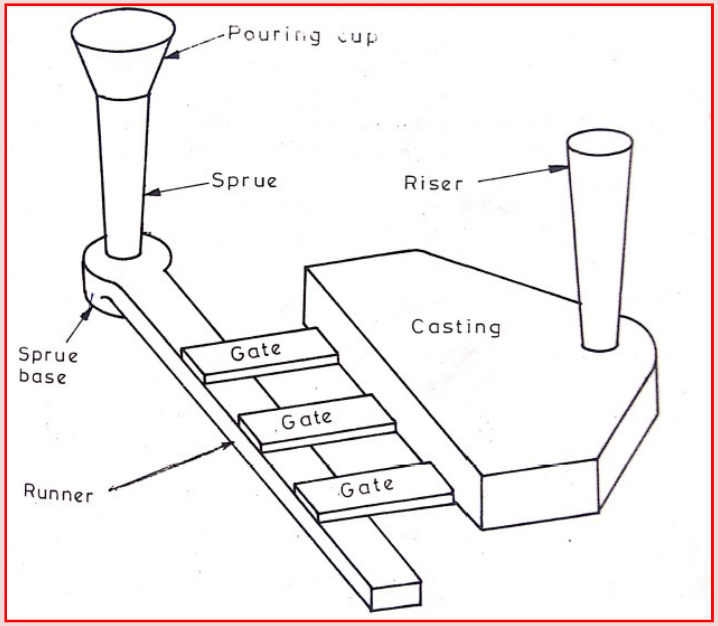
Parts / Elements of Gating system: Gating system refers to all those elements / parts through which the molten metal flows into the mould.

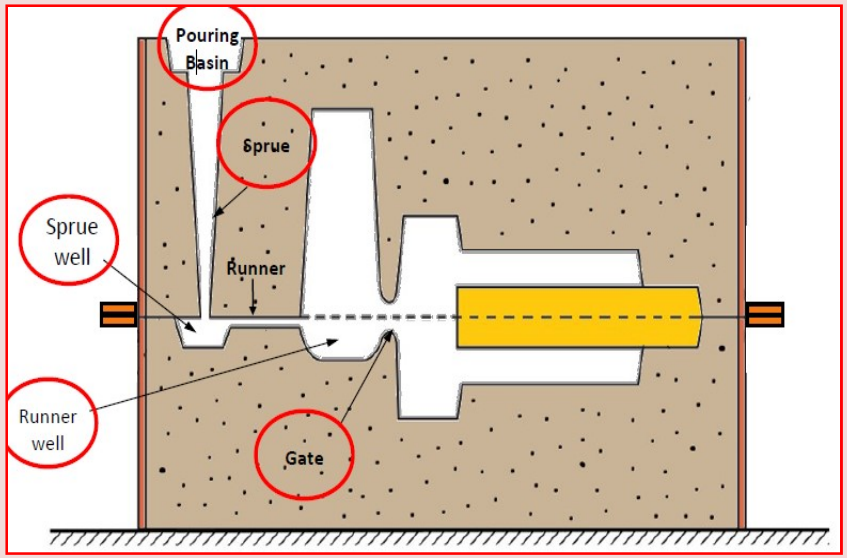
Important Elements/Parts of gating system are:

- Pouring basin/cup.
- Sprue.
- Sprue cup / Sprue well /Sprue basin.
- Runners.
- Runner extension & Runner well.
- Gates or In-gates.
- Risers.





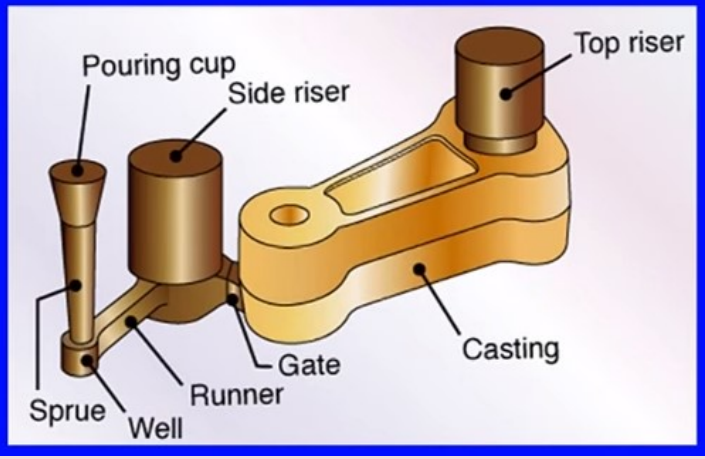




Figs showing the gating system

GATING SYSTEM

It refers to all the sections through which the molten metal passes while entering into the mould cavity.



GATING SYSTEM

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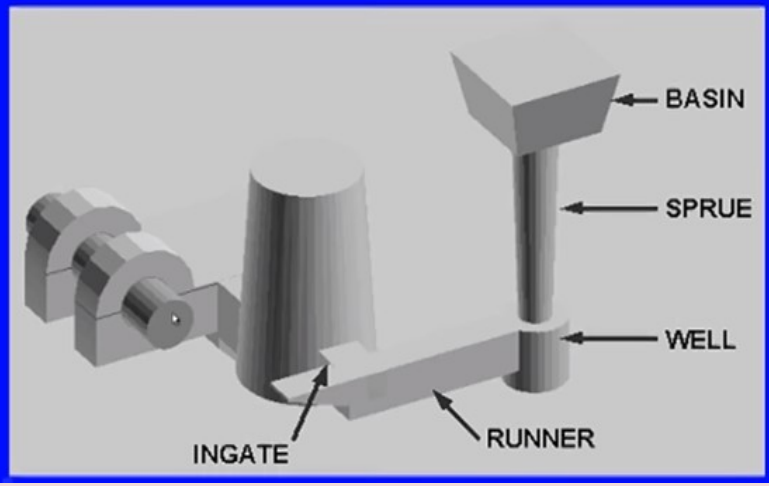
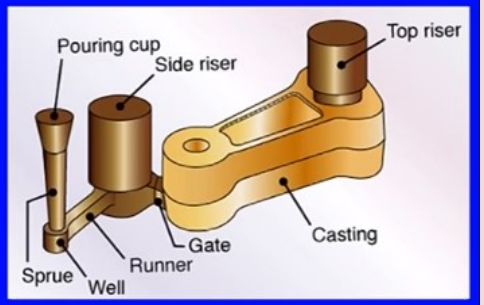
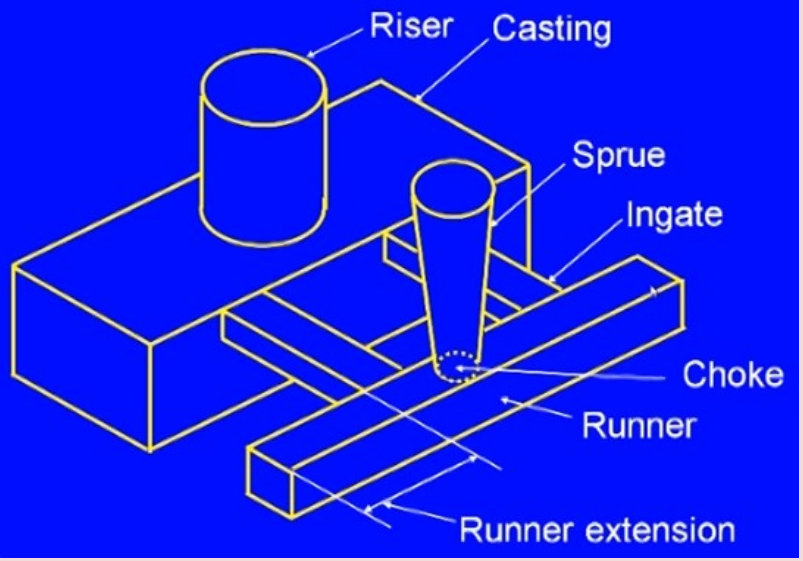


ELEMENTS OF GATING SYSTEM

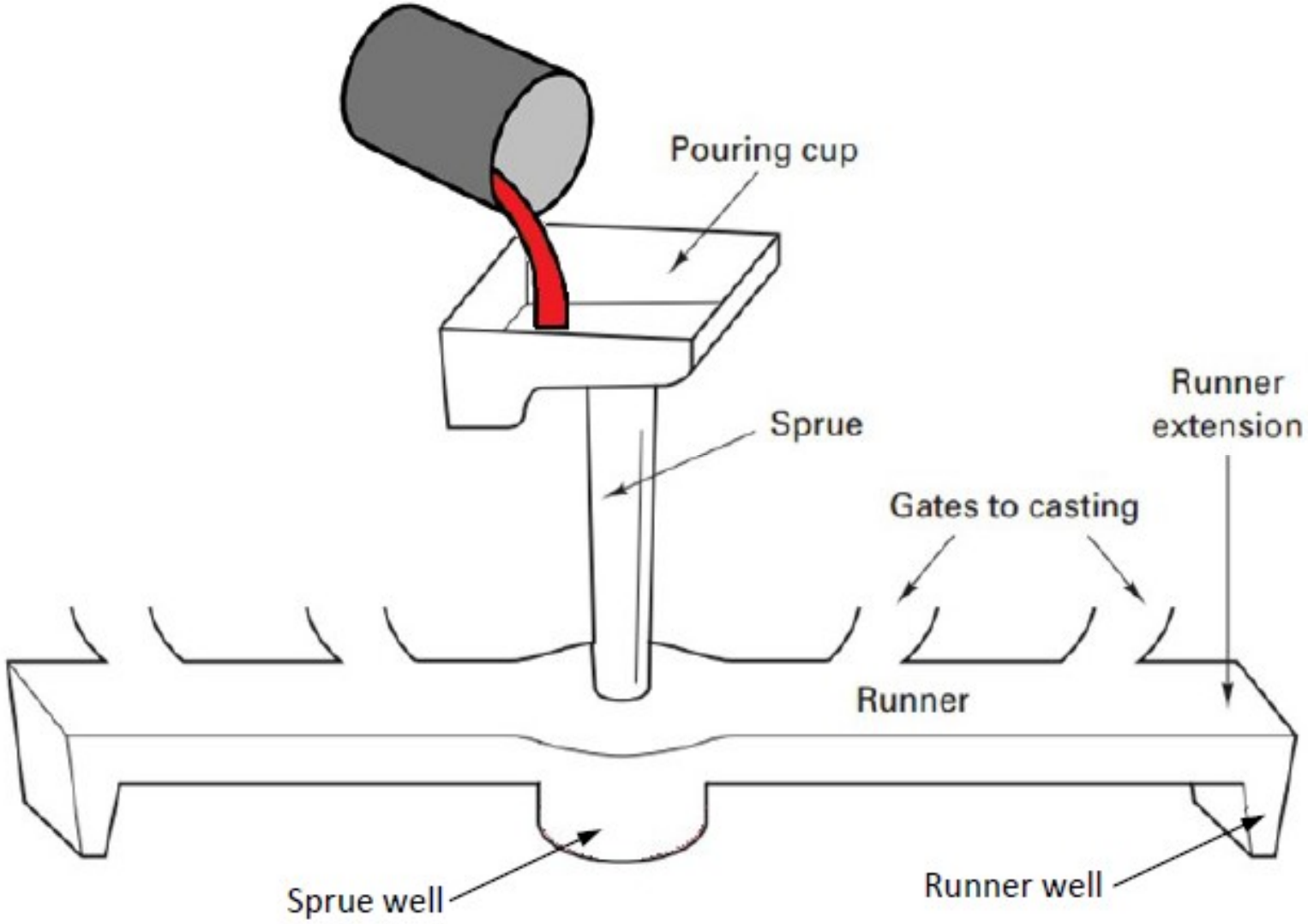
1. Pouring cup
2. Sprue
3. Sprue well
4. Runner
5. Runner extension
6. Ingates (Gates)
7. Riser



