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SIZE REDUCTION





VARIOUS EQUIPMENTS USE IN SIZE REDUCTION

IMPORTANT TABLE



MILL	ACTION	PRODUCT SIZE	USE FOR	NOT USED FOR
CUTTER MILL	CUTTING	20 to 80 mesh	Fibrous Crude (animal and vegetable drug)	Friable materials
Roller Mill	COMPRESSION	20 to 200 mesh	soft material	Abrasive material
Hammer Mill	Impact	4 to 325 mesh	almost all drugs	Abrasive material
Disintegrator	Impact	20 to 80 mesh	almost all drugs	soft and sticky materials.
Ball Mill	Attrition and impact	20 to 200 mesh	Brittle drugs	soft materials
Fluid Energy Mill	Attrition and impact	1 to 30 microns	Moderately hard and friable materials	soft and sticky materials
Edge Runner Mill	Crushing and shearing	20 to 80 mesh	almost all drugs	sticky materials

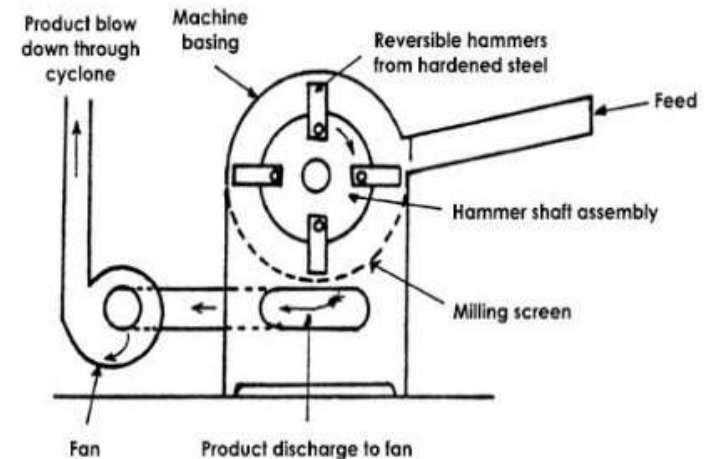


Hammer mill:

Principal: Material is impact b/w rapidly moving hammers on a rotor & the powder material

Uses: it is used to mill dry materials, wet filter press cakes, ointments, slurries etc. Brittle material is best fractured by impact from blunt hammers; fibrous material is best reduced in size by cutting edges.

Variants: Stocks tornado mill, Fitzpatrick comminuting machine (Fitz mill), Micropulvelizer, hammer crusher etc.



Construction & Working



- A hammer mill is essentially a **steel drum** containing a vertical or horizontal **rotating shaft** or drum on which hammers are mounted.
- The hammers **swings** on the ends or **fixed** to the central rotor.
- The rotor is rotates at a **high speed** inside the drum while material is fed into a feed hopper.
- The material is put into the hopper which is connected with the drum.
- The material is **powdered** to the desired size **due to fast rotation of hammers** and is collected under **the screen**.

