POWDER MANUFACTURE

MECHANICAL METHODS:

Dr. Alaa Aladdin

CRUSHING

Crushing is the first step of powder manufacturing .Crusher has an arm that moves the jaws backward and forward to crushing material to a size small enough to fall from the bottom of the jaws.

This type of crusher can be as large as 3m across, producing powders of 5cm at the outlet or as small as 10cm across, producing powders of 1mm at the outlet. It is commonly used in large-scale mining operations.

GRINDING (MILLING)

When considering ceramic powders, we generally find relatively narrow size distributions are desired with the mean size.

To meet these needs various types of mills are used, as the medium including:

(1) mills with balls, pebbles, and rods mills;

(2) high-speed peripheral mills;

(3) fluid energy mills.

Fluid energy mills are able to produce the very finest powders.

Figure .2 shows the various types of Crushing and milling equipment.

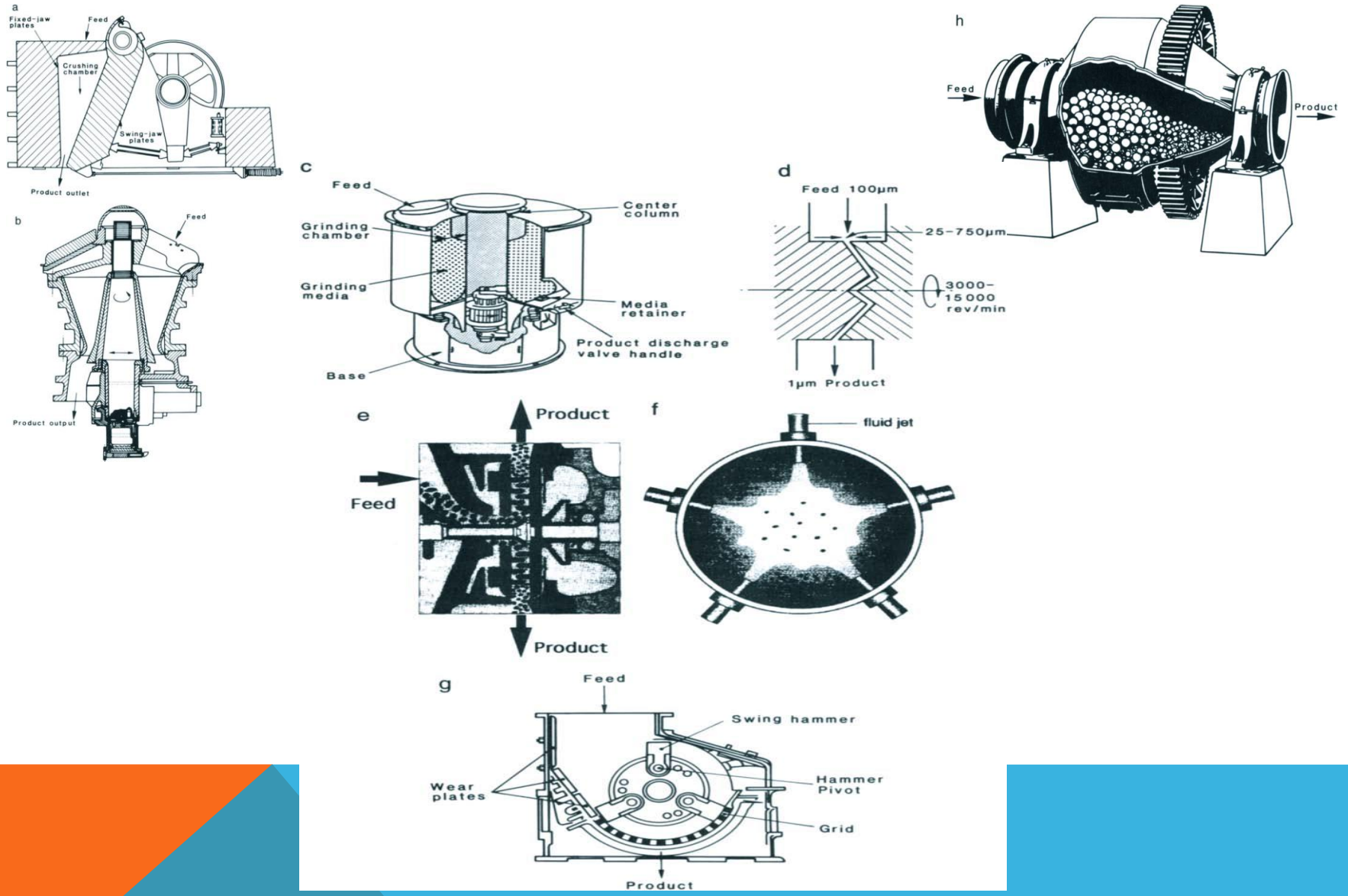


Fig26 Crushing and milling equipment. (a) Jaw crusher, (b) gyratory crusher, (c) vibratory mill, (d) fluid sh ear mill, (e) pin mill, (f) fluid jet mill, (g) hammer mill, and (h) ball mill.