ELEMENTS OF GATING SYSTEM



Flow of Molten metal in the Gating system



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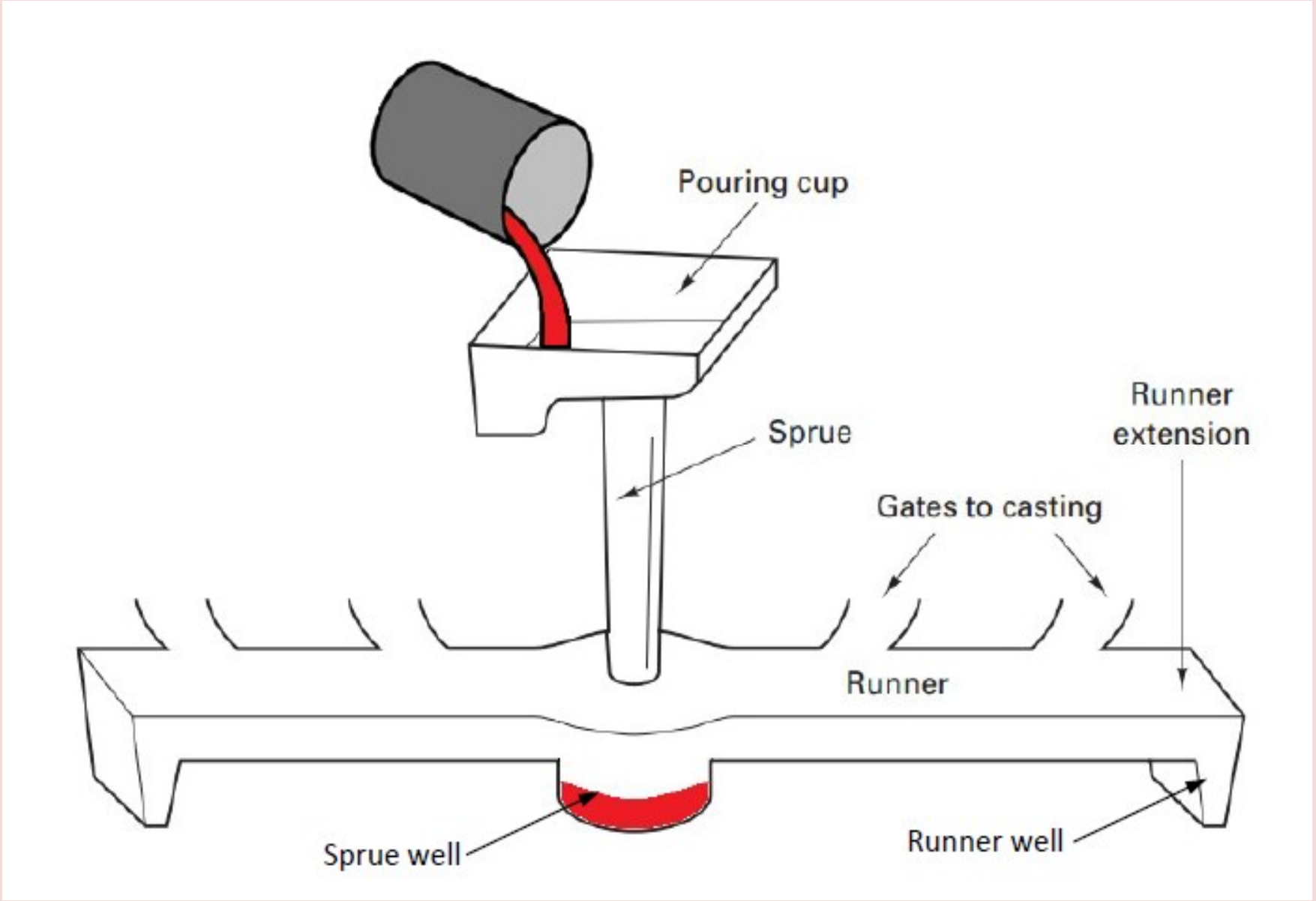

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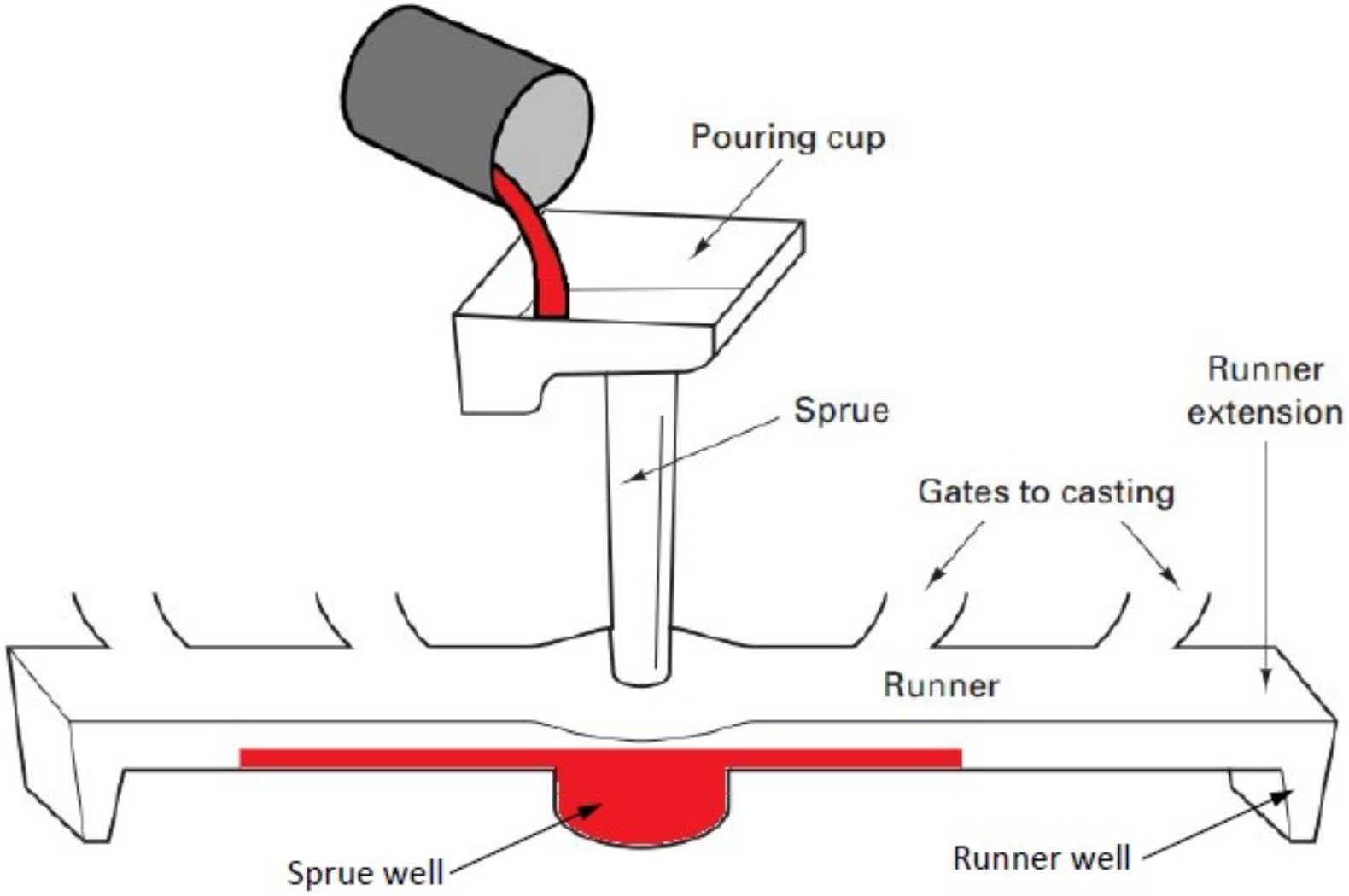
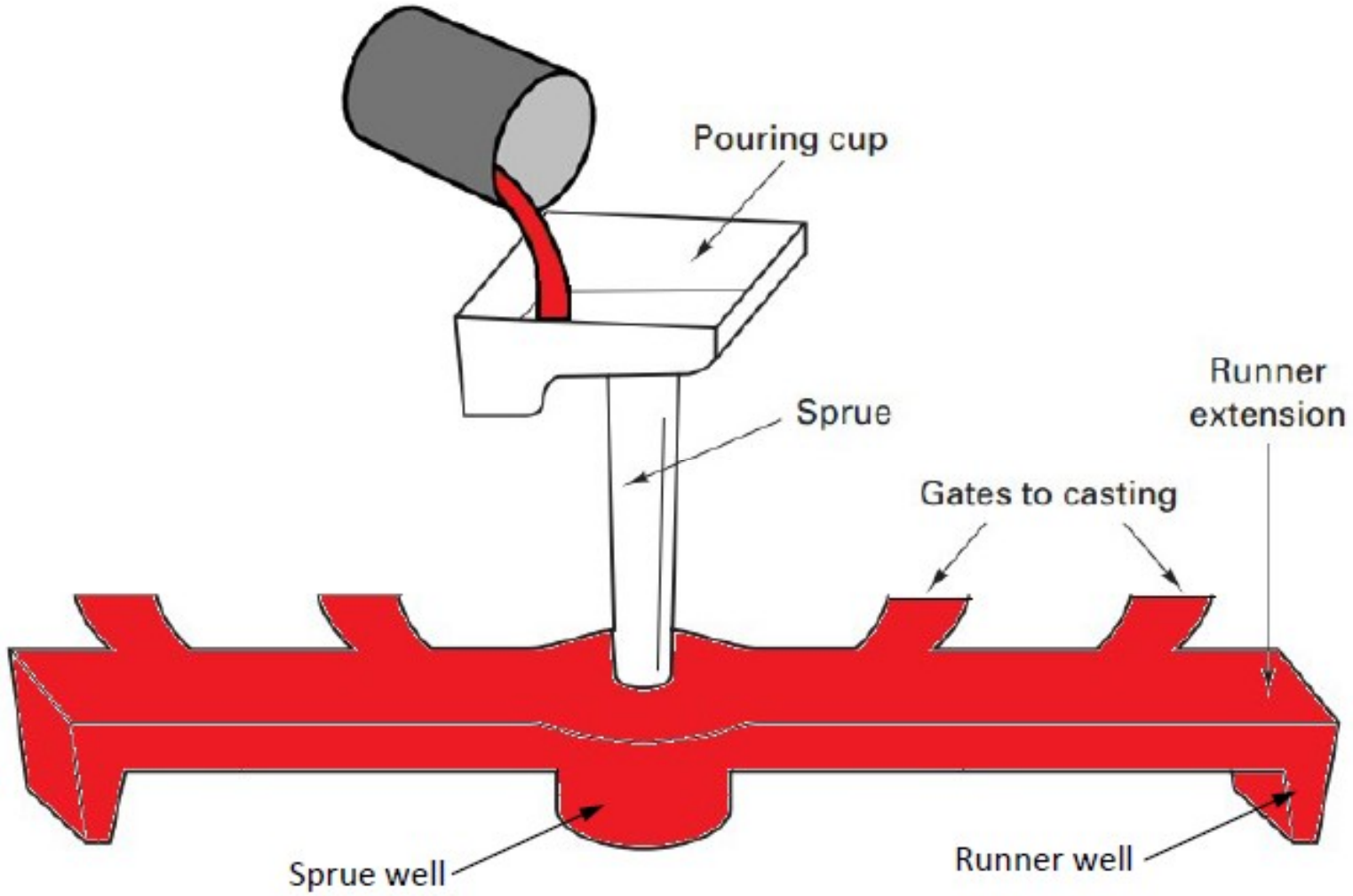