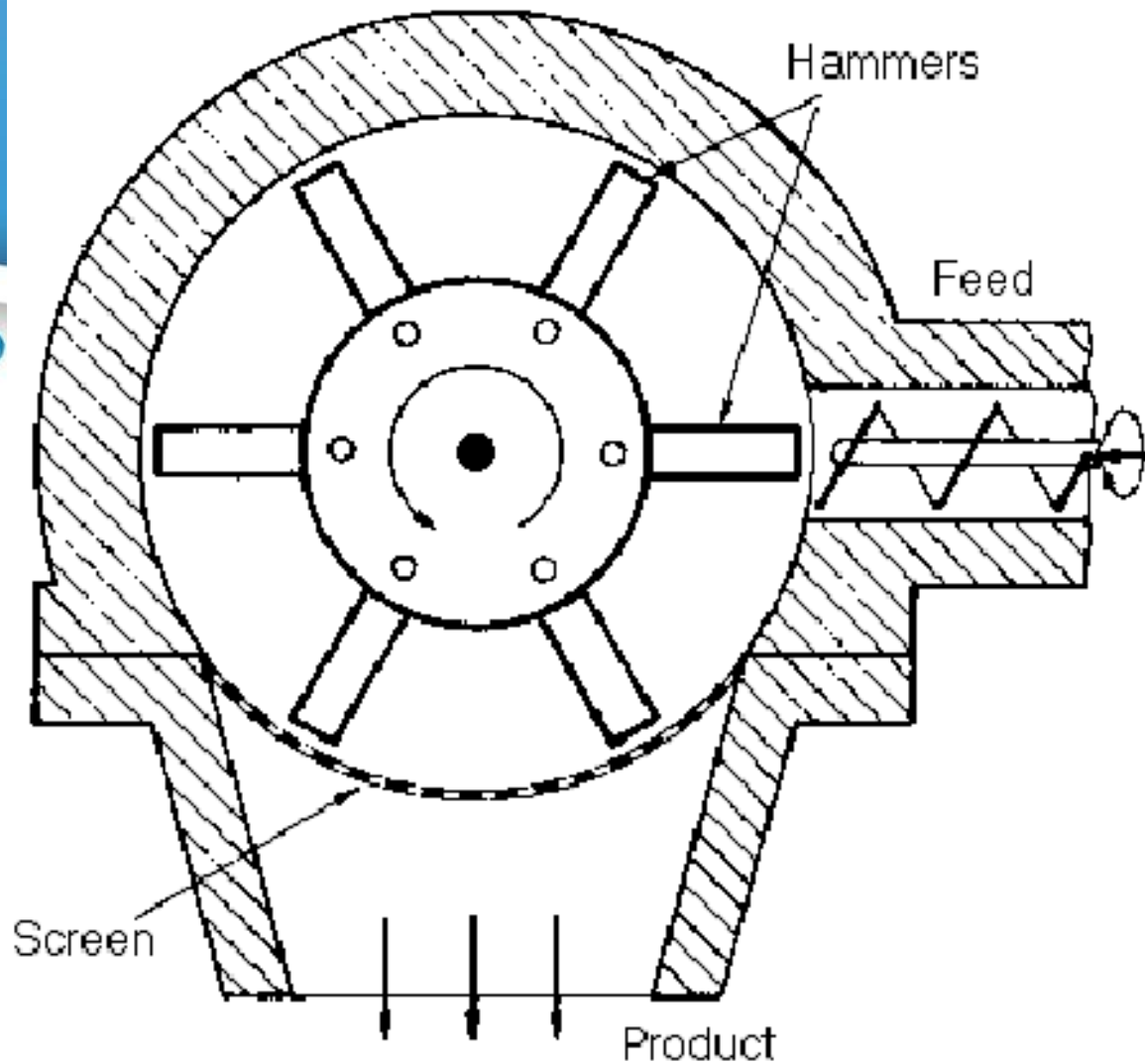
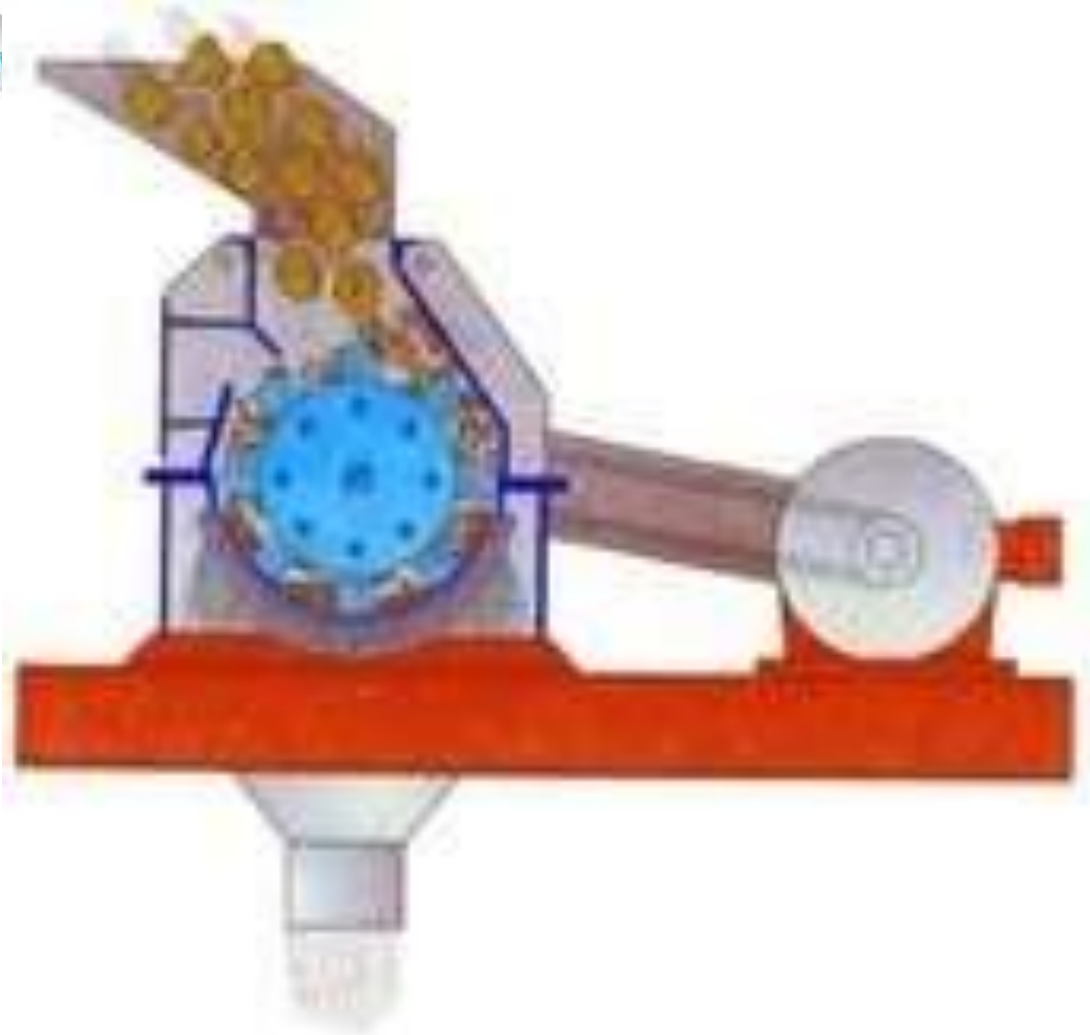
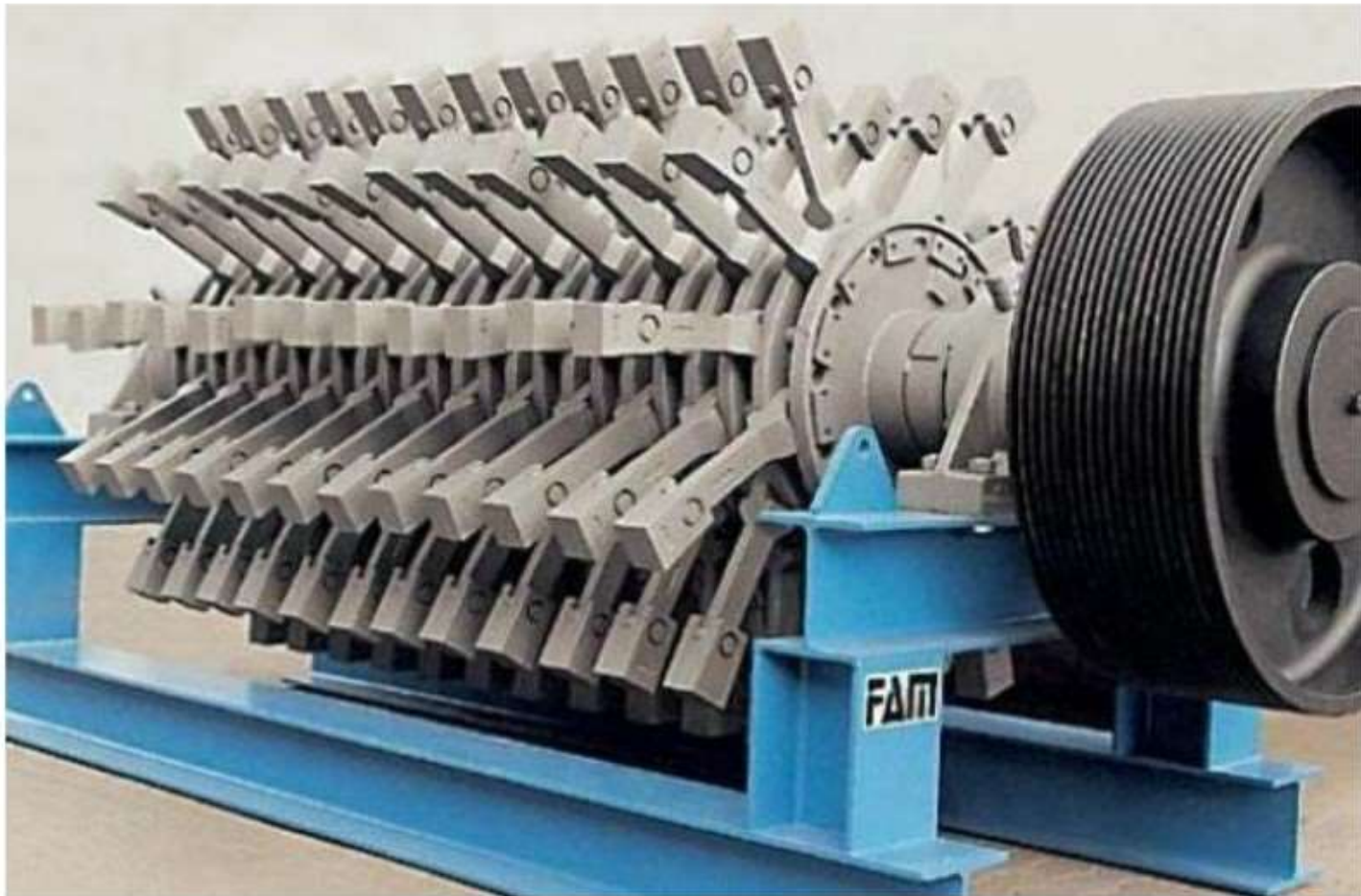


