INTRODUCTION TO STRETCH FORMING

- Stretch forming is the forming of a sheet blank with a rigid(one-piece) punch, whereby the blank is rigidly clamped at the edges.
- The blank can be clamped between rigid tools,corresponding to the upper and lower drawing frames of the

  conventional tools, or be clamped in

  gripping jaws.

Field of application:

- Mainly for production of relatively flat parts of large dimensions as single pieces, prototypes or for small series.

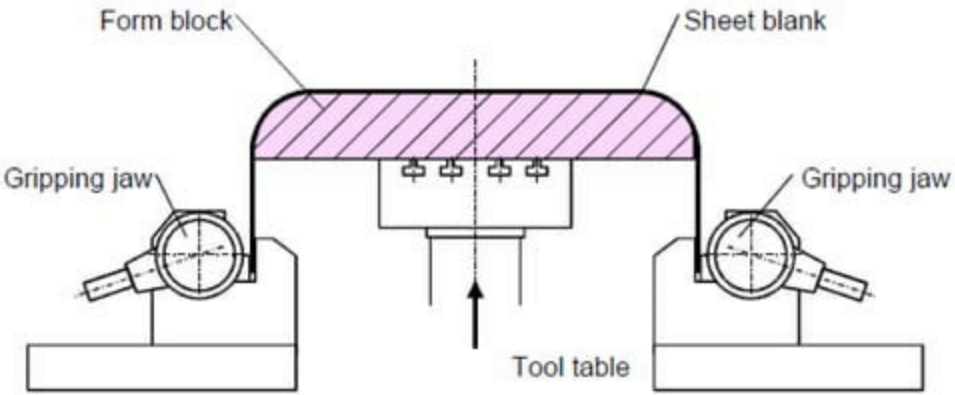
Process types: -

- Simple stretch forming
- Tangential stretch forming
- Stretch forming according to Cyril-Bath
- Multi-sided stretch forming

SIMPLE STRETCH FORMING

- For the simple stretch forming process, the sheet sample which has to be formed, is clamped between two gripping jaws located on opposite ends.
- The forming tool or block is fixed on to a tool table which can be moved hydraulically in a vertical direction. The forces necessary for the forming are transferred through the form block to the sheet sample.

Simple Stretch Forming



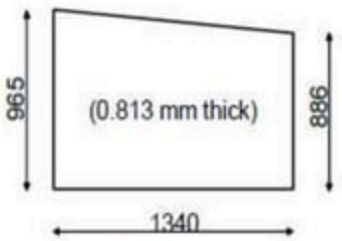
Source: Müller-Weingarten Co.

- The part to be formed receives its contours during the motion of the forming block, the gripping jaws remaining stationary.
- Due to the large area of contact between form block and the blank, the frictional forces prevent a deformation of the sheet in this region.
- Due to the frictional forces acting between form block and blank, the middle regions hardly undergo any deformation, i.e., the maximum possible straining capacity of the sheet is not attained.

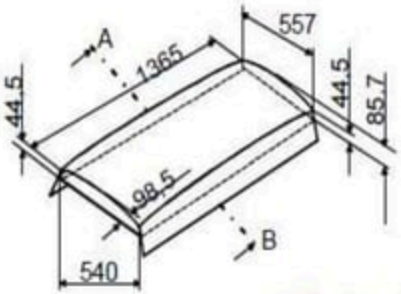
- The sheet material flows under the tensile stress only out of the sheet thickness, so that the surface of the sheet expands.

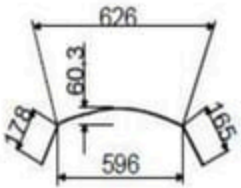
Examples for Simple Stretch Forming -

- Wing parts for the air plane industry can be made by simple stretch forming, starting from trapezoidal blanks.