Flow of Molten metal in the Gating system



Requirements / Functions of Gating System:

1. A good gating system should fill the mould cavity with molten metal with least turbulence.

   - by providing good Pouring basin, Sprue well, avoiding sharp changes in the direction.

2. It should prevent mould erosion and gas pickup during the flow of molten metal into the mould cavity.

   - by reducing metal flow velocity and turbulence.

   - by avoiding direct impingement of molten metal on the mould walls.

3. It should avoid entering of unwanted material (Slag, Dross, sand particles etc.) into the mould cavity.

Functions of Gating System …

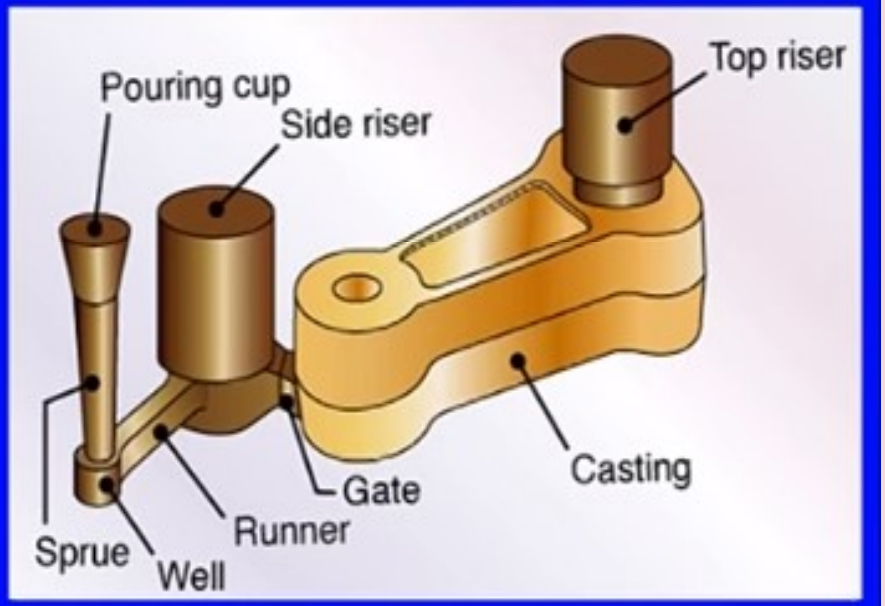
4. It Should promote Directional solidification.
5. It should maintain proper temperature gradient in the casting.
6. It should regulate the right rate of flow of molten metal into the mould cavity.
7. It should help easily to fill completely the mould cavity with molten metal.
8. Gating system design should be economical and simple in design to implement and easy to remove after cast.

FUNCTIONS OF GATING SYSTEM

- To fill the mould cavity completely before freezing
- To minimize turbulence
- To avoiding erosion
- To remove inclusions
- To regulate flow of molten metal
- To consume least metal – less scrap

ELEMENTS OF GATING SYSTEM

1. Pouring cup
2. Sprue
3. Sprue well
4. Runner
5. Runner extension
6. Ingates (Gates)
7. Riser



Pouring Basin.

- It is the important element of the gating system provided on the top surface of the cope, just above the Sprue cup.
- Molten metal is pored into the pouring basin which acts as a reservoir and enter smoothly into the sprue.

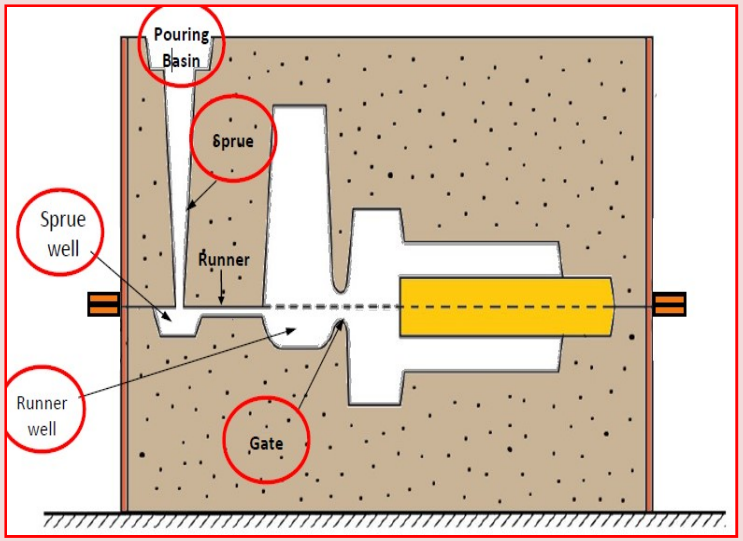
- It helps ..

- to pour the molten metal from the ladle.

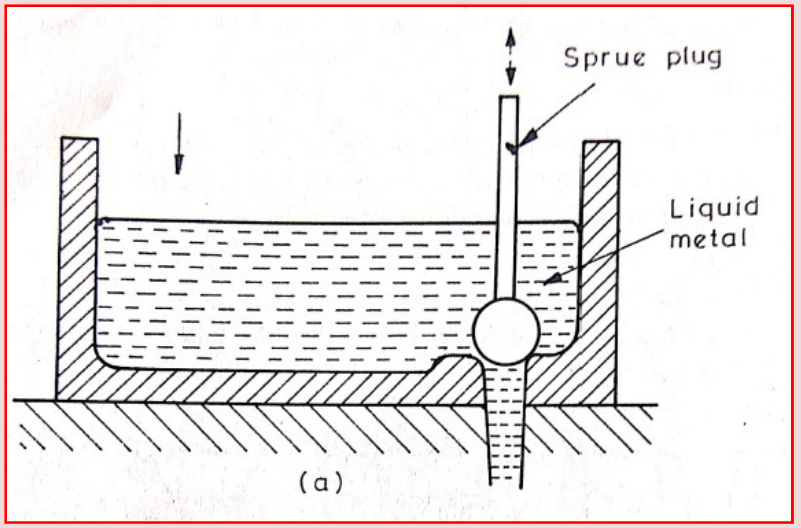
- in maintaining the required rate of metal flow.

- Reduces turbulence, vortexing and avoids mould erosion.

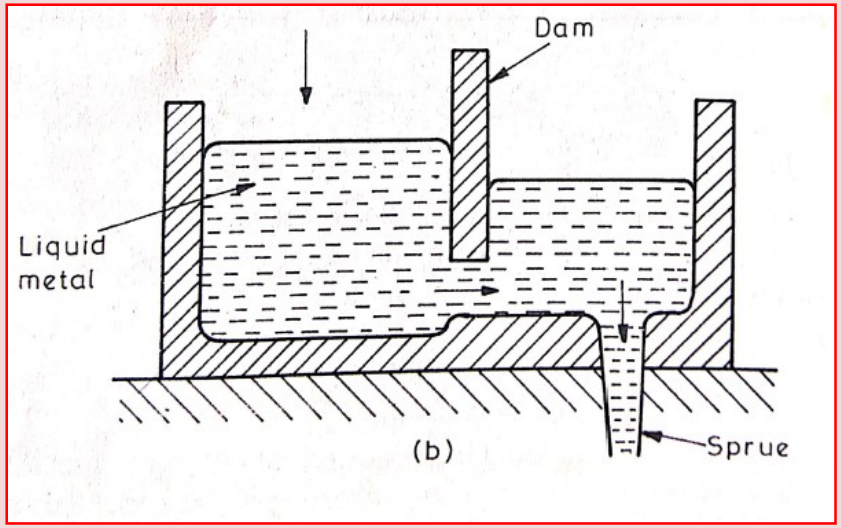
- Avoids entry of slag, gas etc, into the mould cavity.

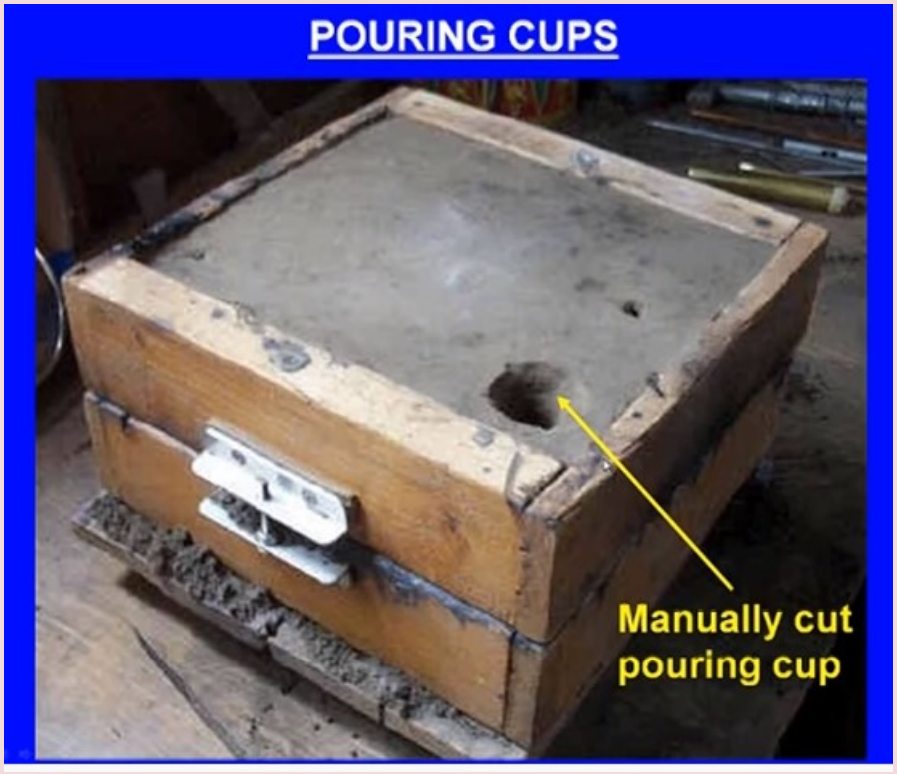


- Pouring basin should be deep and large enough and should be full during pouring operation to avoid vortex formation.