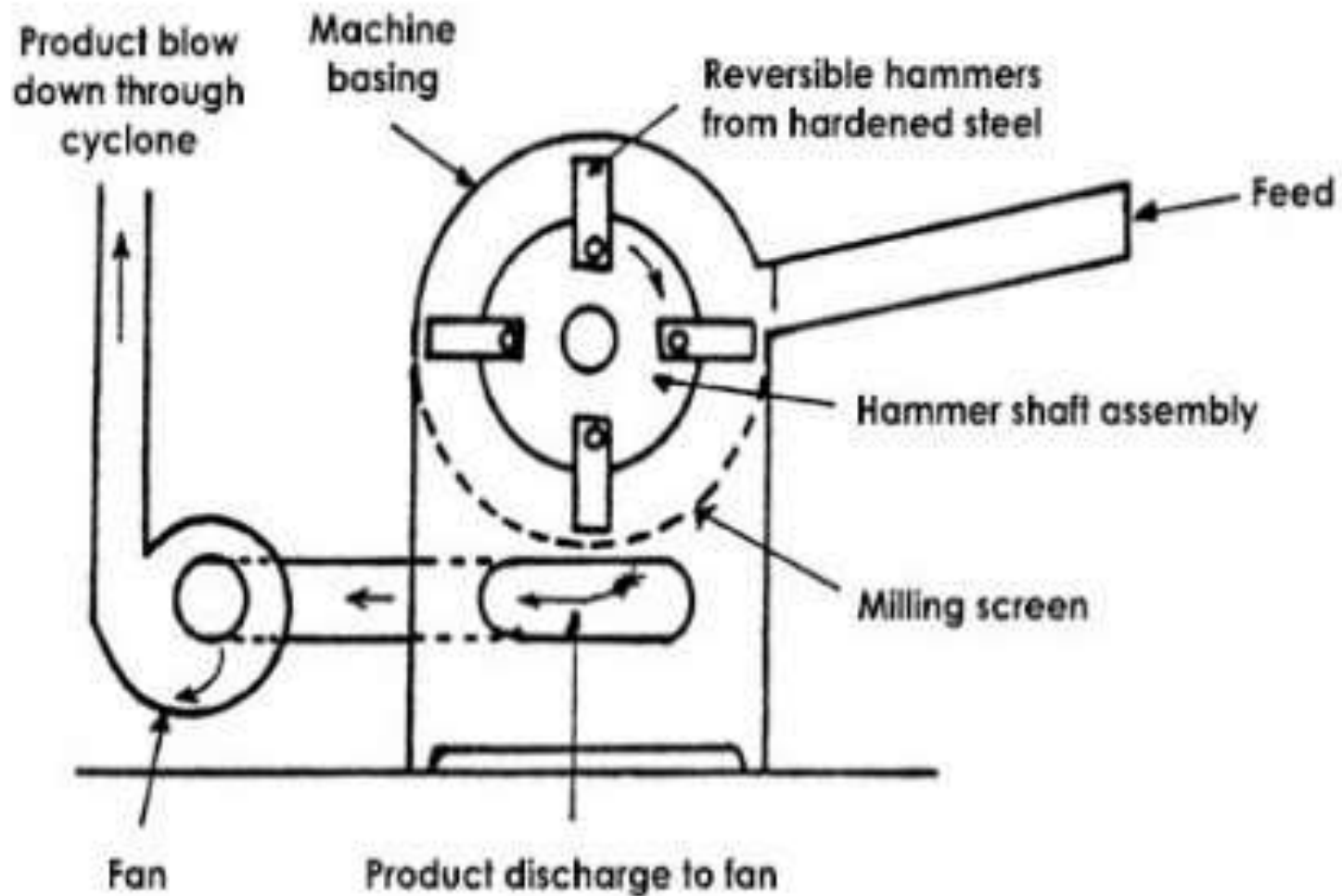
Fig. Hammer Mill

This are mainly operated at 2500 rpm or 1000 to 2500 rpm for the reduction of the large sized particles. High speed rotor uses 10000 rpm speed.



HAMMER MILL





ADVANTAGES OF HAMMER MILL



- It is **rapid** in action, and is capable of grinding many different types of materials.
- They are easy to install and operate, the operation is continuous.
- There is **little contamination** of the product with metal abraded from the mill as no surface move against each other.
- The particle size of the material to be reduced can be easily controlled by changing the speed of the rotor, hammer type, shape and size of the screen.

DISADVANTAGES



- **Heat** buildup during milling is **more**, therefore, product degradation is possible.
- Hammer mills cannot be employed to mill sticky, fibrous and hard materials.
- The screens may get clogged.
- Wearing of mill and screen is more with abrasive materials.

