

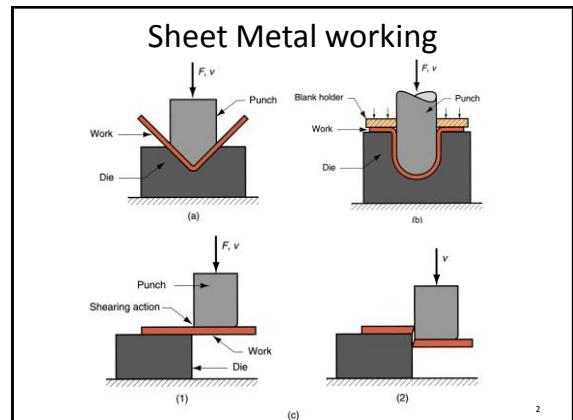


Department of Mechanical Engineering
GENERAL SIR JOHN KOTELAWALA DEFENCE UNIVERSITY

WORKSHOP TECHNOLOGY

Metal Forming - 2
Sheet Metal Forming

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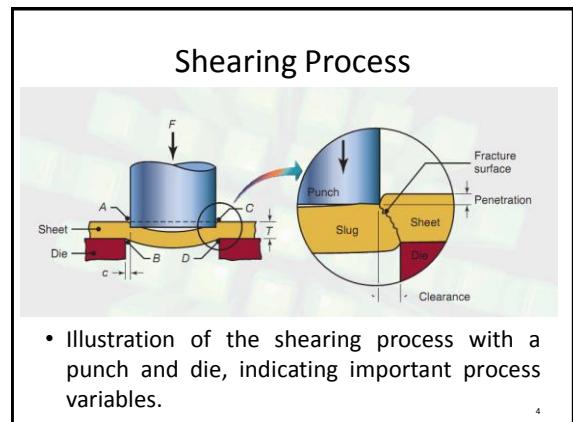
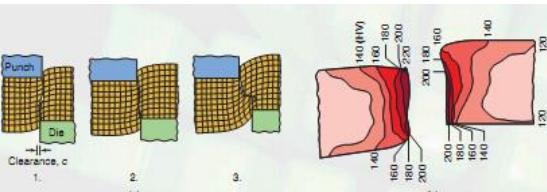
Shearing Process

- Sheet metal subjected to shear stress developed between a punch and a die is called *shearing*.
- Shearing usually starts with formation of cracks on both the top and bottom edges of the work piece. These cracks meet each other and separation occurs.

Process parameters :

- Shape of the material of the punch and die
- Speed of the punching
- Lubrication and clearance

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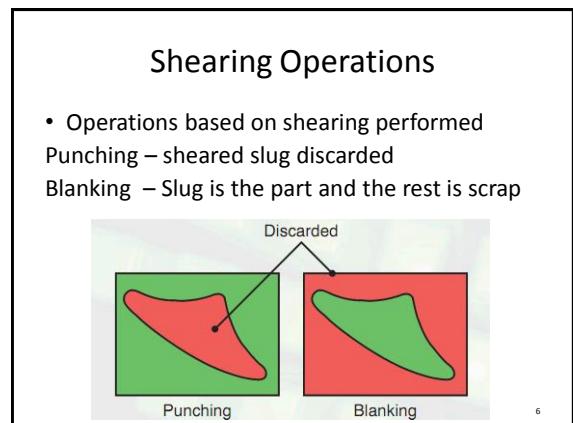
(a) Effect of clearance, c , on the deformation zone in shearing. Three stages show increasing clearance: 1. Punch and die close; 2. Punch moves down, increasing clearance; 3. Punch moves down further, increasing clearance.