- One of the walls of pouring basin is made inclined at 45* to the horizontal and metal is poured on this face to avoid momentum and vortex formation.

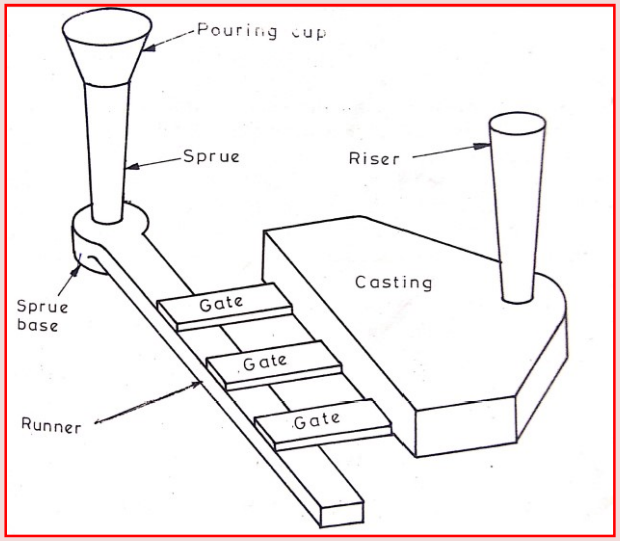


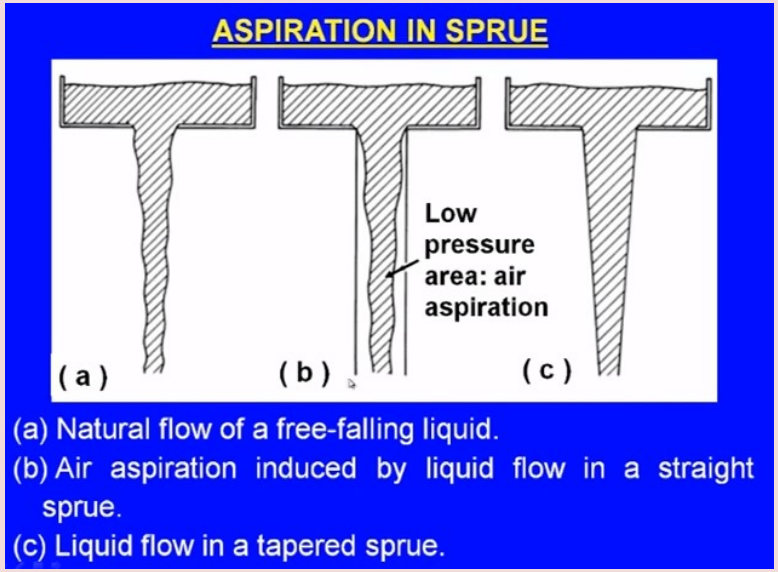


Figs. Pouring cups

Sprue:

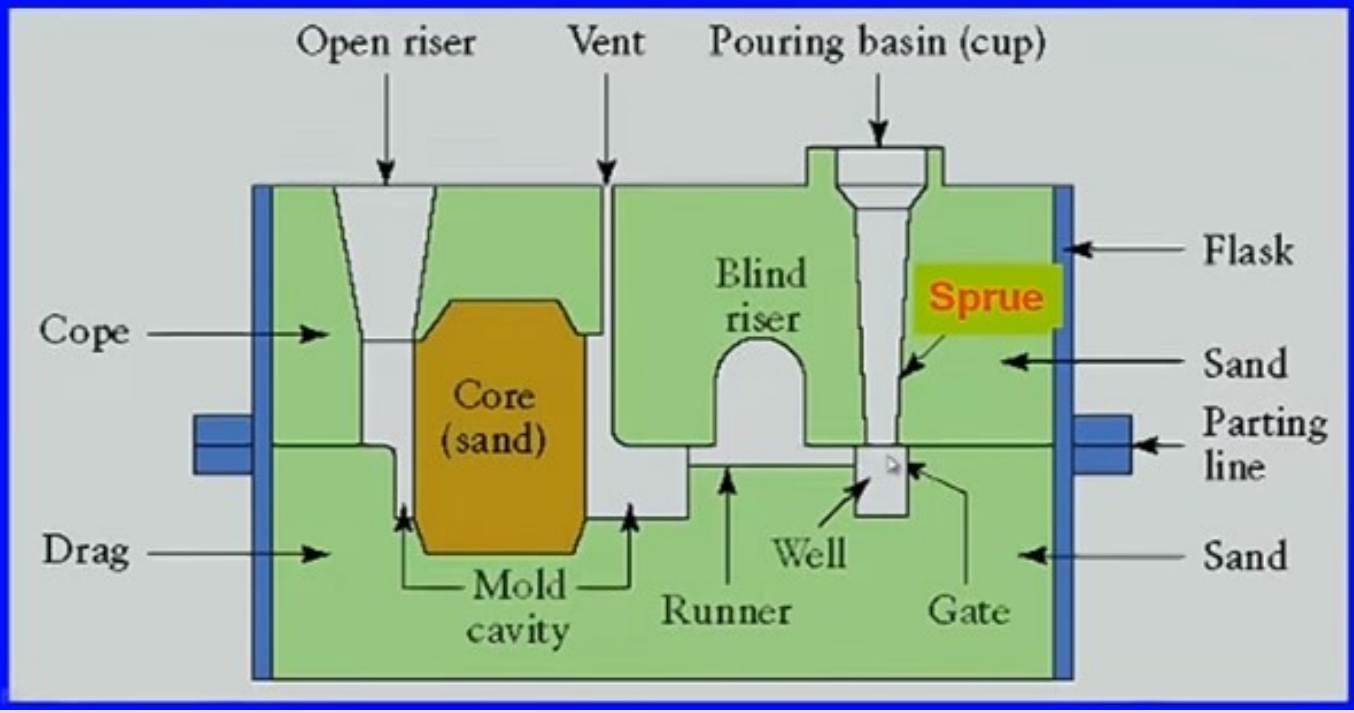
- It is a tapered shape (round or rectangular) vertical passage which transfer the molten metal from the pouring cup / basin into the runner.
- It is tapered to avoid air aspiration during metal flow.
- If sprue are straight like cylinder as shown in fig. Then the metal flow would not be full at the bottom and some low pressure area is created around the metal at the bottom of the sprue. Since the sand mould is permeable (Porous) atmosphere air gets trapped in the cavity (Aspiration).





DESIGN OF SPRUE

Sprue is the vertical passage inside the mould through which molten metal (from the pouring basin) reaches the runner and eventually the mould cavity.



RULES FOR DESIGN OF SPRUE

1. The size of sprue should be optimized to limit the flow rate of molten metal.
2. Vortex formation tendency in a sprue with circular cross section is higher. Hence, rectangular cross-section sprues are better than the circular ones with the same cross-sectional area. However, round sprues are more economical for small castings.
3. Height of the sprue is determined by the casting and the top riser height.

RULES FOR DESIGN OF SPRUE

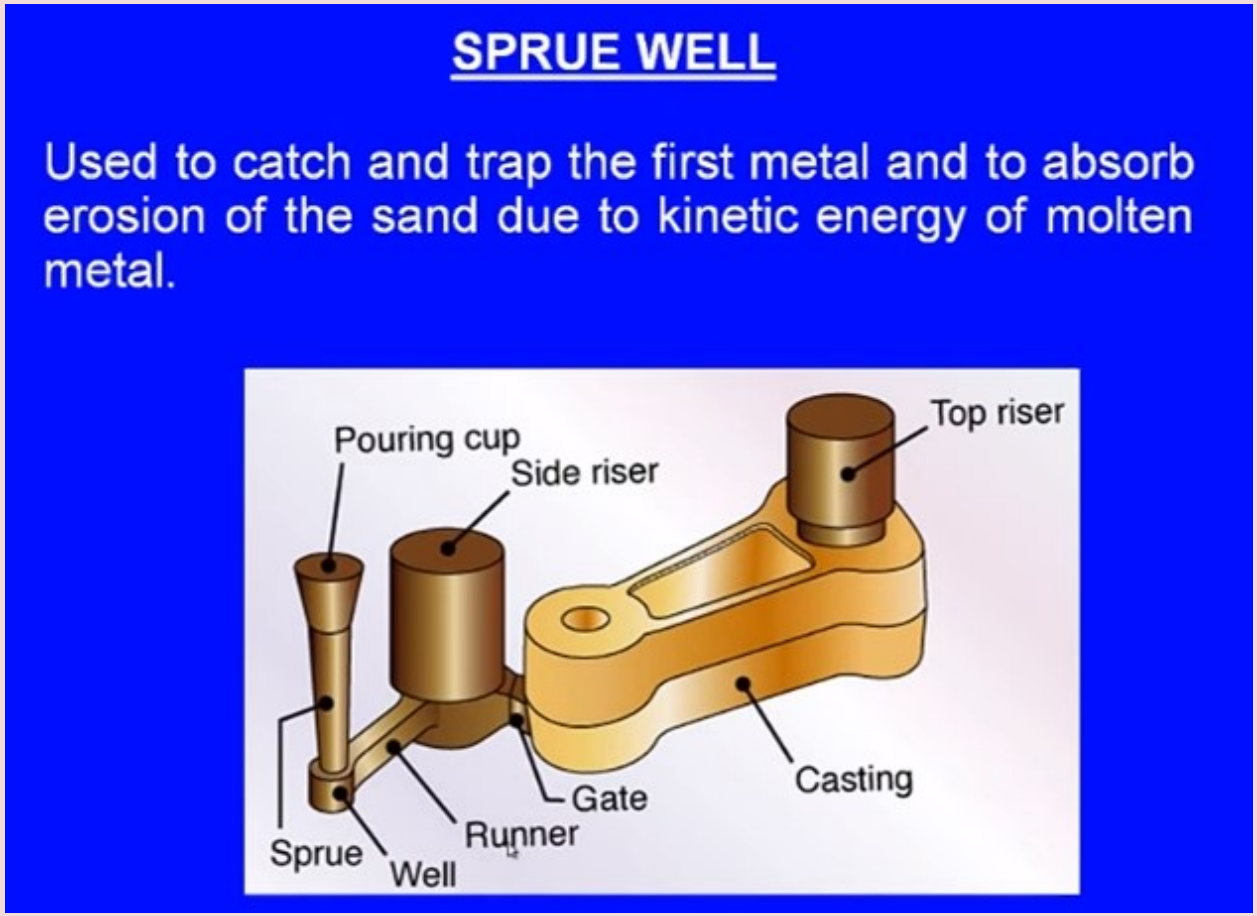
4. Sprues should be tapered by approximately 5% to avoid aspiration of the air.