Blank

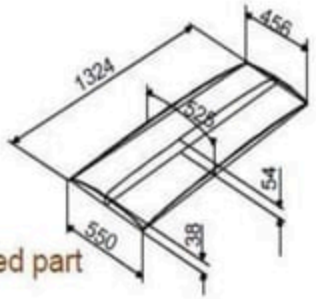




Section A - B

Tool and work-piece

Example for Simple Stretch Forming



Ready shaped part

Source: Sachs

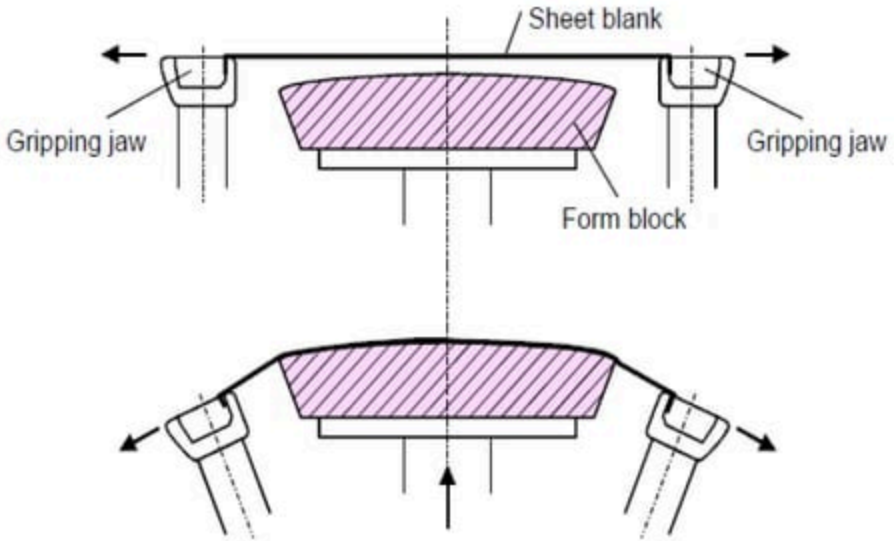
TANGENTIAL STRETCH FORMING

- The main difference to the simple stretch forming is that both the form block as well as the gripping jaws are movable. Using this process, it is possible to subject the blank to a plastic pre-strain prior to the actual forming, so that the whole cross-section of the material undergoes a uniform plastic deformation.

The process can be divided into two steps:

- In the first step, the blank is gripped by two jaws arranged opposite to each other. The jaws then move horizontally away from each other and create a uniform plastic strain in the whole cross-section of the blank.
- In the second step, the form giving block is moved vertically towards the sheet blank. The gripping jaws tilt and orient themselves in the direction of the tensile stressing of the blank, so that the blank, still under the constant tensile stress required for the plastic deformation, is draped tangentially over the form block.

Tangential Stretch Forming



Source: Müller-Weingart Co.

- Another advantage is that the application of an overlaid tensile stress to the work-piece during deformation reduces the residual stress. The reduction of residual stress leads to lower spring back than in the case of simple stretch forming so that the form accuracy is higher and accompanied by a higher blister strength of the sheet part.

Use of Tangential Stretch Forming

- The tangential stretch forming machines are used to fabricate roofing arches for train coaches, door frames and planking for busses, planking parts for the aerospace industry and for the outer covering sheets for cars.

Tangential forming machine

Source: Müller-Weingarten Co.