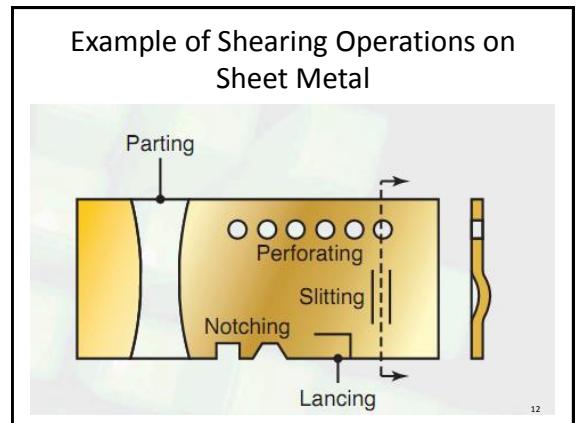
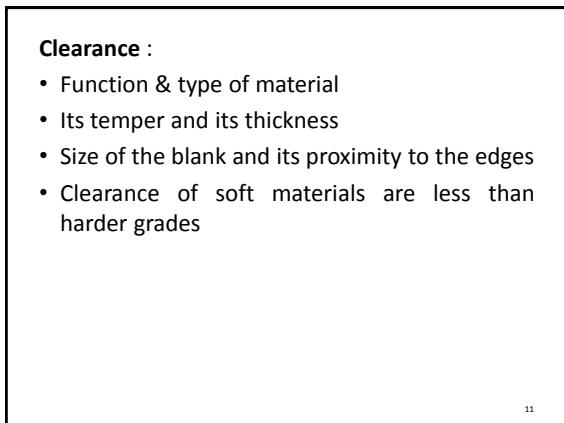
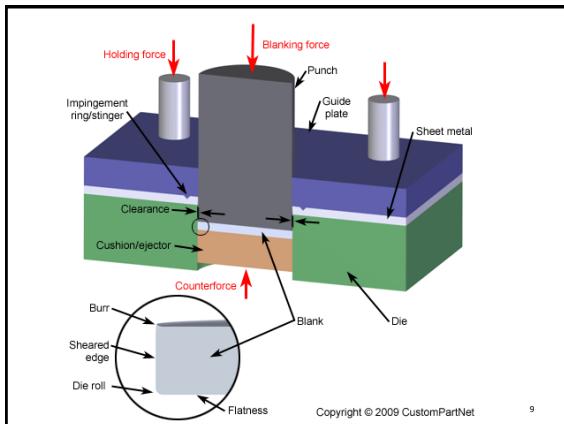
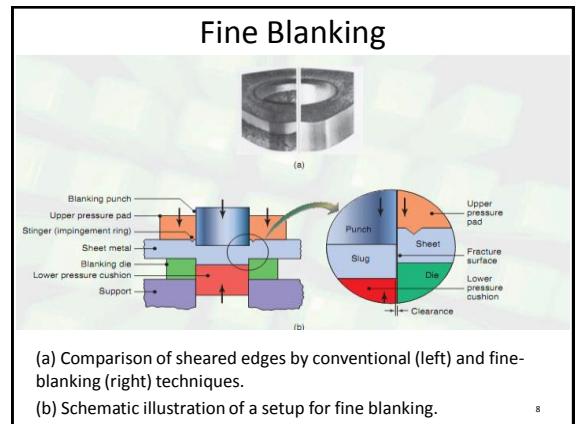
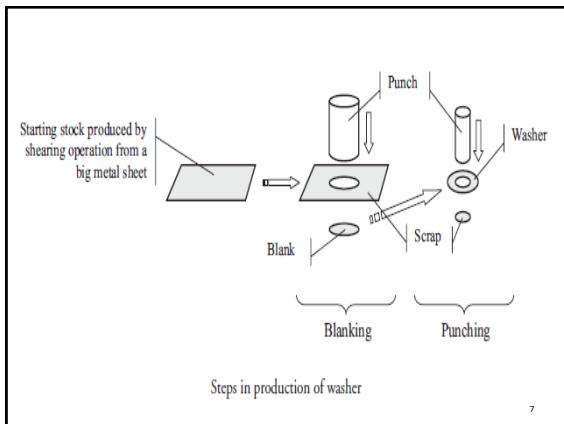
(b) Micro-hardness contours for a 6.4 mm (0.25-in) thick AISI 1020 hot-rolled steel in the sheared region. Contours range from 120 to 220 HV.

a) Effect of clearance, c , on the deformation zone in shearing. Note that, as clearance increases, the material tends to be pulled into the die, rather than being sheared.