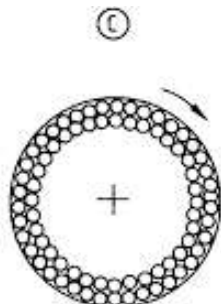
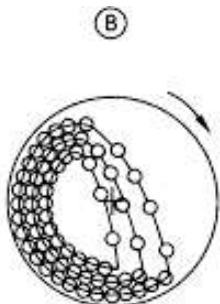
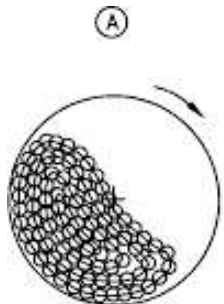
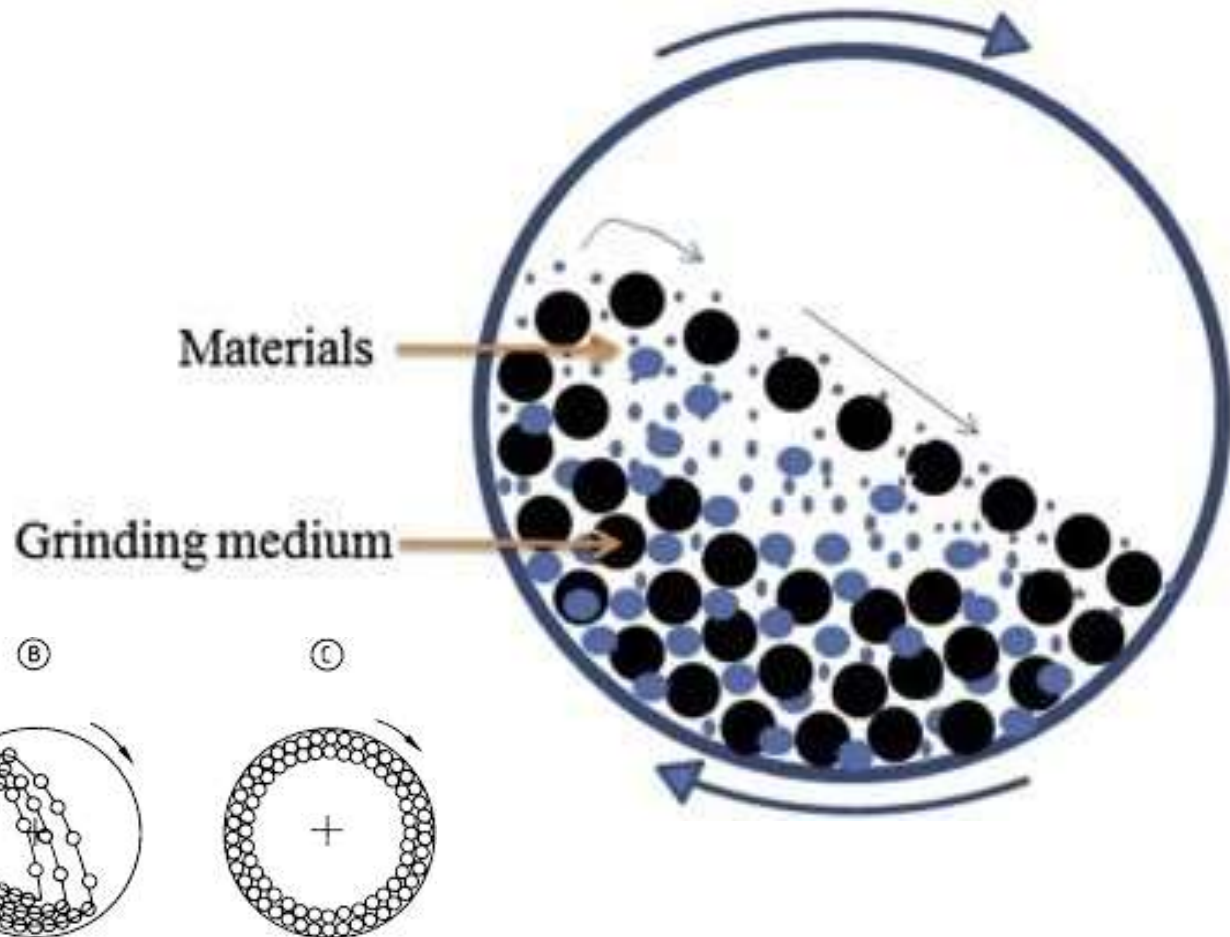
BALL MILL

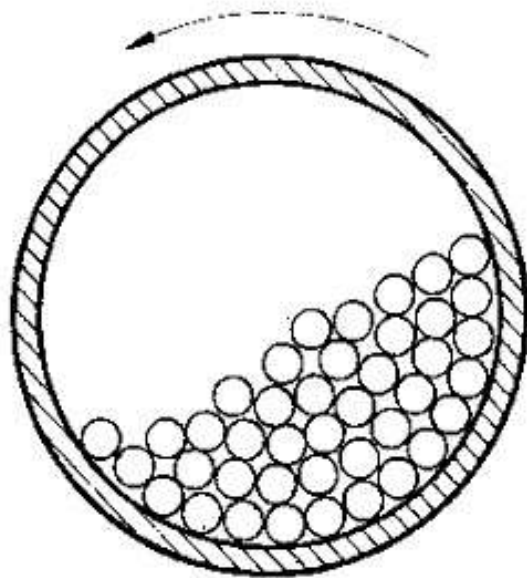


- These are also known as tumbling mills.
- **Principle:** The ball mill works on the principle of impact between the rapidly moving balls and the powder material, both enclosed in a hollow cylinder.
- **Working:** At low speeds, the balls roll over each other and attrition (rubbing action) will be the predominant mode of action. Thus, in the ball mill, impact or attrition or both are responsible for the size reduction.

