MODERN MACHINING & FORMING METHODS
(ELECTIVE - III) Instruction
4 Periods per week Duration of University Examination
3 Hours University Examination
75 Marks Sessional
25 Marks

Unit-V

Stretch Forming: Introduction, types of stretch forming: stretch draw forming, rotary stretch forming or stretch wrapping, compression forming, radial draw forming. Stretch forming equipment & accessories, accuracy & surface finish, process variables & limitations.

Tube spinning: Introduction, methods of tube spinning, Backward spinning, Forward spinning, machines & tools used. Machine variables, speeds & feeds, effect of tube spinning on work metal properties & applications.
Hydrostatic Forming: Process principle, description & applications.
Water Hammer Forming (WHF): Schematic diagram of the process, principle of operation, process variables, work materials, process limitations & applications.

Suggested Reading:

1. P.C. Pandey & H.S. Shah, Modern Machining Process, Tata McGraw Hill Publishing Co. Ltd., New Delhi, 1980.
2. A. Bhattacharya, New Technology, The Institution of Engineers (India), 1984.
3. Davies & Austin, Developments in High Speed Metal Forming, The Machinery Publishing Co. Ltd., 1985.
4. Production Technology, HMT.

Tube spinning: Introduction, methods of tube spinning, Backward spinning, Forward spinning, machines & tools used. Machine variables, speeds & feeds, effect of tube spinning on work metal properties & applications.
Tube Spinning

Basic introduction


A brass vase spun by hand. Mounted to the lathe spindle is the mandrel for the body of the vase; a shell sits on the "T" rest. The foreground shows the mandrel for the base. Behind the finished vase are the spinning tools used to shape the metal.

Metal Spinning

Alternate Names: **Spin Forming** or **Spinning** or **Metal Turning**

Basic introduction

It is a metalworking process by which a disc or tube of metal is rotated at high speed & formed into an axially symmetric part.

- Spinning can be performed by hand or by a CNC lathe.
- It does not involve removal of material, as in conventional wood or metal turning
    - It forms (moulds) sheet material over an existing shape.
- It is the most advantageous way to form round metal parts for commercial applications.
- Artisans use the process to produce architectural detail, specialty lighting, decorative household goods & urns.
- Commercial applications include rocket nose cones, cookware, gas cylinders, brass instrument bells, & public waste receptacles.

- Virtually any ductile metal may be formed, from aluminum or stainless steel, to high-strength, high-temperature alloys.
- The diameter & depth of formed parts are limited only by the size of the equipment available.

History

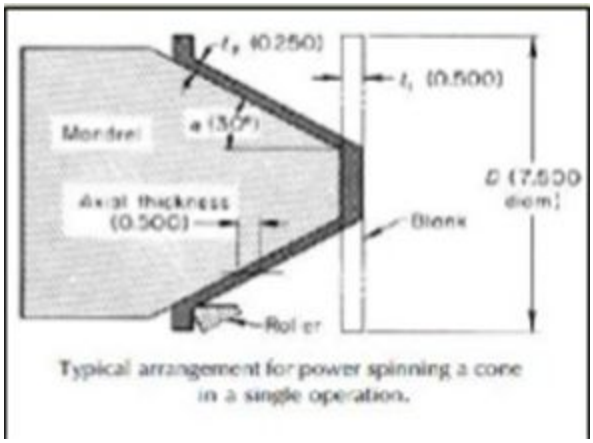
- Introduced in 1840.
- One of the oldest techniques for chip-less production of circular hollow metal components.
- 1st used exclusively for production of fine gold, silver & pewter hollow-ware & chalices.
- Only soft nonferrous metals were employed in industrial applications as late as the 1st world war.
- Around 1920, the industry began to experiment with tougher materials, heavier gauges, & larger diameters.

Basic idea:

It is a cold forming process in which the sheet metal appears to flow somewhat like a piece of clay on potter's wheel.

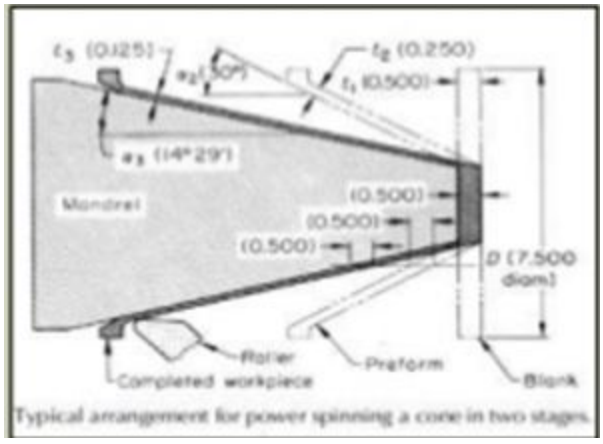
Types

Single Pass Spinning:



- Mental diameter is 7.5 inch 188 mm
- Thickness of the preform is 0.5 inch
- The included semi Apex angle of cone is 30°
- Wall thickness of finished component is 0.25 inch

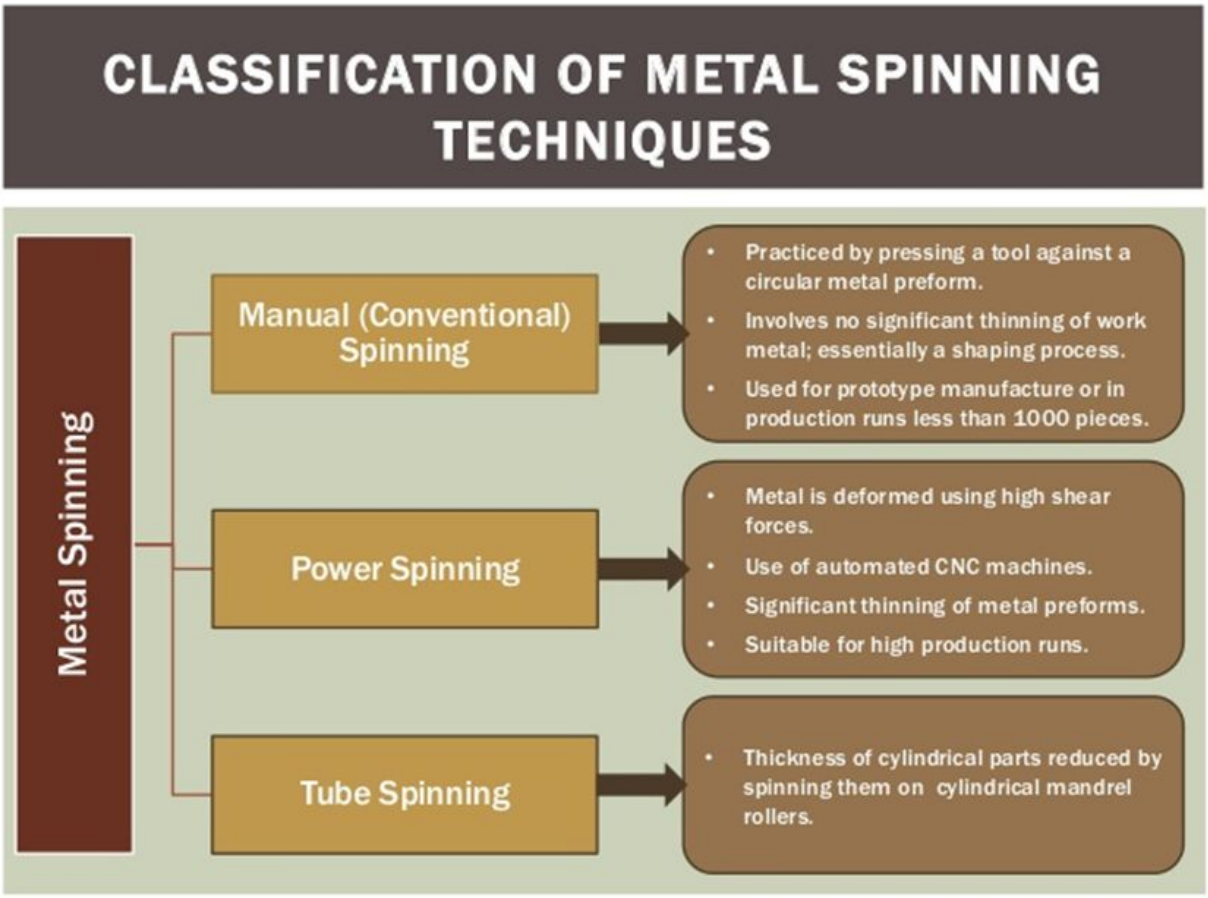
Multi Pass Spinning



- The semi Apex angle of cone is less than 15 degrees
- the thickness of the finished product is reduced successively in accordance with the Sine law 0.125 inch
- Original blank diameter is retained at big end of the cone.

Metal spinning techniques

- Manual (conventional) spinning
    - a tool is pressed against a circular metal preform.
    - No significant thinning of work metal involved.
        - It is essentially a shaping process.
    - Used for prototype manufacture or in production runs less than 1000 pieces.