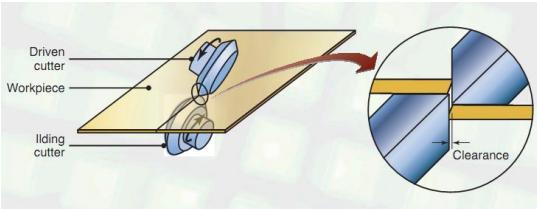
b) Micro-hardness contours, for a 6.4 mm (0.25-in) thick AISI 1020 hot-rolled steel in the sheared region.

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Rotary Shearing (Slitting)



- Slitting with rotary blades.

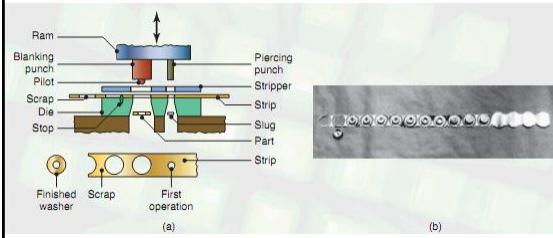
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Dies and Punches

- **Simple**- single operation with a single stroke
- **Compound**- two operations with a single stroke
- **Combination**- two operations at two stations
- **Progressive**- two or more operations at two or more stations with each press stroke, creates what is called a strip development.

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Progressive Die

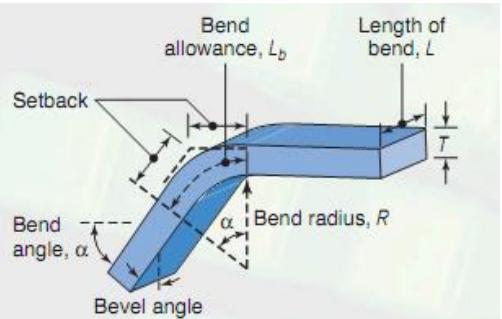


(a) Schematic illustration of producing a washer in a progressive die.

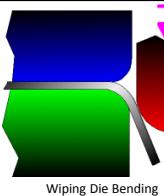
(b) Forming of the top piece of a common aerosol spray can in a progressive die. Note that the part is attached to the strip until the last operation is completed.

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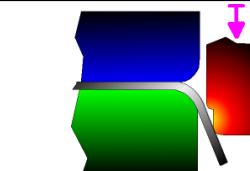
Bending



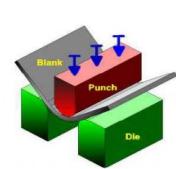
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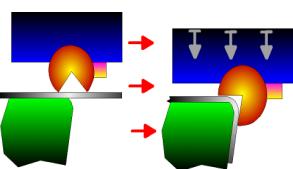
Wiping Die Bending



Double Die Bending

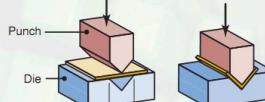


Air Bending

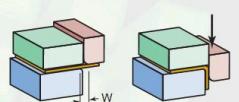


Rotary Bending

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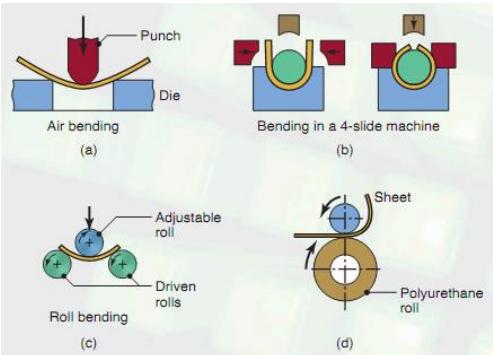
(a) V die