TABLE 1 Types of Size-Reduction Equipment		
1	Jaw crushers	continuous
2	Gyratory crushers	continuous
3	Heavy-duty impact mills	continuous
4	Roll crushers and shredders	continuous
5	Tumbling media mills	(batch and continuous)
6	Stirred media mills	(batch and continuous)
7	Vibratory media mills	(batch and continuous)
8	Fluid shear mills	(batch and continuous)

This energy is a sum of the energy required:
(1) To move the machine, its kinetic energy, and friction;
(2) To move the material, its kinetic energy, plastic and elastic deformation, and internal friction;
(3) To break the material into smaller particles size.

In almost all cases, the energy required by the mills shown in Figure 27 is very poorly used. The energy required to break the material is often less than 1% of the total energy needed to run the mill.

The energy, E, required to grind material into a smaller particle size, L, from size, L_0, can be described by [6]:

$$E = -\int_{L_0}^{L} \frac{C}{L^n} dL$$

Where **n, C** is a constant

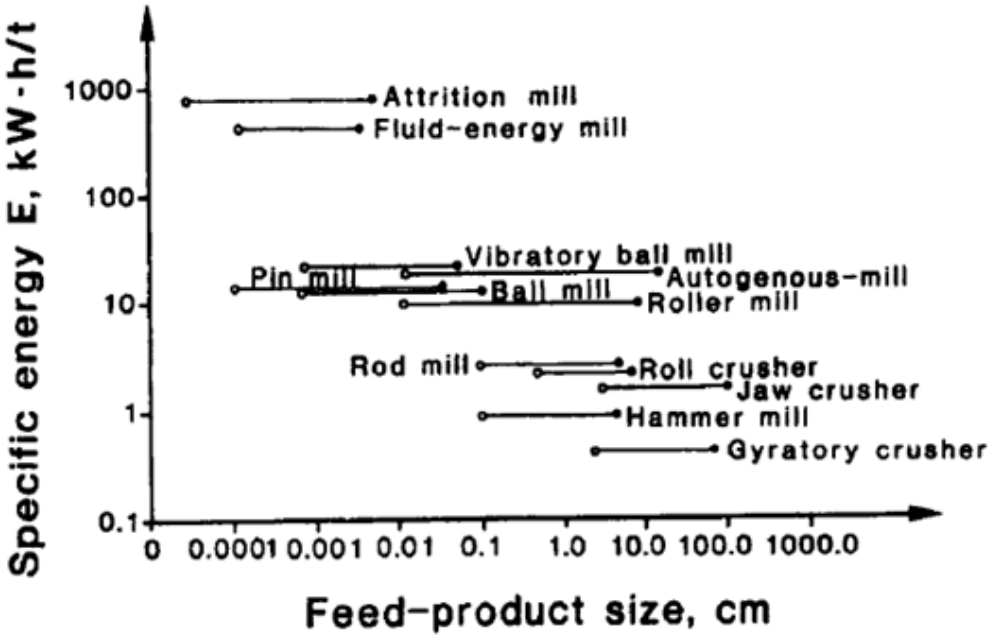
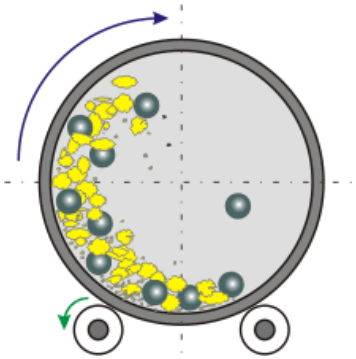