Working principle

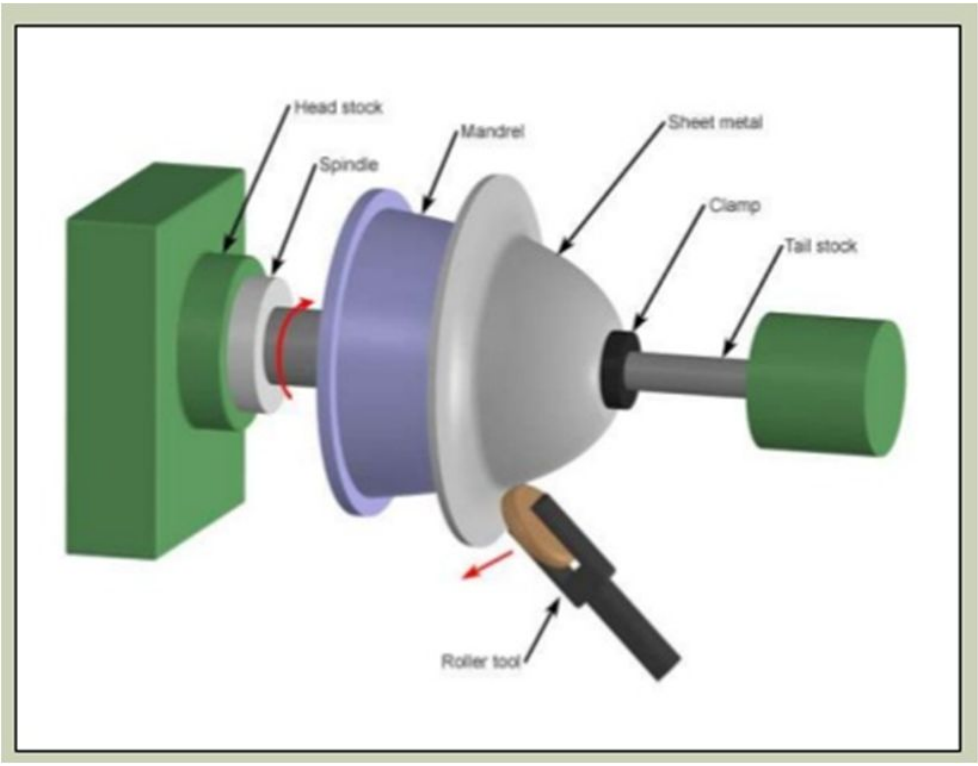
Equipment

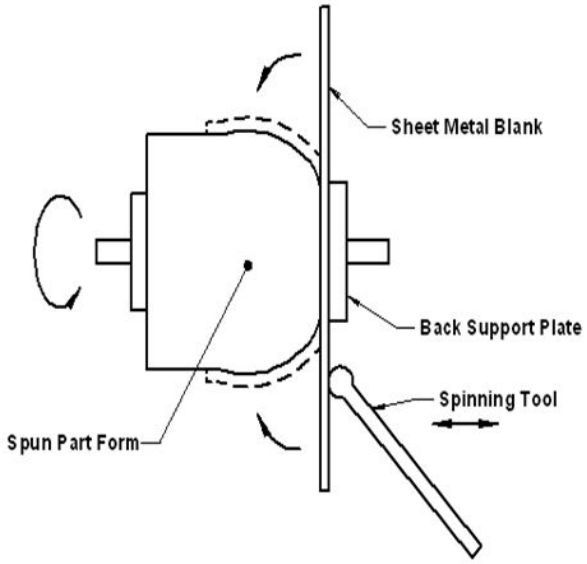
- The basic hand metal spinning tool is called a spoon, though many other tools (be they commercially produced, ad hoc, or improvised) can be used to effect varied results.
- Spinning tools can be made of hardened steel for using with aluminium or solid brass for spinning stainless steel or mild steel.
- Some metal spinning tools are allowed to spin on bearings during the forming process.
    - This reduces friction & heating of the tool, extending tool life & improving surface finish.
    - Rotating tools may also be coated with thin film of ceramic to prolong tool life.
    - Rotating tools are commonly used during CNC metal spinning operations.
- Commercially, rollers mounted on the end of levers are generally used to form the material down to the mandrel in both hand spinning & CNC metal spinning.
- Rollers vary in diameter & thickness depending the intended use.
- The wider the roller the smoother the surface of the spinning; the thinner rollers can be used to form smaller radii.

- Cutting of the metal is done by hand held cutters, often foot long hollow bars with tool steel shaped/sharpened files attached.
    - In CNC applications, carbide or tool steel cut-off tools are used.
- The mandrel does not incur excessive forces, as found in other metalworking processes, so it can be made from wood, plastic, or ice.
    - For hard materials or high volume use, the mandrel is usually made of metal.