5. Standard filter should be placed at the outlet of the sprue / well as the metal flows into the runners.

6. The sprue should be located centrally on the runner, with an equal number of gates on each side.

Sprue well : **This is a reservoir for molten metal at the bottom of the sprue to reduce the momentum of the metal and reduces the erosion of mould.**

The molten metal then changes its direction and flows into the runners uniformly.

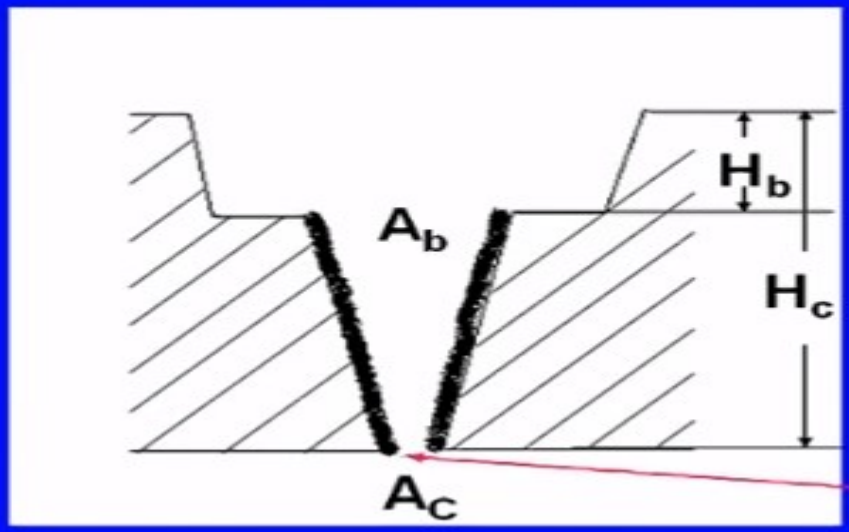


RULES FOR DESIGN OF SPRUE WELL

Sprue well area is two to three times the area of the sprue exit (choke).

CHOKE AREA

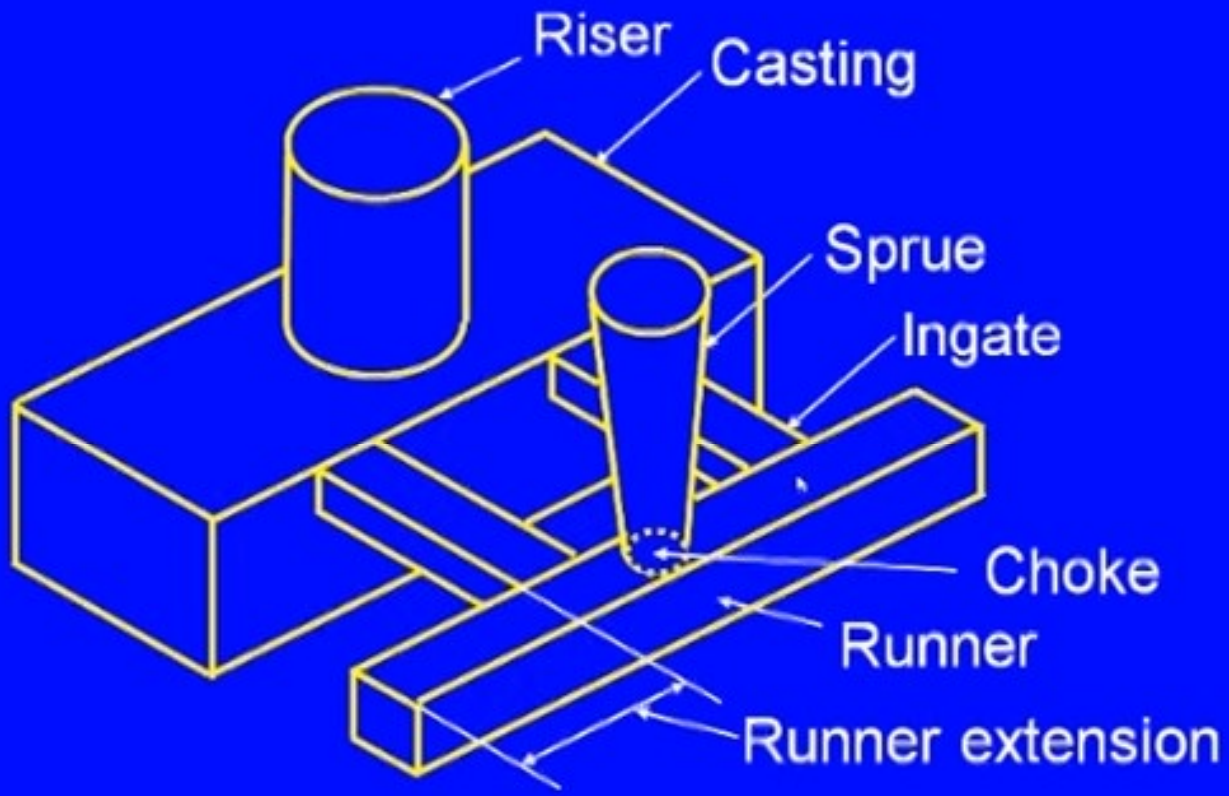
The smallest area that occurs at the bottom of the sprue is known as '**Choke area**'.



Runner:

- It is a passage / channel connected between sprue well and the gate.
- It is generally located in the horizontal plane (Parting line/plane)
- Runners are made rectangular or trapezoidal in c/s .
- Generally (for ferrous metals) runners are cut in the cope and the gates are cut in the drag (Fig)
- This helps in trapping the slag and other impurities in the upper portion of the runner.
- The runner should always flow full to effective trapping of slag.

DESIGN OF RUNNER



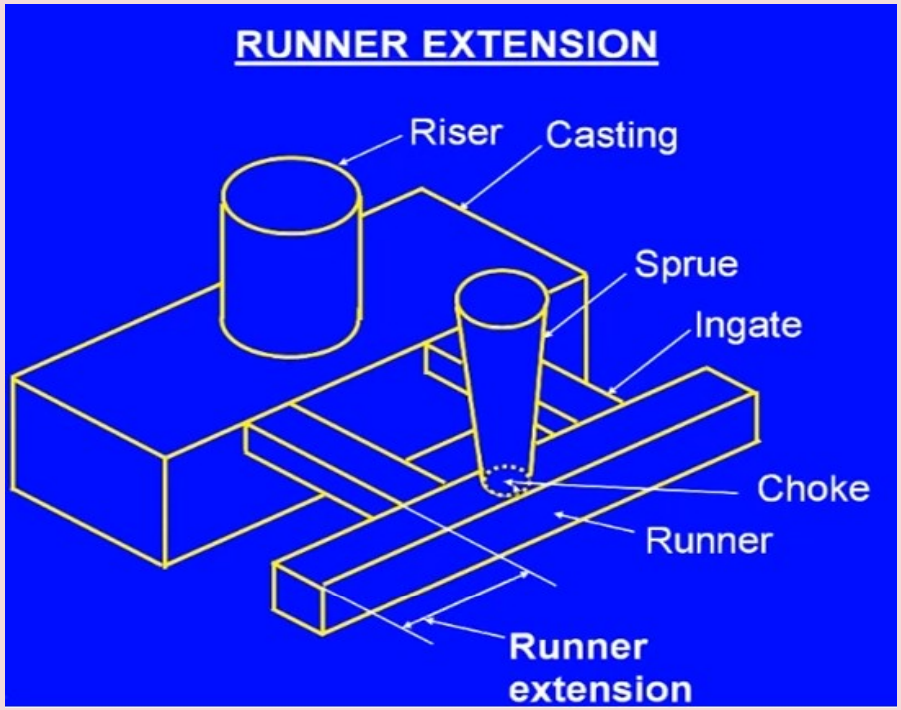
Runner is the horizontal channel through which the molten metal flows from the sprue to the gate.

RULES FOR RUNNER DESIGN

1. Typical cross-section of a runner is square.
2. The runner's cross-sectional area is generally two to four times the cross-sectional area of the choke.
3. Abrupt changes in the direction of runners should be avoided. If the change in direction is more than about 15°, the joint needs to be filleted.
4. Runners should maintain a minimum distance from the casting (4 to 5 times the thickness of the gate).

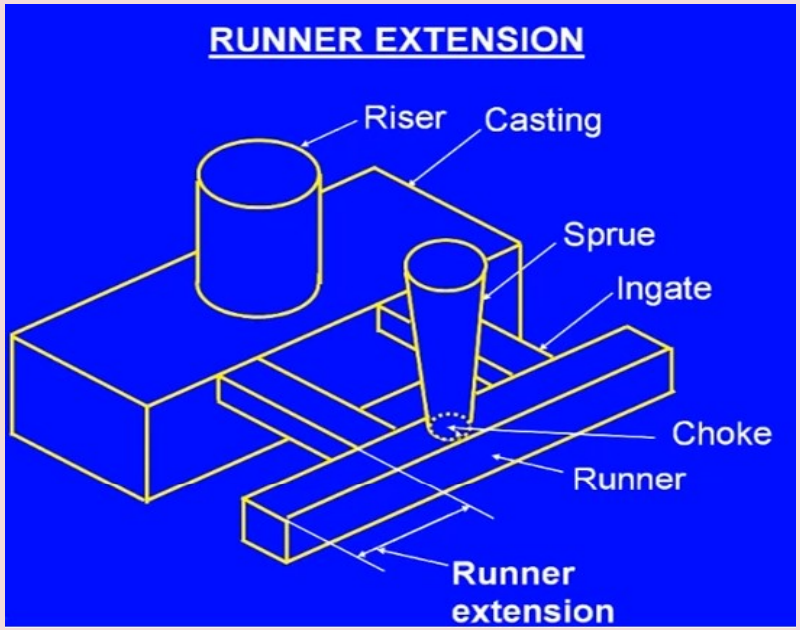
Runner Extension:

- **The end portion of the runner is called Runner extension.**
- **It is extended beyond the last gate to trap slag.**
- **The metal initially come along with the slag floating at the top of the ladle and it flows straight beyond the gate to the runner extension and slag is trapped.**



Gates / In-gates:

- These are nothing but passages / opening through which the molten metal enters into the mould cavity.
- It connects the runner or sprue/sprue well and the mould cavity.
- The shape and c/s should be such that it should be easily broken off from the cast.