(b) Wiping die

- Common die-bending operations, showing the die-opening dimension W

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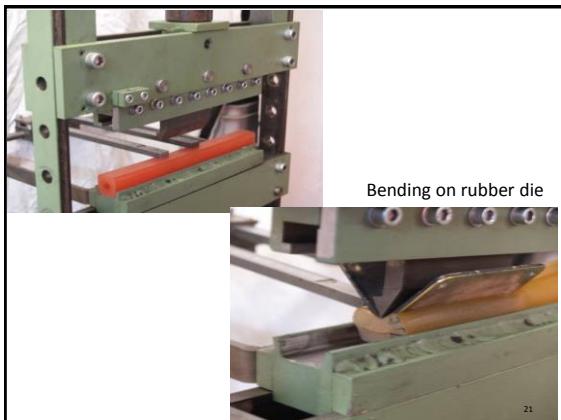
- Examples of various bending operations

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Roll Bending



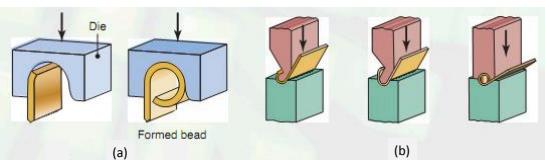
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Beading

- The periphery of the sheet metal is bent into the cavity of a die.

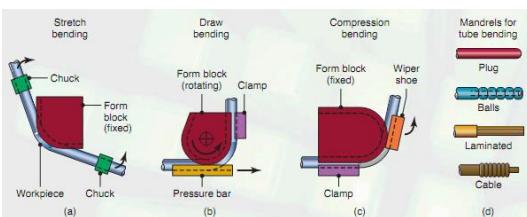


(a) Bead forming with a single die.
(b) Bead forming with two dies in a press brake

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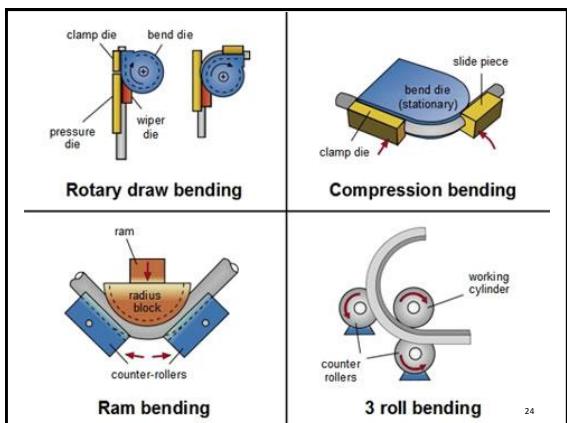
Bending and Forming Tubes

Special tooling required to avoid buckling and folding



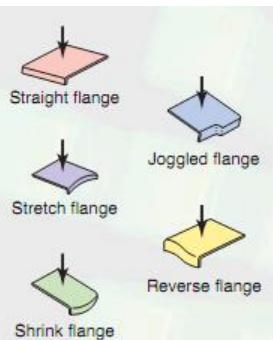
- Methods of bending tubes. Using internal mandrels, or filling tubes with particulate materials such as sand, prevents the tubes from collapsing during bending. Solid rods and structural shapes are also bent by these techniques.

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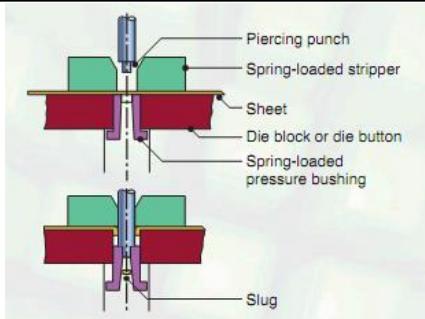
Flanging



- Flanging is a process of bending the edges of sheet metals to 90°

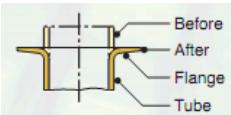
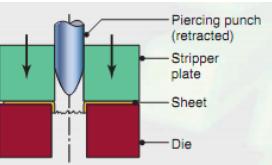
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- Dimpling



- First hole is punched and expanded into a flange
- Flanges can be produced by piercing with shaped punch

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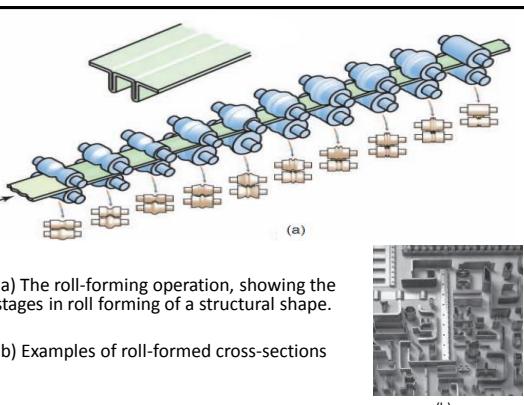
- Piercing sheet metal with a punch to form a circular flange. In this operation, a hole does not have to be pre-punched; note, however, work will be consisted with the rough edges along the circumference of the flange.