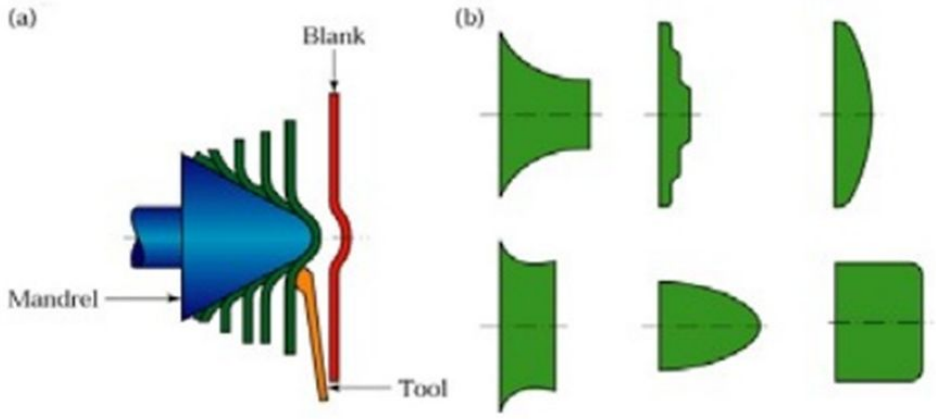
Process description

- The spinning process is fairly simple.
- A formed block is mounted in the drive section of a lathe.
- A pre-sized metal disk is then clamped against the block by a pressure pad, which is attached to the tailstock.
- The block & workpiece are then rotated together at high speeds.
- A localized force is then applied to the workpiece to cause it to flow over the block.
- The force is usually applied via various levered tools. Simple workpieces are just removed from the block, but more complex shapes may require a multi-piece block.
- Extremely complex shapes can be spun over ice forms, which then melt away after spinning.
- Because the final diameter of the workpiece is always less than the starting diameter, the workpiece must thicken, elongate radially, or buckle circumferentially.[1]





Shear Spinning



Schematic illustration of the conventional spinning process (b) Types of parts conventionally spun. All parts are antisymmetric

Process variations

- A more involved process, known as reducing or necking, allows a spun workpiece to include reentrant geometries.
    - If surface finish & form are not critical, then the workpiece is "spun on air"; no mandrel is used.
    - If the finish or form are critical then an eccentrically mounted mandrel is used.
- "Hot spinning" involves spinning a piece of metal on a lathe while high heat from a torch is applied to the workpiece.

    - Once heated, the metal is then shaped as the tool on the lathe presses against the heated surface forcing it to distort as it spins.
    - Parts can then be shaped or necked down to a smaller diameter with little force exerted, providing a seamless shoulder.

Process parameters

Performance characteristics

Advantages

- Several operations can be performed in one set-up.
- Work pieces may have re-entrant profiles & the profile in relation to the center line virtually unrestricted.
- Forming parameters & part geometry can be altered quickly.
    - & at less cost than other metal forming techniques.
- Tooling & production costs are also comparatively low.
- Spin forming, often done by hand, is easily automated.
- It is an effective production method for prototypes as well as high quantity production runs.
- Other methods of forming round metal parts include hydroforming, stamping, forging & casting.
    - These other methods generally have a higher fixed cost, but a lower variable cost than metal spinning.
- As machinery for commercial applications has improved, parts are being spun with thicker materials in excess of 1in (25mm) thick steel.
- Conventional spinning wastes a considerably smaller amount of material than other methods.
- Objects can be built using one piece of material to produce parts without seams.
    - Without seams, a part can withstand higher internal or external pressure exerted on it.
    - For example: scuba tanks & CO_2 cartridges.

Disadvantages

- If a crack forms or the object is dented, it must be scrapped.
- Repairing the object is not cost-effective.

Applications

- CNC metal spinning is quick, efficient & precise, but typically doesn't have the versatility of deep drawing or pressing. Due to the nature of the process, metal spinning cannot create irregular shapes; however, for bell-shaped, spherical, & tubular forms, metal spinning is often highly cost-efficient. This is not a result of the high fixed cost of metal spinning, but of the relatively low variable costs.
- Metal spinning is fairly flexible due to the ease of applying automation, which leads to faster lead times in producing short or long runs of a product. If a product doesn't require

specialized tooling, turnaround can be as short as two to three weeks. These faster lead times also foster appeal for metal spinning as a quick & efficient production method for prototypes or one-offs. With the use of CNC machines, metal spinning can be highly competitive with other forms of metal product fabrication.

- Manufacturers use metal spinning to produce lamps, spheres, vases, solid wood furniture & many other items. It also has alternate applications, such as the production of metal sculpture for artistic & design purposes.