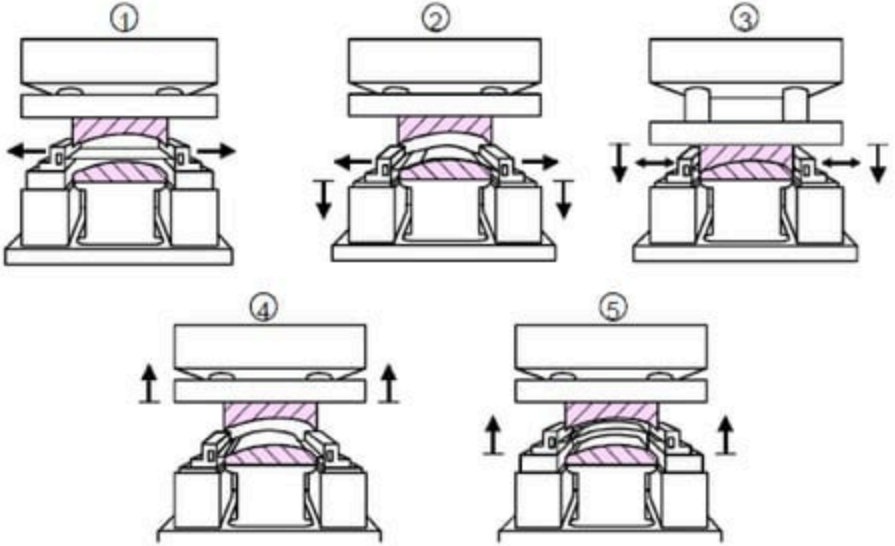
The Cyril-Bath Process

- Based on the principle of tangential stretch forming, the Cyril-Bath company has developed a process which makes it possible to apply tangential stretch forming in a mechanical or hydraulic drawing press. The Cyril-Bath process is used to fabricate large, relatively plane sheet shapes in small and large series, e.g. car bonnets (hoods).
- The process can be classified as a combination of stretch forming and deep drawing operations. It was the Cyril-Bath process, also called the stretch-draw process, which made it possible to introduce stretch forming for the mass-production of body parts.

Operation Steps of the Cyril-Bath Process

1. Clamping and pre-straining the sheet blank
2. Drawing the sheet blank over the form block
3. Application of counter pressure
4. Moving back the counter pressure equipment
5. Opening the gripping jaws and removing the sheet shape

The Cyril-Bath Process



- The system consists of two gripping jaws arranged opposite to each other and which can be moved horizontally and vertically. These are mounted between the stands of a simple hydraulic press. A form block is mounted on the table of the press between the gripping jaws. The counter pressing equipment is mounted on the ramming punch of the press.

Operational Steps of the Cyril-Bath Process

The whole process is conducted in following steps.

- The sheet blank is clamped between two gripping jaws located opposite to each other. The grips are moved away from each other stressing the blank, without touching the form block, to an elongation of e = 2 % up to 4 %.

- Without reducing this applied stress, the gripping jaws are moved downwards so that the blank is wrapped around the form block to produce the convex contour.

- The ramming punch is now moved downwards to produce the counter pressure required for forming the concave contours. In order to prevent tearing in the over-stressed regions of the concave contours, the gripping jaws are moved horizontally and vertically in well-defined and controlled steps during the downward motion of the counter pressing punch.

- The punch is moved back to its original starting position

.

- The gripping jaws are opened and also moved to their original starting position, enabling the shaped part to be removed.

Multi axial Stretch Forming

- The aim of this development was to use the advantages of both these processes(The Cyril-Bath process and of the tangential stretch forming Process) and, at the same time, to eliminate the disadvantage of the two-sided stressing by arranging gripping jaws all around the form block. In order to achieve these goals, the requirements listed in the overhead were set up:

Requirements for a Flexible Stretch Forming Machine

1. The gripping jaws should be able to be arranged around the sheet blank in order to increase the variety of shape types which can be produced.

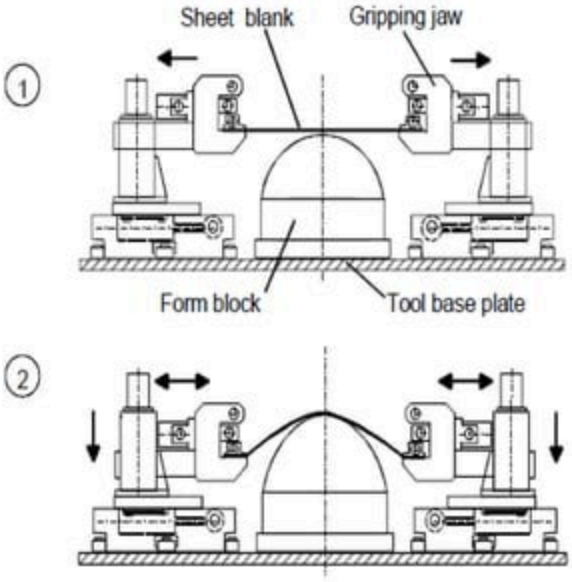
2. A segmented gripping system, allowing optimal control of material flow and production of shapes with unsymmetrical contours, should be used.