Specific energy E, kW-h/t
1000
100
10
1
0.1
Attrition mill
Fluid-energy mill
Vibratory ball mill
Pin mill
Autogenous-mill
Ball mill
Roller mill
Rod mill
Roll crusher
Jaw crusher
Hammer mill
Gyratory crusher
0
0.0001
0.001
0.01
0.1
1.0
10.0
100.0
1000.0
Feed-product size, cm

Fig27

ball mills: ball mills, also known as centrifugal or planetary mills, are devices used to rapidly grind materials to colloidal fineness size (approximately 1 μm and below) by developing *high grinding energy via centrifugal action* and/or planetary action.



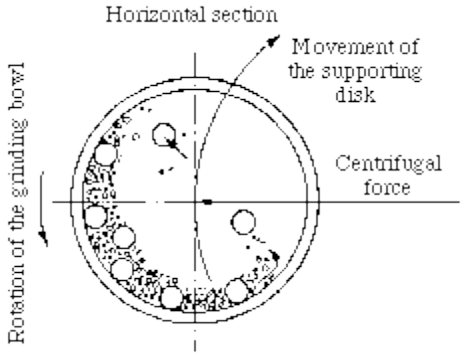


Fig. 28.

• **Roll mills:** in three roll mills, the material to be milled is placed between the feed and center rolls.

•each adjacent roll rotates at gradually higher speeds.

for example; the feed roll may rotate at 30 rpm, the center roll at 90 rpm and the final roll at 270 rpm.

material is transferred from the center roll to the (final) apron roll by adhesion.

The dispersion is achieved by the shear forces generated between the adjacent rolls.

The milled material is removed from the apron (final) roll by a knife that runs against the roll.

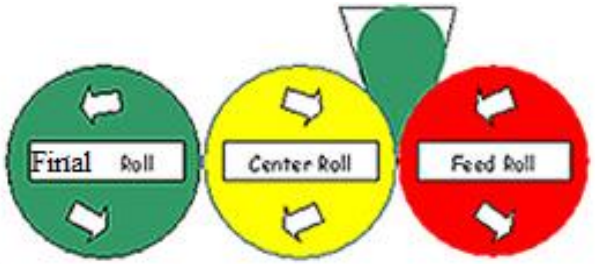
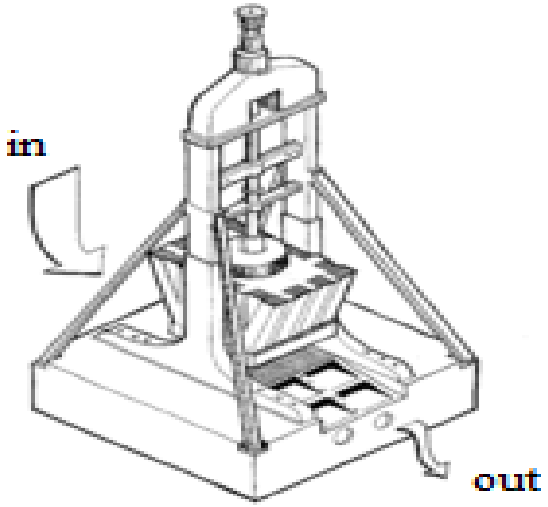