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Roll forming

- Roll forming is used for continuous lengths of sheet metal.
- Used for large production runs.

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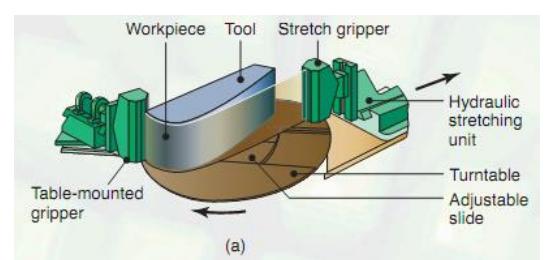
(a) The roll-forming operation, showing the stages in roll forming of a structural shape.

(b) Examples of roll-formed cross-sections

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Stretch-Forming

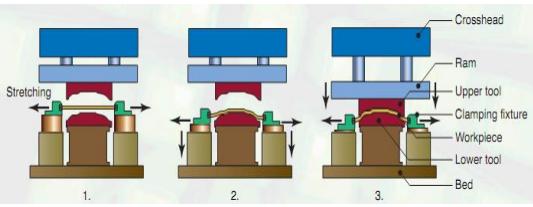
Sheet metal clamped along its edges and stretched over a die or form block in required directions.



Schematic illustration of a stretch-forming operation.
Aluminum skins for aircraft can be made by this process.

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Stretch-Forming

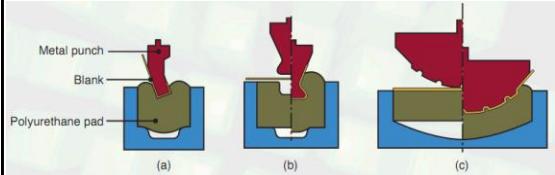


- Stretch forming in a hydraulic press

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Forming with a Rubber Pad

In bending and embossing of sheet metal , the female die is replaced with rubber pad



- Examples of bending and embossing sheet metal with a metal punch and a flexible pad serving as the female die.

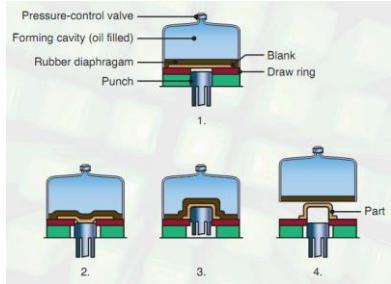
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Hydro-form (or) fluid forming process

- The pressure over rubber membrane is controlled through out the forming cycle ,with max pressure up to 100 Mpa.
- As a result the friction at the punch-cup interface increases, this reduces the longitudinal tensile stresses in the cup and delays fracture.

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Sheet Hydroforming



- The principle of the hydroform process, also called fluid forming.

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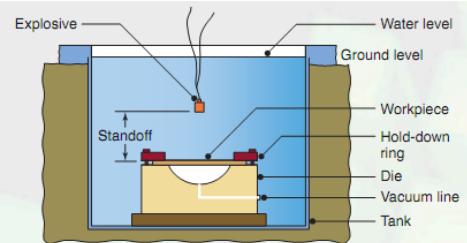
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Explosive Forming

- Explosive energy used for metal forming
- Sheet-metal blank is clamped over a die
- Assembly is immersed in a tank with water
- Rapid conversion of explosive charge into gas generates a shock wave. The pressure of this wave is sufficient to form sheet metals.