3. The system should be able to be enhanced and adapted to fabricate convex-concave shaped parts.

The process steps involved in the forming of shaped sheet parts with a flexible segmented stretch forming machine, are as follows:

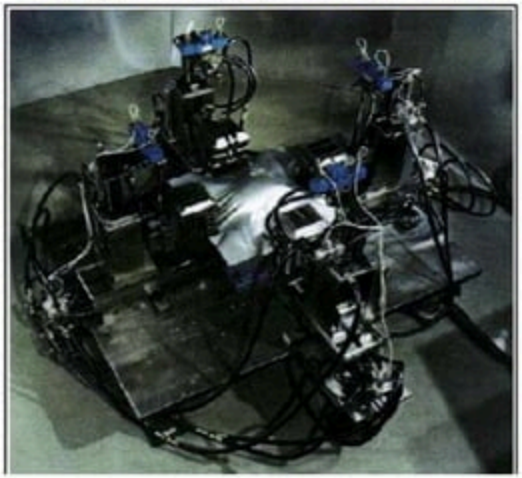
- The sheet blank is fixed to the leading edge of the gripping jaws. The gripping segments are then moved towards each other so that the blank can be clamped in all four gripping jaws. The gripping segments then move apart, thereby pre straining the blank.
- The vertical and horizontal movements are coordinated, making it possible to trace a curved path with which the blank can be drawn over the form block.

Principle of a Flexible Stretch Forming System



- The basic module consists of a gripping jaw which can be moved horizontally or
- vertically by means of a hydraulic cylinder. The gripping jaws can move 200 mm
- horizontally and 250 mm vertically. A further hydraulic cylinder activates the toggle lever sheet gripping jaws, whereby the gripping width is 250 mm. The total
- constructional height of a module is 1,223 mm with a constructional length of 820 mm.
- The determination and programming of the path to be traced is decisive for both the forming operation as well as for the accuracy with which the contours can be replicated.
- Each stressing segment can thus be programmed to describe its own individual path. This can be achieved either by linear movements or by simple curves traced by applying small discreet movements directly to the supports.
- For form blocks with complicated geometries, the travel paths must be manually predetermined using the part drawing as a basis. The fine adjustment is then carried out experimentally, using an iterative method.

Four-sided Stretch Forming Using a Hemispherical Punch



The arrangement of the segments of a four-sided stretch forming machine with a hemispherical punch. Each of the four gripping segments can be operated individually, i.e., each grip can be positioned and controlled independently.

Advantages:

- Stretch forming is widespread in the aerospace industry. It allows the manufacture of large parts, most often made of Aluminum, with lower tooling costs than the regular drawing tools due to less run.

On the workpiece:

- very low and homogeneous residual stresses,
- greatly reduced spring back,
- machining and assembly operations without deformation since no fiber are compressed.
- increased hardness by about 2 %,
- forming of sheets, bars and rolled or extruded sections,
- final normalized metallurgical state of the product after completion of the various forming and heat treatment phases

- **On the press and the tool:**
- easy and fast tools changeover,
- finished product matching the shape of the tool,
- low cost forming (1 tool instead of 1 die + 1 punch) : about one-third of conventional tools,

Disadvantages:

- A disadvantage of stretch forming is that the middle regions of the sheet are not sufficiently formed, so that the strain distribution in the sheet cross section is not uniform. This leads on the one hand to a spring back and consequently a loss in dimensional accuracy and on the other hand to insufficient work hardening

Thank you