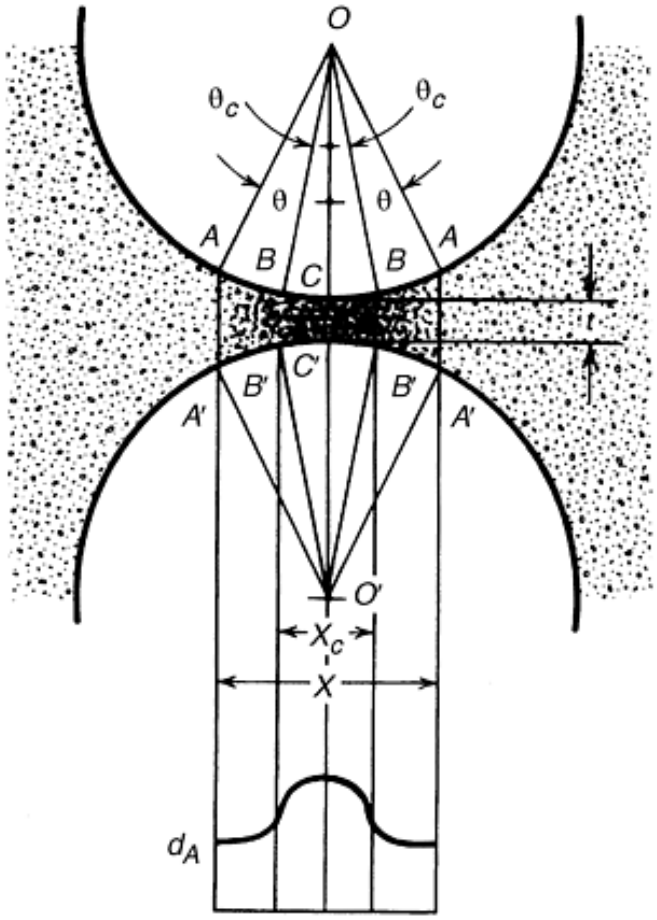
Fig. 29 ROLL MILLS

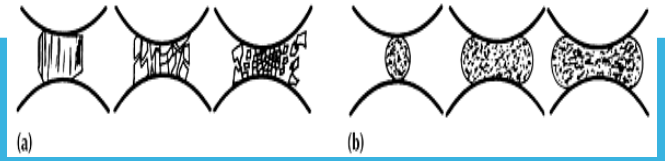
- **STAMPING MILLS :**

  A STAMP MILL IS A TYPE OF MILL MACHINE THAT CRUSHES MATERIAL BY POUNDING RATHER THAN GRINDING, EITHER FOR FURTHER PROCESSING OR FOR EXTRACTION OF METALLIC ORES.

  BREAKING MATERIAL DOWN IS A TYPE OF UNIT OPERATION.

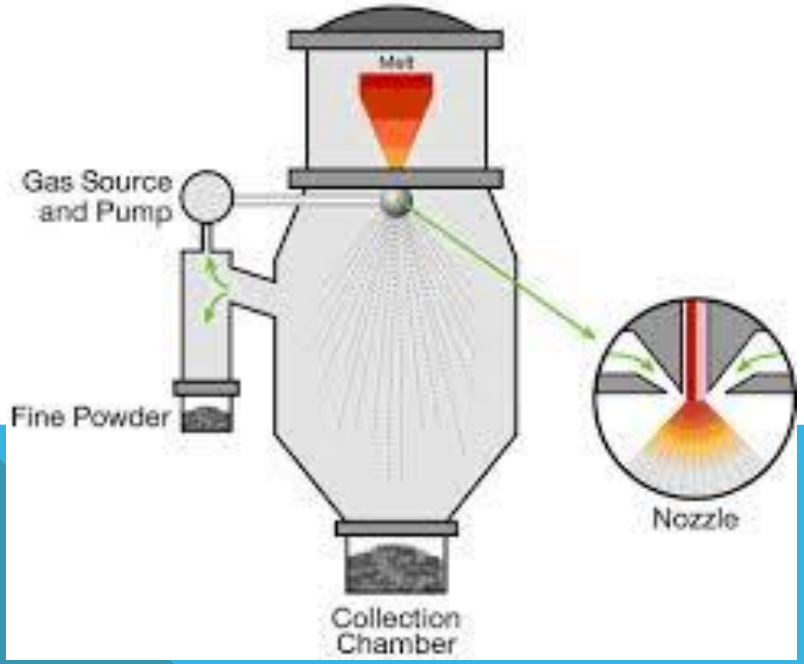



O
θc
θc
θ
θ
A
B
C
B
A
t
C′
B′
B′
A′
A′
O′
Xc
X
dA


(a)
(b)

C-Throwing: This method is casting the molten material (in degrees just above the melting point) in the form of a liquid stream through the air or a soft neutral atmosphere, where it is then dropped into the water.