RULES FOR GATES DESIGN

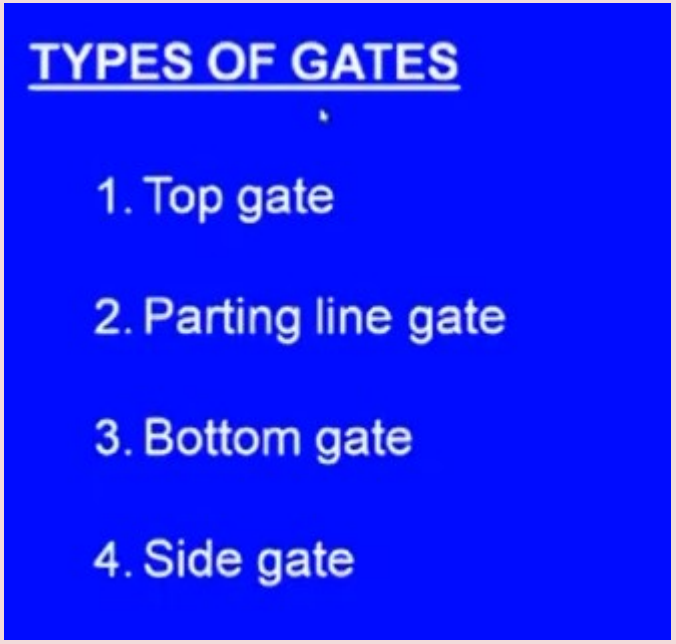
- Multiple ingates often are preferable for large parts.
- A fillet should be used where an ingate meets a casting; - Produces less turbulence.
- The minimum ingate length should be three to five times the ingate's width, depending on the metal being cast.
- Curved ingates should be avoided, as far as possible.

Types of Gates:

Depending upon the applications various types of gates are used in the casting process.

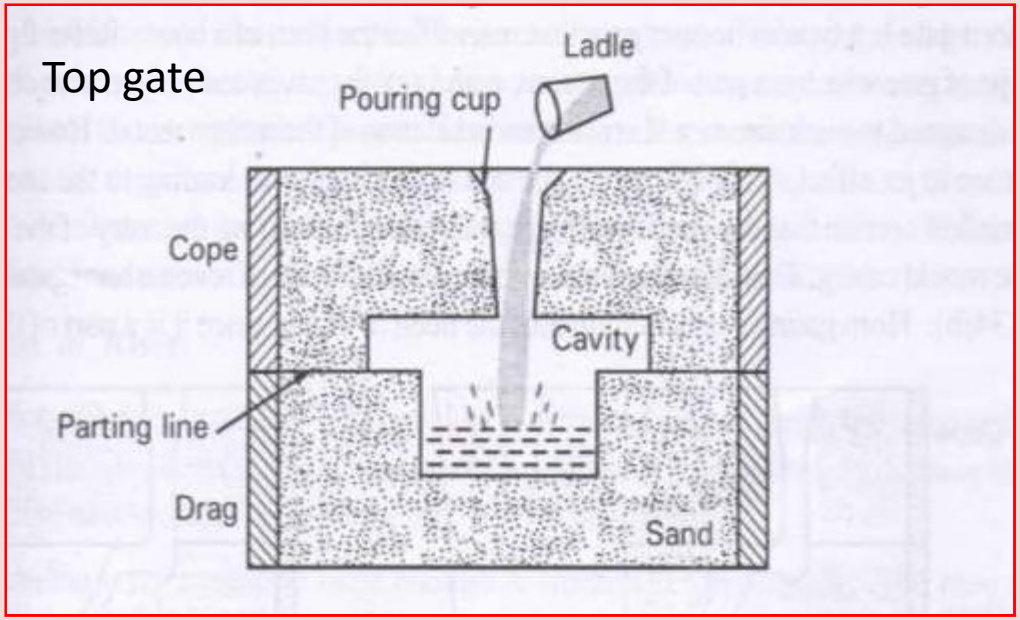
Some of the commonly used gates are as follows.

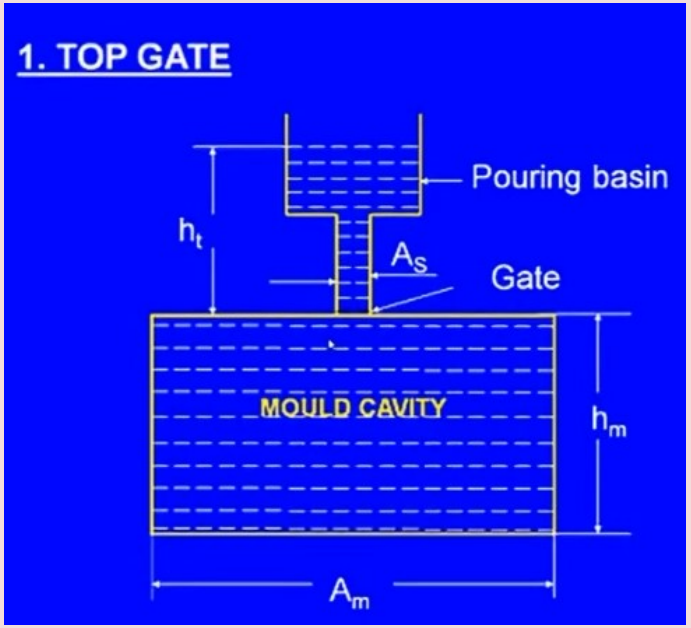
- **Top Gates. (Open pour gate, Strainer gate, etc.)**
- **Bottom Gates. (Simple bottom gate, Horn gate, etc.)**
- **Parting Line Gates.**
- **Side Gates.**
- **Multiple Gates (Branch Gates).**



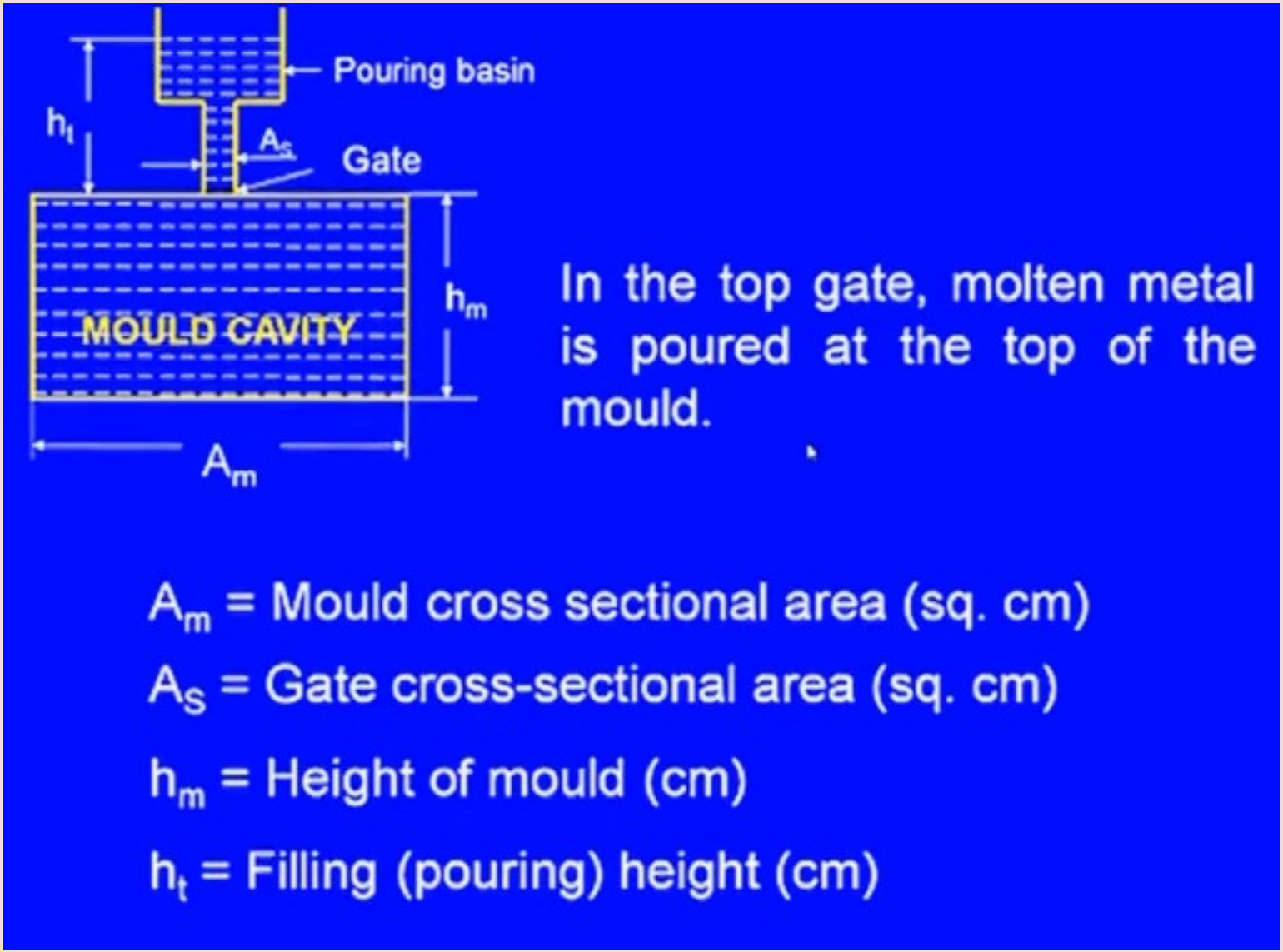
Top gate

- In this type of gate molten metal enters the mould cavity from top, hence the name Top gate.
- Molten metal from pouring basin is fed directly into the mould cavity.
- The hottest metal remains at the top of casting , this promotes directional solidification from the casting towards the gate.





Top Gate:



In the top gate, molten metal is poured at the top of the mould.

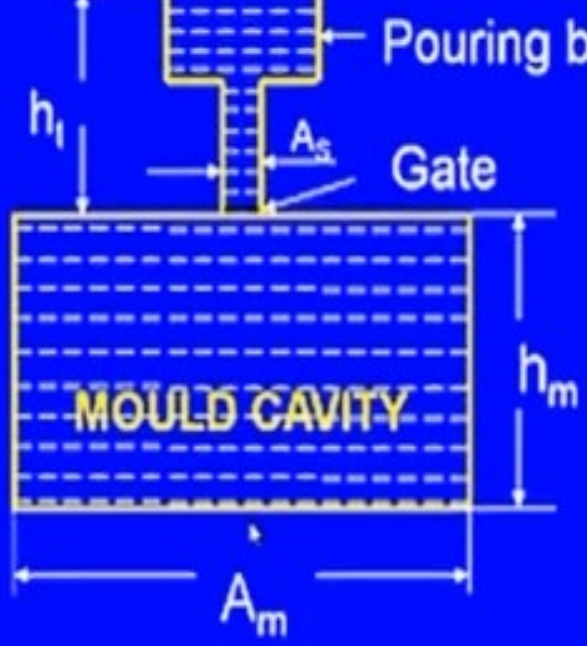
A_m = Mould cross sectional area (sq. cm)

A_S = Gate cross-sectional area (sq. cm)

h_m = Height of mould (cm)

h_t = Filling (pouring) height (cm)

Top Gate:



ADVANTAGES:

Simple design.