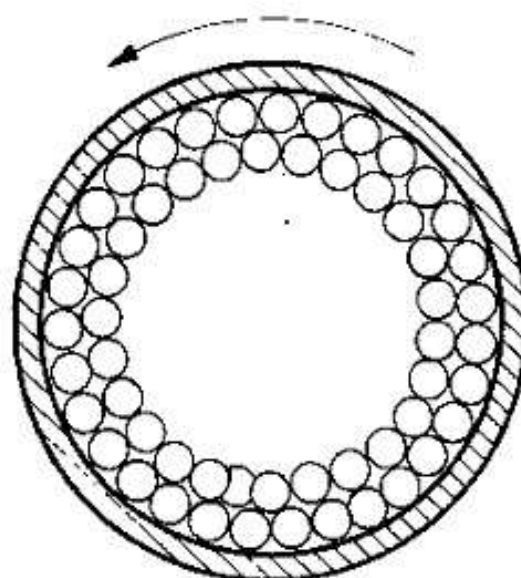


Rotating direction of mill

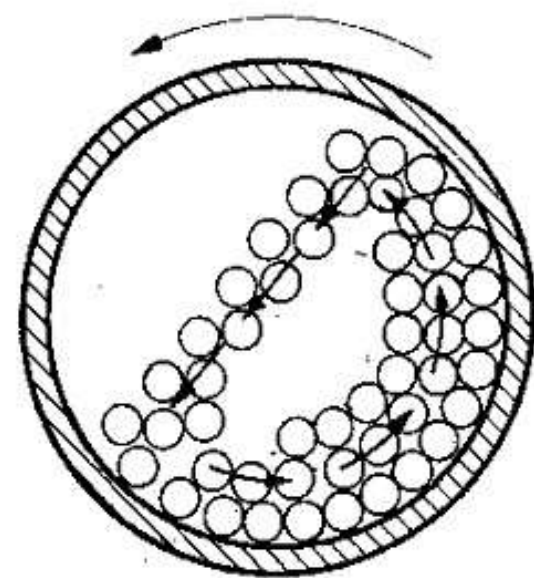




(a) Low speed with sliding



(b) High speed with centrifuging



(c) Correct speed with cascading

Fig. Ball mill operation

Uses: Ball mill at low speed is used for milling dyes, pigments & insecticides. Stainless steel balls are preferred in the production of ophthalmic & parental products.

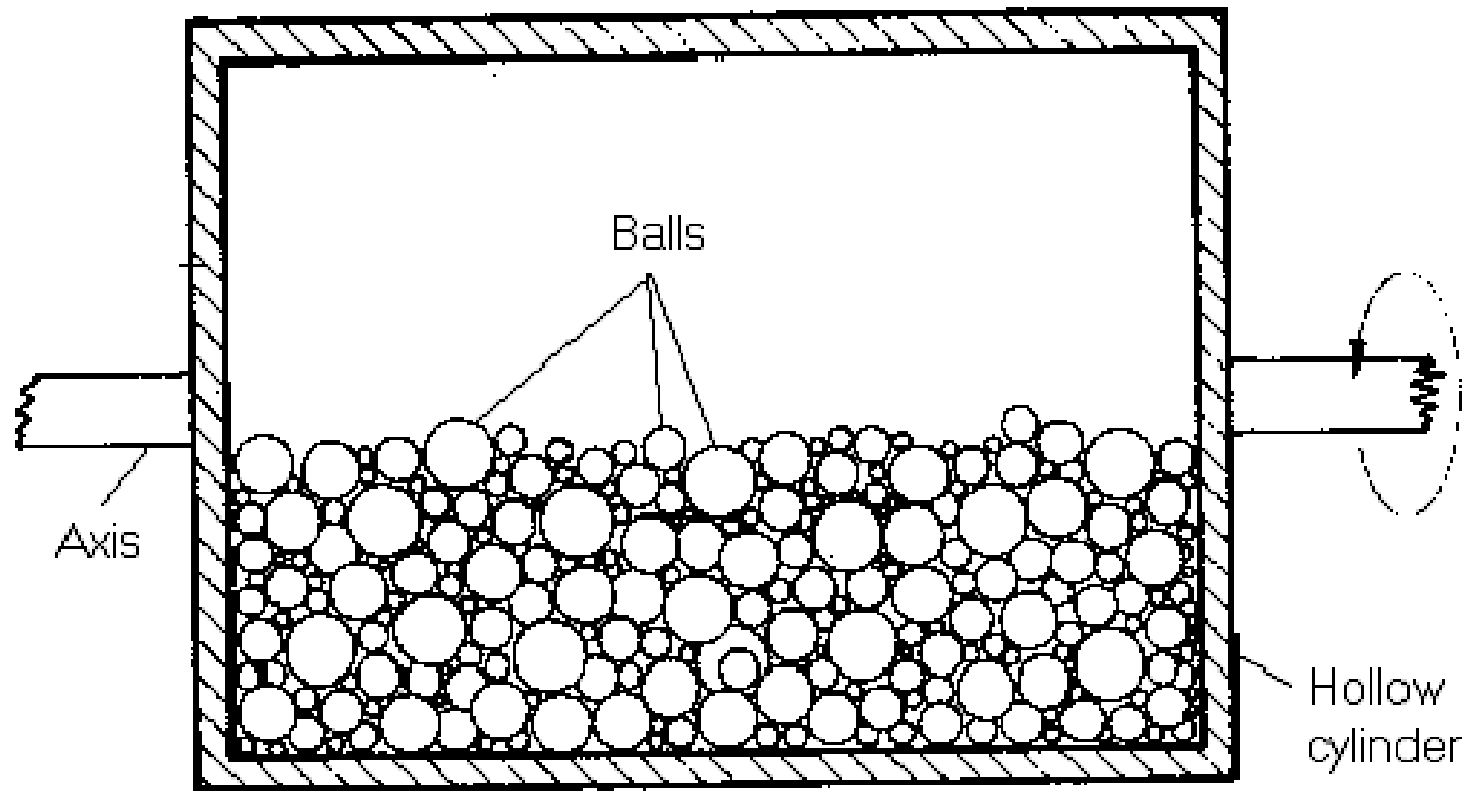


Fig. Ball mill

Advantages:



- It can produce **very fine powder**.
- Ball mill is used for both **wet and dry grinding** processes.
- **Toxic substances** can be ground, as the cylinder is closed system.
- **Rod or bars** can also be used as grinding media.
- (example: **Sticky material** are size reduced) In ball mill,
- installation, operation and labour costs are **low**.

Disadvantages:



- The ball mill is a **very noisy** machine.
- Ball mill is a **slow process**.
- **Soft, fibrous material** cannot be milled by ball mill.