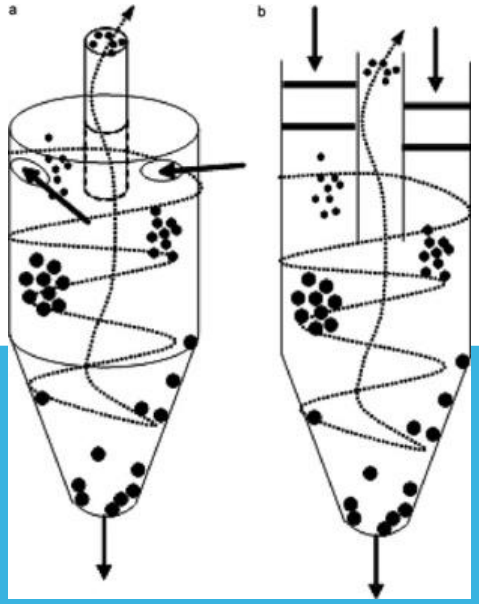
When freezing occurs in the air, the resulting particles are spherical shape, either when freezing occurs in the water consists of particles feathery shape.



D- Condensation:

A method for preparing powder granules (big particles) by a liquid condensation process comprising preparing a slurry by mixing powders with a binding agent and a binding agent soluble solvent, dropping the slurry to a binding agent insoluble solvent to fix the binding agent so that the binding agent cannot be released to a surface of a droplet of the slurry.

Coagulating the droplet by solvent exchange between the soluble solvent inside the droplet and the insoluble solvent at the surface of the droplets, and separating the coagulated droplet from the insoluble solvent, drying it to completely removing a residual solvent.



E- Atomization : Used to produce powders of materials with low melting temperature.

The process taking place by passing molten through a small hole and then subjected to a compressed air stream, making particle breaks to parts very soft, so it freezes directly due to the speed of heat leaking them, using air (or gas) or water.

This method is a method for the production of powders of particles different sizes by controlling the following factors:

A - The size of the hole that passes through the molten metal.

B - The temperature of the molten metal and the flow velocity.

C - Temperature, speed and type of ablation factor (air or inert gas)

The Particle size D can be calculated from the following equation:

$$D = C/V \sin \alpha$$

where :

V the speed of the water used,

C constant depends on the type of material and design private system

α is the angle of spray

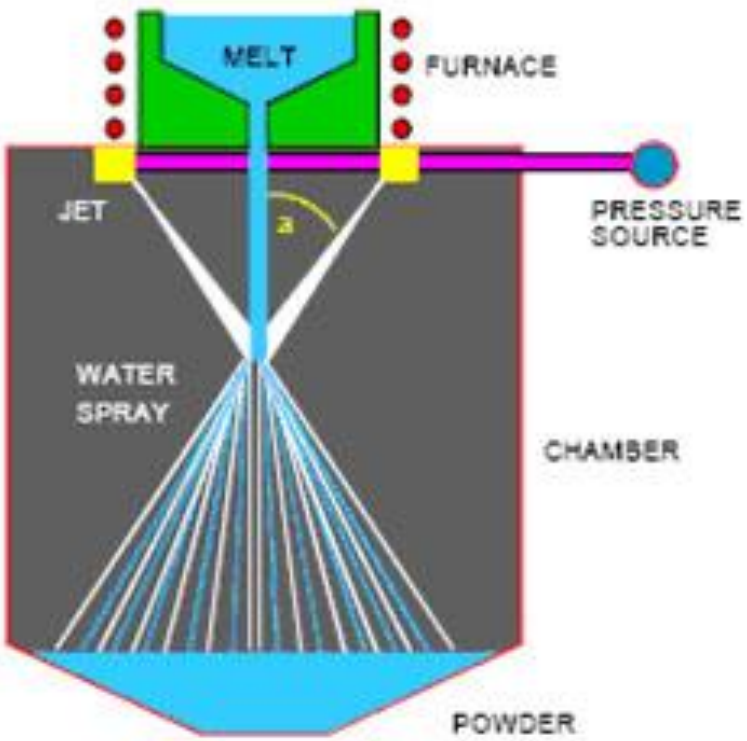

MELT
FURNACE
JET
a
PRESSURE
SOURCE
WATER
SPRAY
CHAMBER
POWDER

Fig. 34