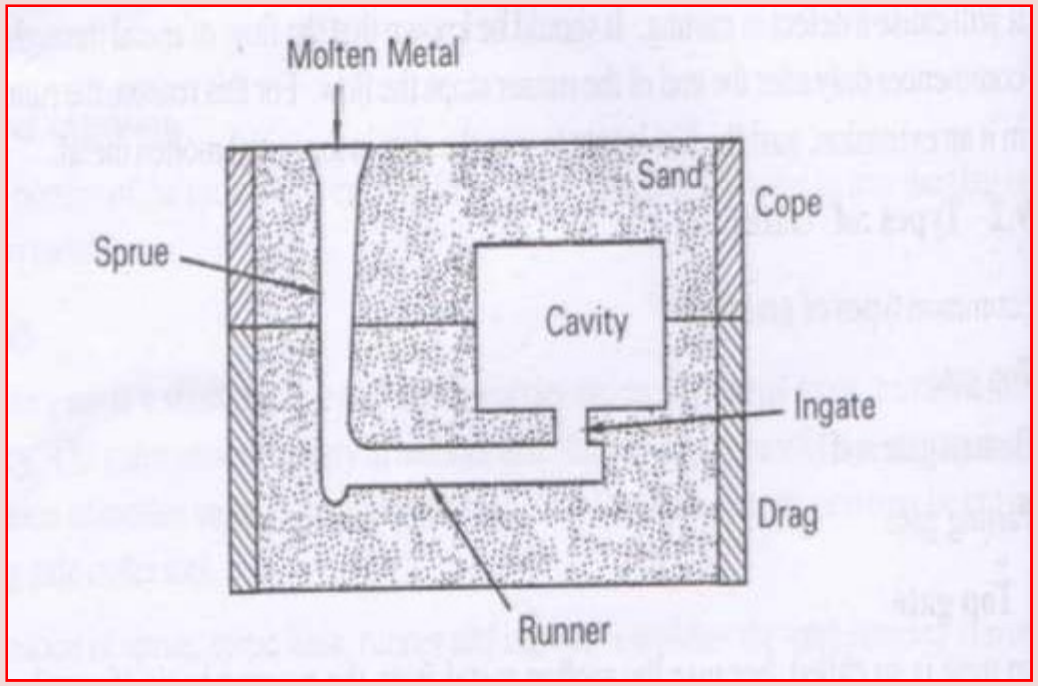
DISADVANTAGES:

Turbulence and erosion is caused in case of large castings.

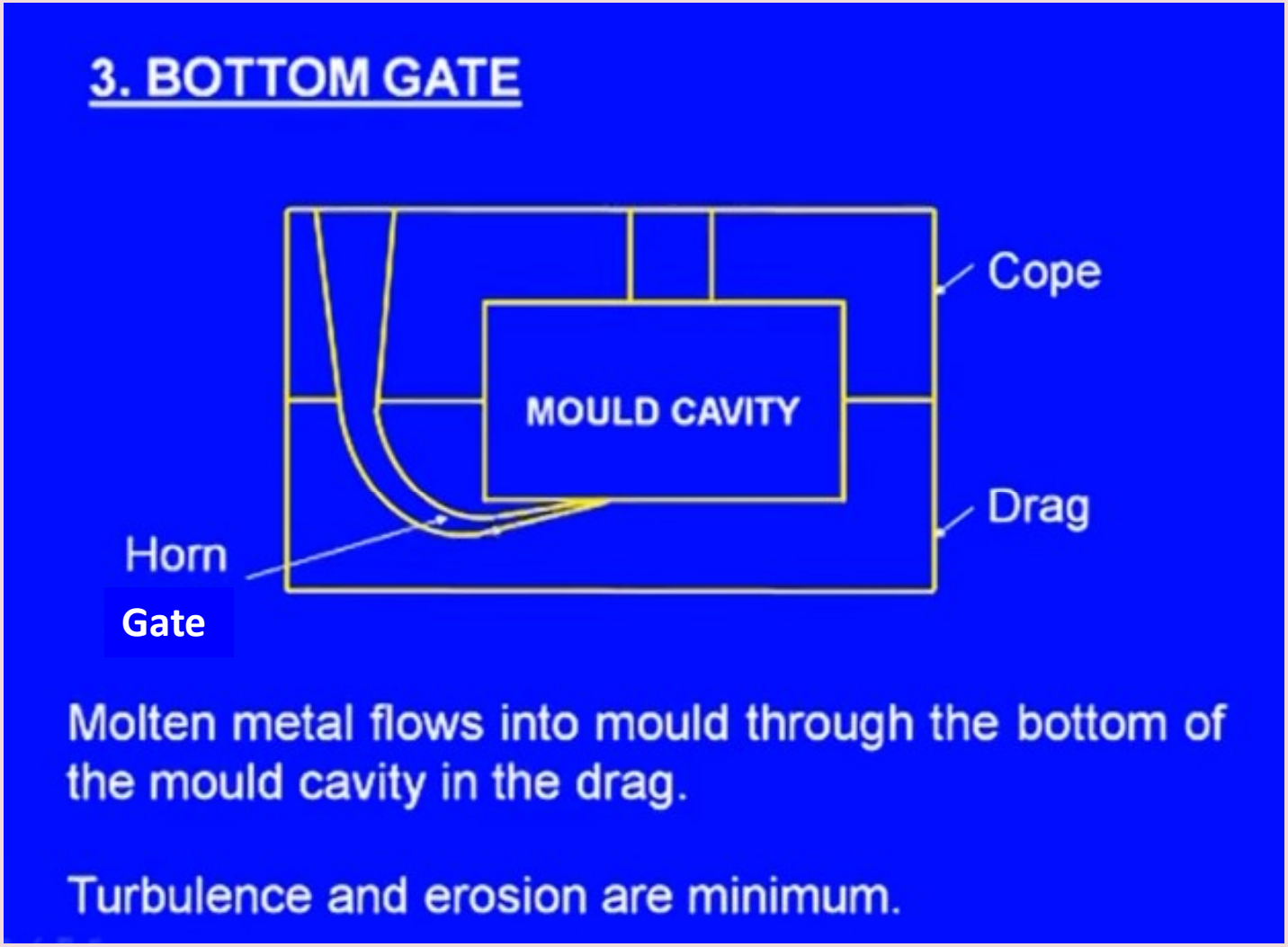
Can be used where moulds are erosion resistant.

Bottom gate

- The molten metal enters from bottom to the mould cavity.
- It minimizes turbulence and erosion in the mould cavity.
- Provides unfavorable temperature gradients that do not promote directional solidification.

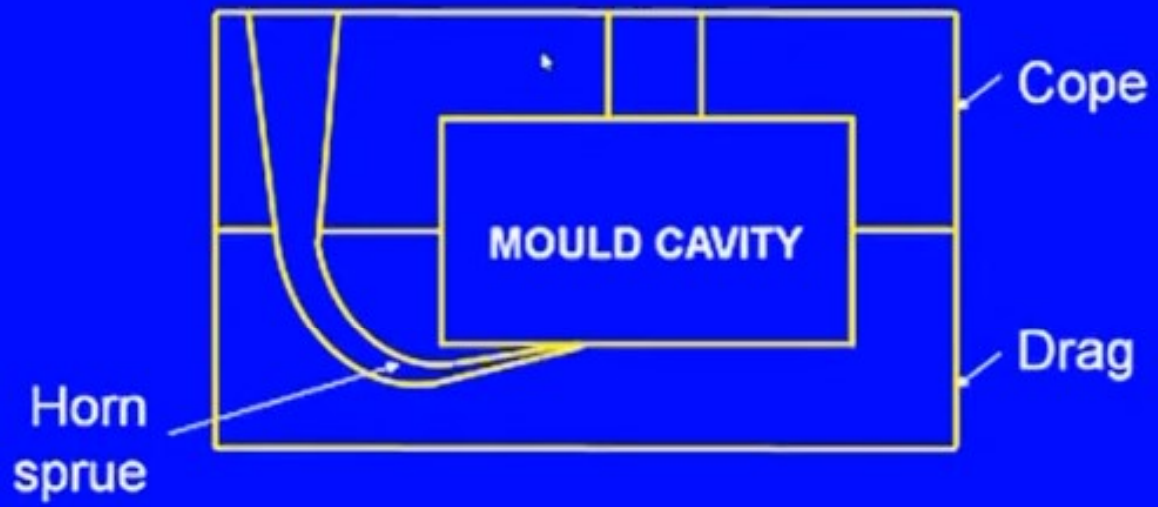


Bottom Gate:


3. BOTTOM GATE
Cope
MOULD CAVITY
Drag
Horn
Gate
Molten metal flows into mould through the bottom of the mould cavity in the drag.
Turbulence and erosion are minimum.

Bottom Gate:

3. BOTTOM GATE



DISADVANTAGES:

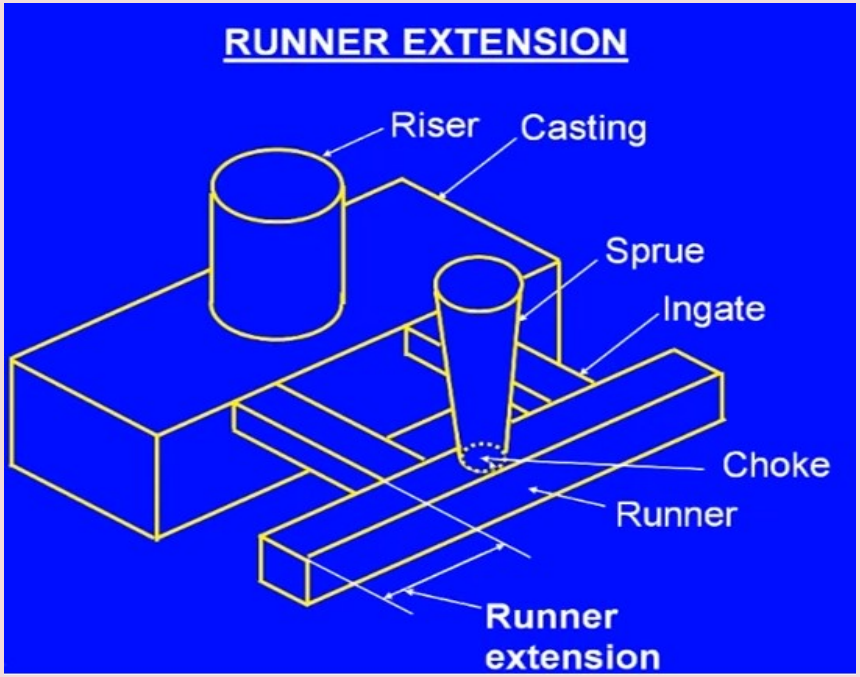
Metal at the top of the cavity will be at a lower temperature.