Ball mill or Pebble mill or Tumbling mill:

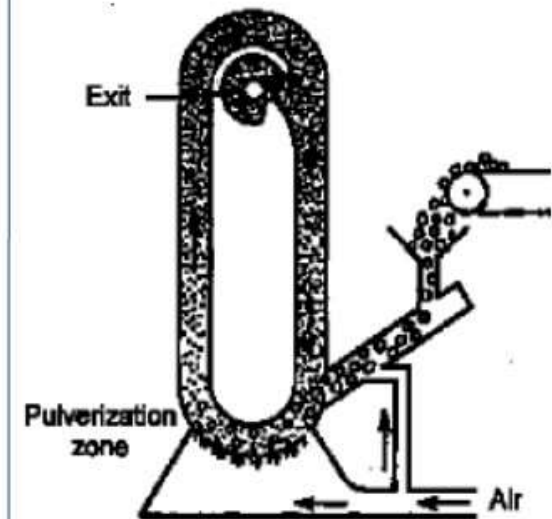
Variants:

- Hardinge mill
- Continuous ball mill
- Vibrating ball mill



Fluid energy mill or Jet mill or Microfibers or Ultrafine grinder:

Principal: Material reduced in the size by attrition & impact. The feed stock is suspended within a high velocity air stream. Milling takes place because of high velocity collision b/w the suspended particles.



Uses: It is used for to reduce the particle size of antibiotics & vitamins. Moderately hard materials can be processed for size reduction. Ultra fine grinding can be achieved.

Variants: Centrifugal- impact pulverizer.

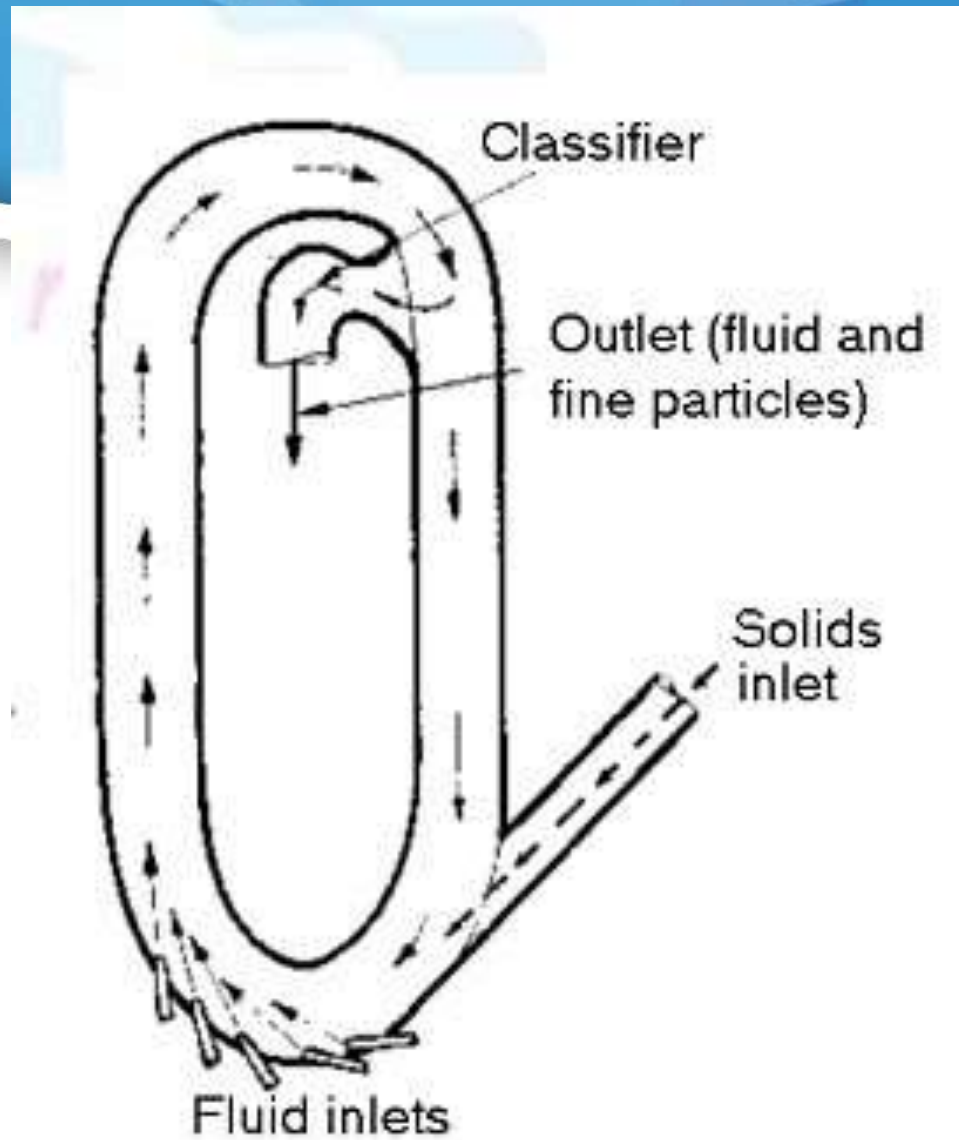
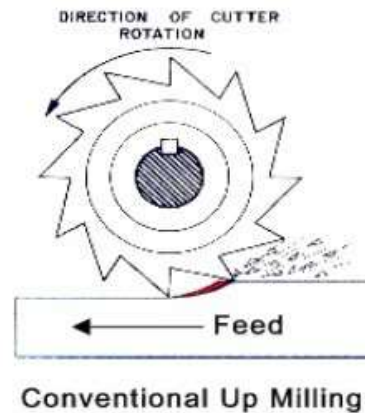


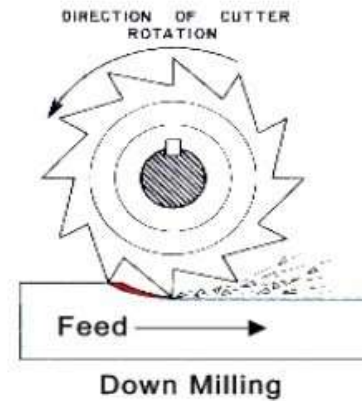
Fig. Fluid energy mill



Rotary Cutter Mill:



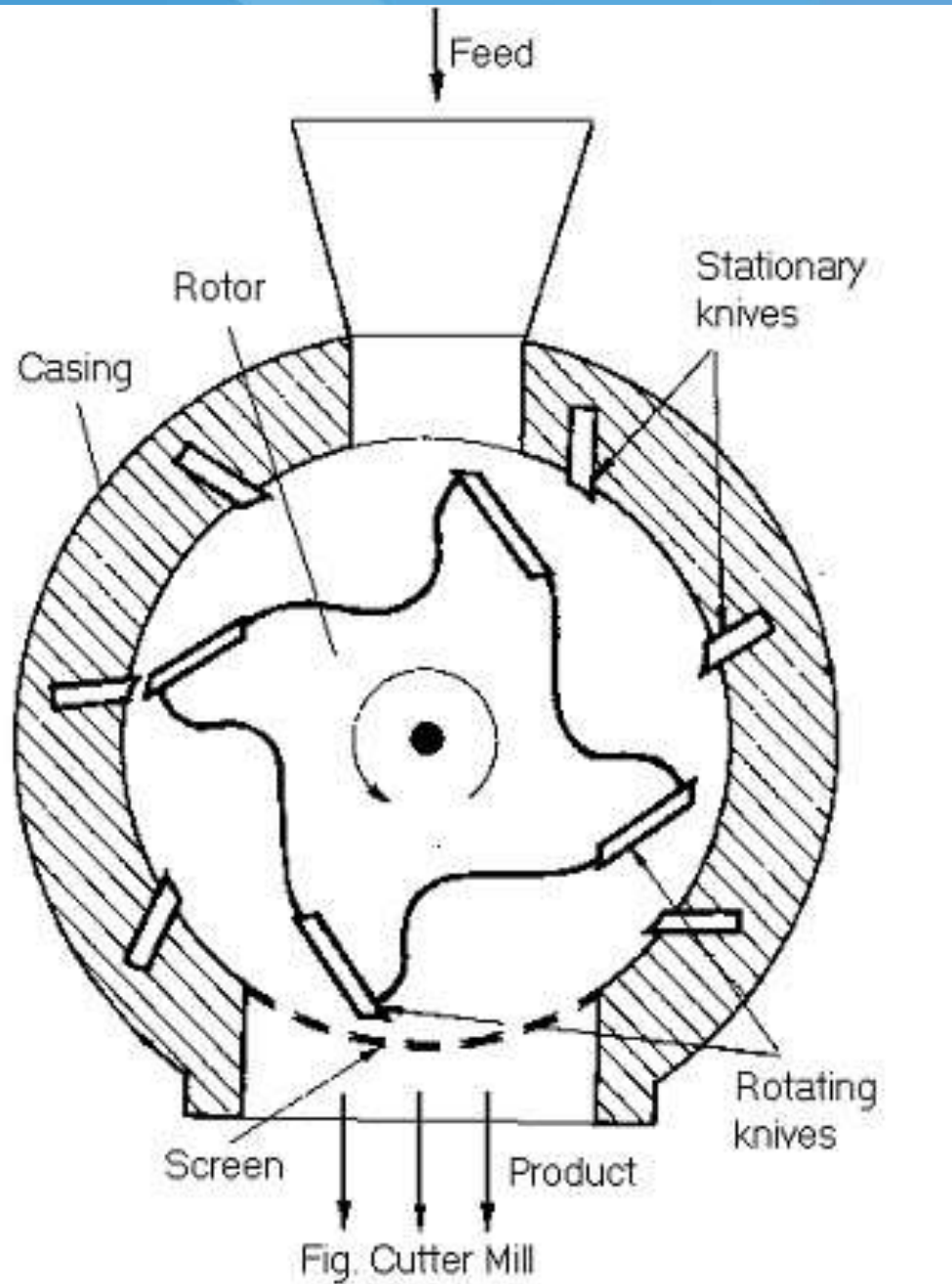
Conventional Up Milling



Down Milling

Principle: Cutting with sharp knives.

Use: Cutter mill is used for size reduction of tough & fibrous material like animal tissues, medicinal plants, plant parts. It is also used in the manufacture of rubber, plastics and plastic material.



ROLLER MILL



Principal: Material is crushed by the applicationn of stress. Stress is applied by rotating heavy wheels, mullers or rollers.

Uses: for crushing seeds before extraction of fixed oil. Also used to crush soft tissue to help in penetration of solvents._

Variants: Multiple smooth rollers or corrugated, ribbed, or saw-toothed rollers can provide cutting action also

ROLLER MILL

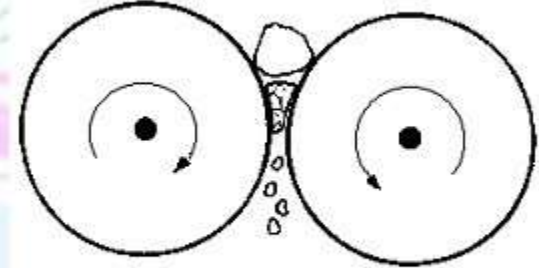
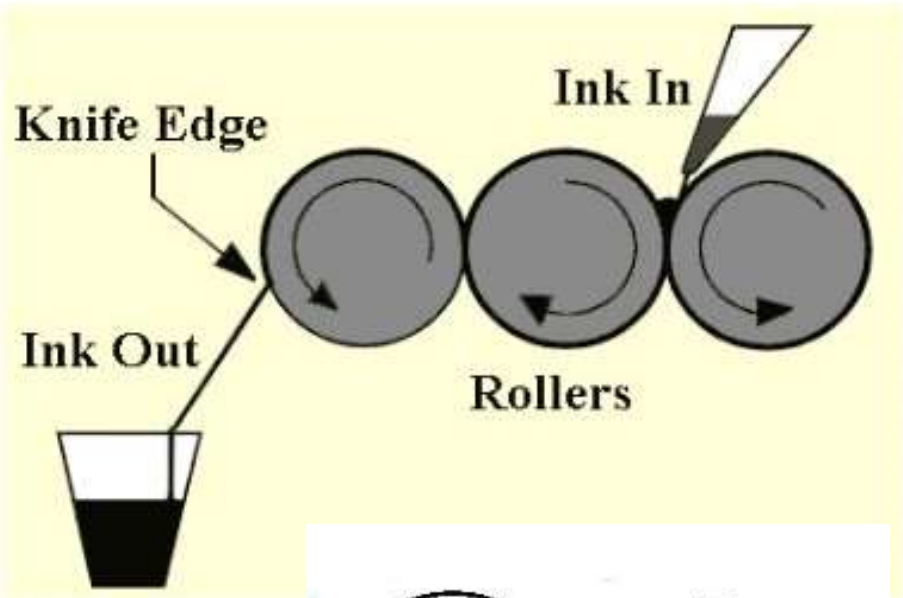
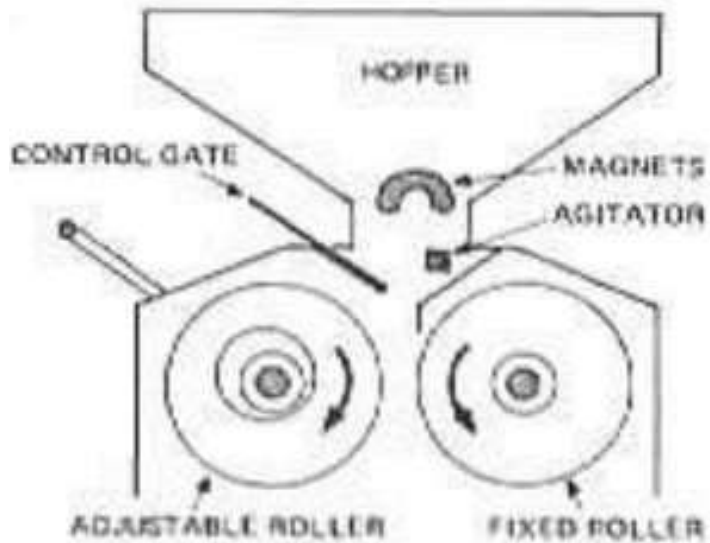