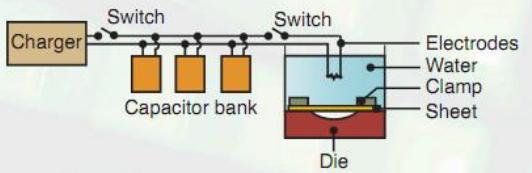
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Explosive Forming



- Schematic illustration of the explosive forming process. Although explosives are typically used for destructive purposes, their energy can be controlled and employed in forming large parts that would otherwise be difficult or expensive to produce by other methods.

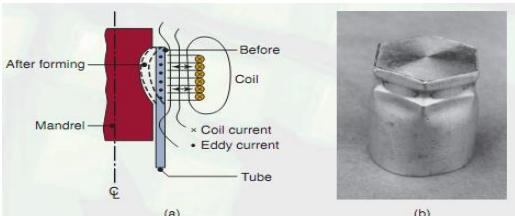
Electro-hydraulic Forming



- Schematic illustration of the electro-hydraulic forming process

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Magnetic-Pulse Forming

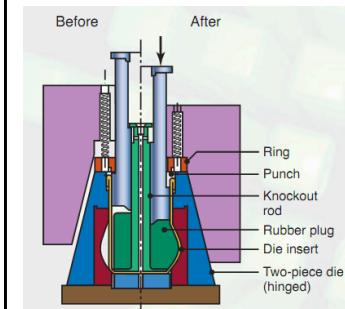


- (a) Schematic illustration of the magnetic-pulse forming process. The part is formed without physical contact with any object.
- (b) Aluminum tube collapsed over a hexagonal plug by the magnetic-pulse forming process.

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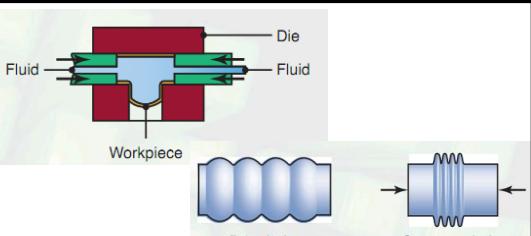
Bulging

Process involves placing tabular, conical or curvilinear part into a split-female die and expanding it.



Bulging of a tubular part with a flexible plug. Water pitchers can be made by this method.

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- Production of fittings for plumbing by expanding tubular blanks with internal pressure; the bottom of the piece is then punched out to produce a "T" section.

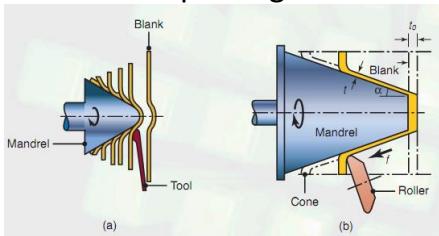
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Spinning

- Shaping thin sheets by pressing them against a blunt tool and to force the material into a desired form
- Conventional spinning :
A circular blank if flat or performed sheet metal held against a mandrel and rotated, while a rigid metal (tool) is held against a mandrel.

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Spinning



- Schematic illustration of spinning processes:
 - (a) conventional spinning
 - (b) shear spinning. Note that in shear spinning, the diameter of the spur part, unlike in conventional spinning, is the same as that of the blank. The quantity f is the feed (in mm/rev or in./rev).
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- Typical shapes produced by the conventional spinning process. Circular marks on the external surfaces of components usually indicate that the parts have been made by spinning, such as aluminum kitchen utensils and light reflectors.
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Shear Spinning

- Known as power spinning, flow turning, hydro-spinning, and spin forging
- Produces axisymmetric conical or curvilinear shape
- Single rollers and two rollers can be used
- It has less wastage of material
- Typical products are rocket, motor casing and missile nose cones.

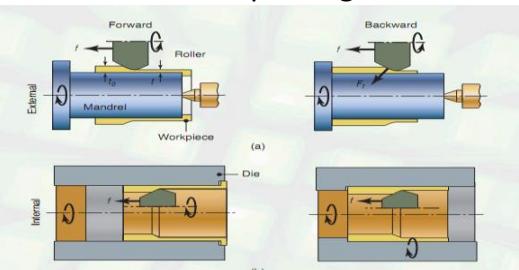
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Tube Spinning

- Thickness of cylindrical parts are reduced by spinning them on a cylindrical mandrel rollers
- Parts can be spun in either direction
- Large tensile elongation are obtained within certain temperature ranges and at low strain rates.