Side Gate:

Here, Gates are provided at the sides of the mould cavity, not at the top or at the bottom

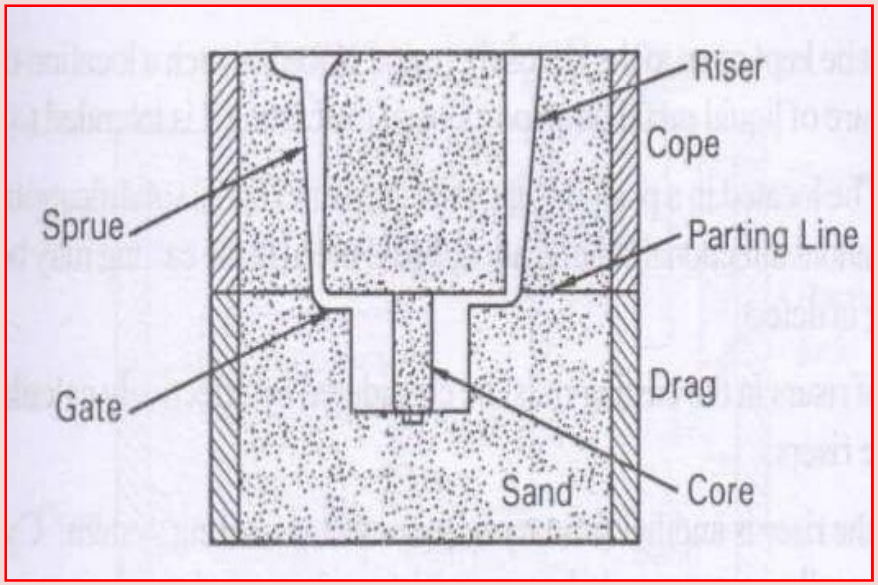
Multi - Gate:

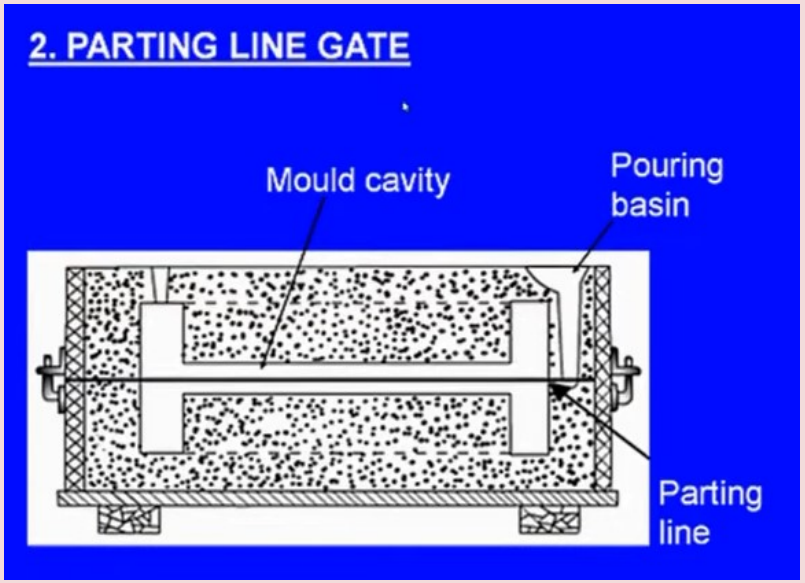
Here more than one gate will be provided for a single mould cavity (For large size castings)



Parting Line Gates

- **It is most commonly used gate and is a compromise between top and bottom gates.**
- **The gate is provided at the parting line of the mould .**





Riser:

A riser or feeder head is another important element of gating system.

It is a vertical passage which will be connected to the cast.

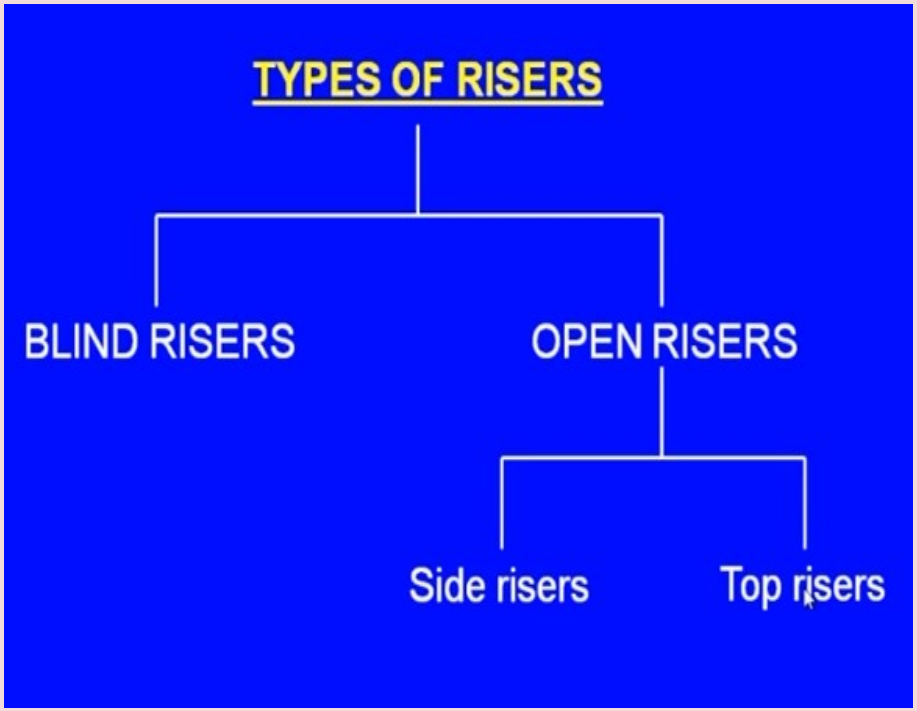
It is made in the cope to store the liquid metal and supply the same to the casting as it solidifies.

Types of Risers:

1. Open Risers.

– Top Riser & Side Riser

2. Blind Riser (Closed Riser).



Why Design of Riser?

- An undersized riser could lead to shrinkage defects and ultimately result in rejection of the casting.
- An oversized riser requires excess molten metal and results in excess power / fuel consumption for melting.
- Hence, the size of the riser must be optimized using some systematic methods.

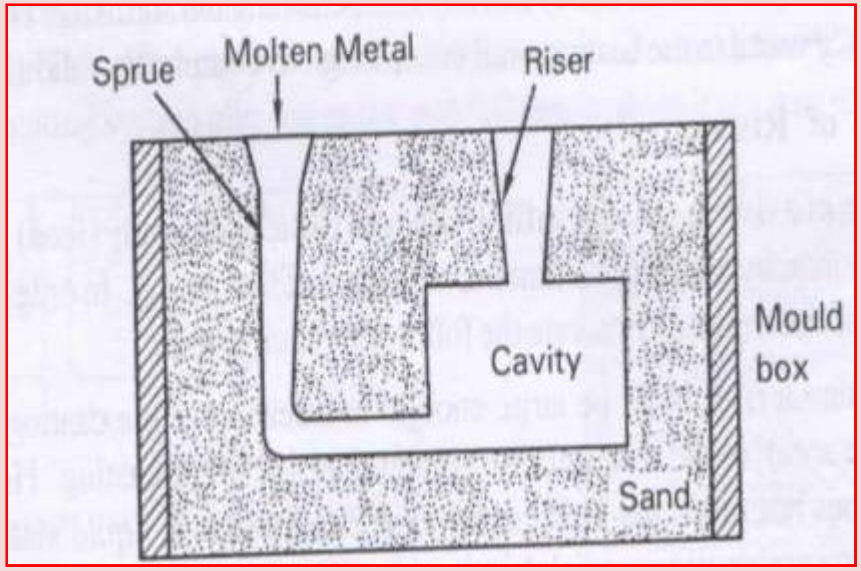
GUIDELINES FOR RISER DESIGN AND LOCATION

- The riser (feeder) must not solidify before the casting.
- The volume of riser(s) must be large enough to feed the entire shrinkage of the casting.
- The pressure head from the riser should enable complete cavity filling.
- Riser must be placed so that it enables Directional Solidification.

Types of riser

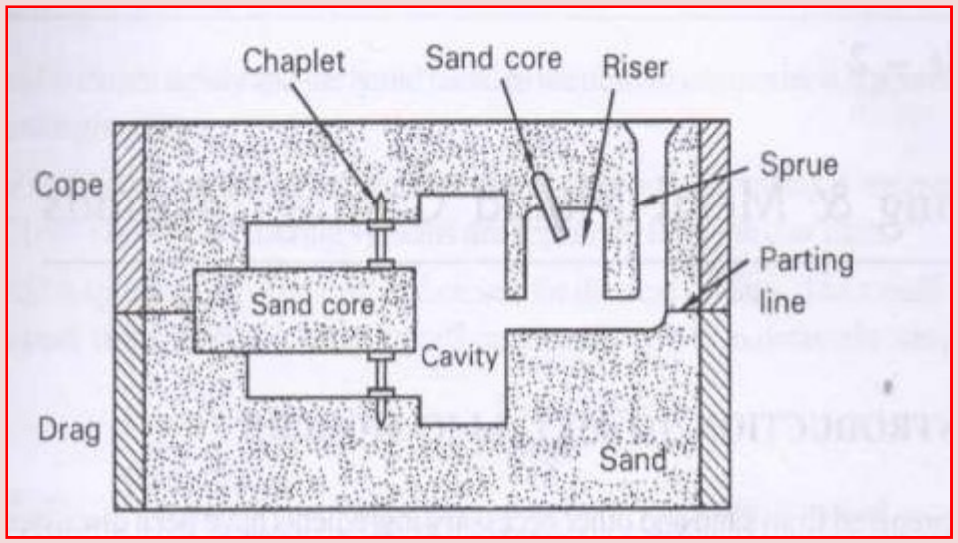
1. Open riser

- The top surface of the riser will be open to the atmosphere.
- The open riser is usually placed on the top of the casting.
- Gravity and atmospheric pressure causes the liquid metal in the riser to flow into the solidifying casting.



2. Blinder riser

- It is completely enclosed in the mould and not exposed to the atmosphere .
- The metals cools slower and stay longer promoting directional solidification.
- The liquid metal is fed to solidifying casting under the force of gravity alone.



Functions of Risers:

- **Acts as a molten metal reservoir and Avoids shrinkage defects.**
- **Promotes directional solidification.**
- **Helps in escaping air and other gases from mould.**
- **Riser full of molten metal Indicates mould cavity is filled completely.**
- **Casting solidifies under the liquid metal pressure, so the quality of casting will be high.**

PRIMARY FUNCTION OF A RISER

- It acts as a reservoir of molten metal in the mould to compensate for shrinkage during solidification.

SECONDARY FUNCTIONS OF A RISER

- It gives an indication that the cavity is full with the molten metal.
- It also enables escape of hot gases during pouring of molten metal.

END