Fig. Roller mill

ROLLER MILL

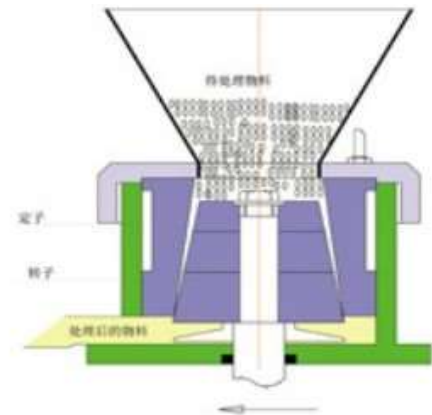




Colloid mill:

Principal: Colloidal mill consists of two steel discs having clearance b/w them. When the material is passed through these discs, they get sheared. Thus coarse particles are broken down in small particles due to shear.

Uses: Colloidal mill is used for preparing colloidal dispersion, suspension, emulsion & ointments. It is used for dry milling. Fibrous material can be milled using rough surface rotor & stator.



Principle



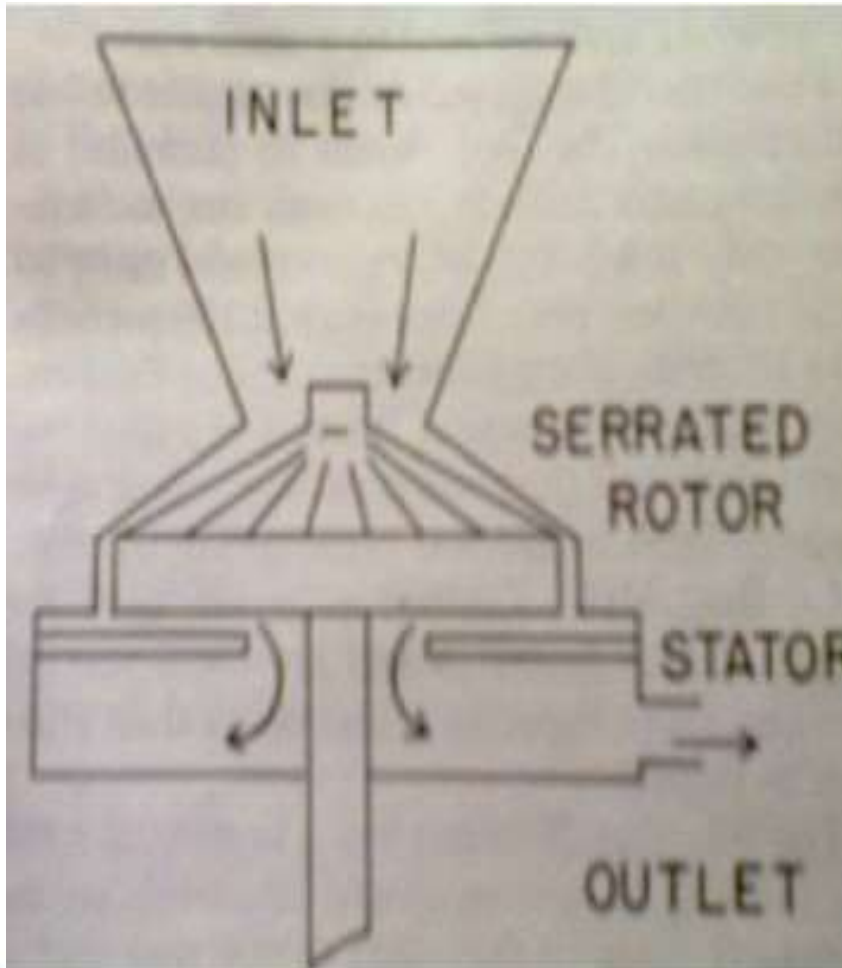
- Colloidal mill works on the principle of rotor-stator.
- The size reduction is affected due to shearing, when the material is passed between the narrow gap of milling surfaces of rotor and stator. A rotor turns at high speeds of 3000 - 20000rpm. The high levels of hydraulic shear applied to the process liquid disrupt structures in the fluid.
- Higher shear rates leads to smaller droplets of 1 micron. Based on a rotor rotating at high speed and very close to a conical stator, the particle size is done by modifying the gap between the rotor and the stator

Construction



- A colloidal mill consist of a **high speed rotor and a stator** with a conical milling surfaces between
- Which is an adjustable clearance ranging from **0.002 to 0.03** inches.
- The rotor speed is **3000 to 20000**rpm.
- The material to be ground should be pre milled as finely as possible to prevent damage to the colloidal mill.
- Rotors and the stator may be **smooth surfaced or rough surface**.
- With the rotor and the stator there is a thin uniform film of material between them and it is subjected to the maximum amount of shear.

Colloidal Mill





A colloid mill is a machine that is used to reduce the particle size of a solid in suspension in a liquid, or to reduce the droplet size of a liquid suspended in another liquid.

Colloid mills work on the **rotor-stator principle:**

A rotor turns at high speeds (2000 - 18000 RPM**).**

Working



- The material is placed into the mill through the inlet hopper.
- It is then passed through the narrow gap between the rotor and stator and thus reduced the fine particle size.
- A colloid mill is a hydraulic shear producing device.
- The colloid mill works to reduce the size of the suspended droplets.
- The mill allows the solid particles to become so small.

Colloid mills are used in the following industries



- **Pharmaceutical**
- **Cosmetic**
- **Paint**
- **Soap**
- **Textile**
- **Paper**
- **Food**