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Tube Spinning



Examples of

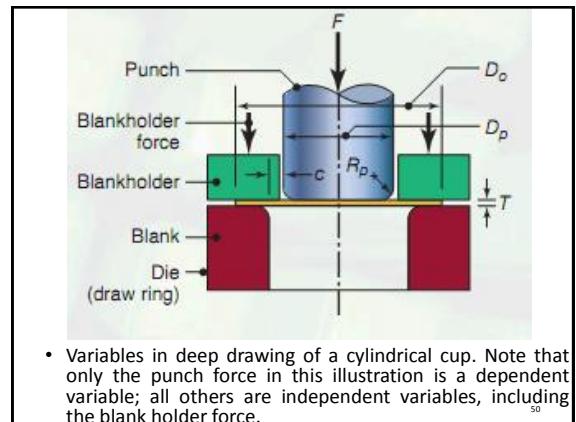
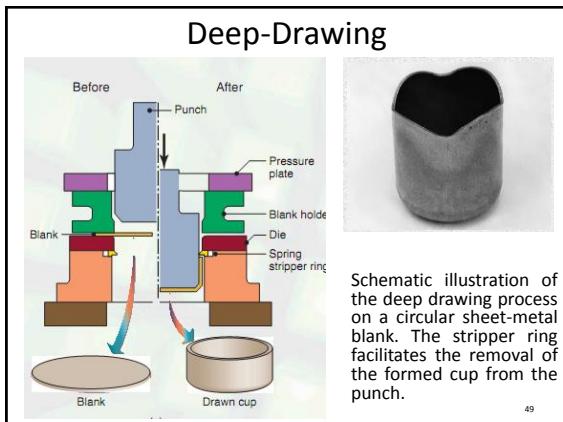
- (a) external and
- (b) internal tube spinning, and the process variables involved.

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Deep-Drawing

- Punch forces a flat sheet metal into a deep die cavity
- Round sheet metal block is placed over a circular die opening and held in a place with blank holder & punch forces down into the die cavity

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Deep drawing Practice

- Blank holder pressure – 0.7% -1.0 % of Yield strength + UTS
- Clearance usually – 7% -14 % > sheet thickness
- Draw beads are used to control flow of blank into die cavity.
- Ironing is a process in which the thickness of a drawn cup is made constant by pushing of the cup through ironing rings.
- Redrawing** – Containers or shells which are too difficult to draw in one operation undergo redrawing

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Ironing

Process of thinning the walls of a drawn cylinder by passing it between a punch and die whose separation is less than the original wall thickness.

Punch, Die, and Cup are shown. The cup is being pressed between the punch and die, causing the walls to thin out.

Schematic illustration of the ironing process. Note that the cup wall is thinner than its bottom. All beverage cans without seams (known as two-piece cans) are ironed, generally in three steps, after being deep drawn into a cup. Cans with separate tops and bottoms are known as three-piece cans.

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Embossing

Presswork process in which raised lettering or other designs are impressed in sheet materials

(a) shows a flat sheet being stamped with a raised design. (b) shows the resulting raised pattern on the surface.

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Sheet metal working Summary

- Shearing
 - Rotary Shearing
 - Punching
 - Blanking
- Bending
 - Die bending
 - Wiping Die Bending
 - Double Die Bending
 - Air Bending
 - Rotary Bending
 - V die bending
 - Roll bending
 - Tube bending
 - Stretch bending
 - Draw bending
 - Compression bending
- Flanging
- Dimpling
- Forming
 - Roll forming
 - Stretch forming
 - Forming with rubber pad
 - Sheet hydroforming
 - Explosive forming
 - Electrohydraulic Forming
 - Magnetic-Pulse Forming
 - Bulging
- Spinning
 - shear spinning
 - Tube spinning
- Deep-Drawing
- Embossing

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