# ALUMINIUM FORGING

## Introduction

Forging is the shaping between shaped or flat dies, of a metal into a near final product by hammering, or application of hydraulic pressure.

As the metal is shaped during the forging process, its internal grains are deformed, to follow the general shape of the part. Grain flow is continuous throughout the part, giving the highest possible strength characteristics. Significantly stronger than cast or machined.

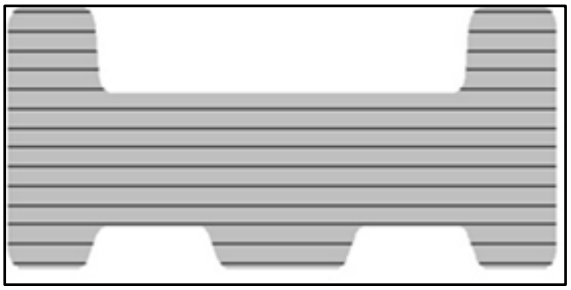

*Figure 2: Machined grain flow*

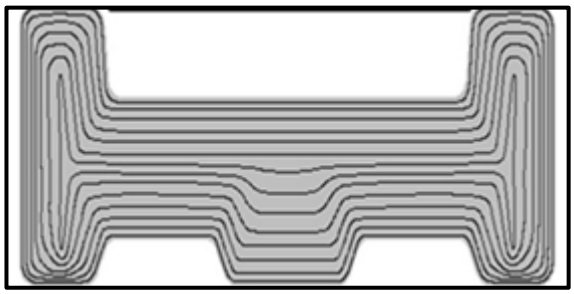

*Figure 1: Forged grain flow*

Forging is used for highly stressed and/or fatigued parts, such as in aircraft undercarriage gear, internal combustion engine conrods, camshafts, pistons, braking components, and suspension arms.

Forged components have an advantage of near net shape, minimising further machining.

## The Process

The great majority of aluminium forgings are made using heat-treatable alloys, but forgings of pure aluminium (1xxx series) and of some of the non-heat-treatable alloy families find application in certain fields.

Blanks are cut from extruded stock or from ingot and, before forging, are preheated to temperatures in the range of 400° - 500°C, according to the alloy used. For the production of hand forgings the blank is hot worked between flat dies, usually on a pneumatic hammer or a press with care being taken to ensure that the degree of deformation is sufficient to provide adequate breakdown of the original cast microstructure. The rough outline of the component is developed, with the grain flow or fibre of the material in the direction of deforming.

Hand forgings are usually associated with small quantity requirements or prototypes which do not warrant the cost of dies. Since these forged pieces are produced without shaped dies they cannot be made to strict dimensional accuracy. Machining is then used to produce final components. Sometimes forged pieces are preferred as an alternative to rolled plate or extruded section for machining stock to ensure that no cast microstructure has been retained.

Die-forgings, i.e. pressing and drop-forgings or stampings, are usually subjected to open die forgings in the same manner prior to the final operation in dies cut to the final required shape. Simple components may be pressed or stamped directly from extruded stock.

Die forgings are produced using shaped dies, providing a product with a high degree of dimensional consistency which considerably reduces the machining to the finished form. Such forgings have the advantages of good mechanical properties and structural integrity compared to castings.

The technology of die forming has advanced to produce close-to-form forgings with higher standards of dimensional accuracy. In the non-heat treatable alloys where mechanical properties depend on the degree of cold working it is possible to cold forge.

Hydraulic presses of up to 12,000 tonnes capacity and hammers with tups weighing as much as 20 tonnes are in use for the largest forgings.

**The Product**
The reasons for using the forging route can be summed up as follows:

- The production of the highest strength components.
- A high strength to weight ratio.
- Maximised fatigue resistance.
- High shock resistance.
- Economic means of designing and making a shape.
- Machining can be minimised and a high production rate can be achieved.
- The need for joints and welds is eliminated.
- The surface finish is good and the elimination of porosity ensures pressure tightness.

This combination of good mechanical properties, dimensional accuracy and surface finish means that aluminium forgings are used in highly stressed parts where structural integrity is of paramount importance. The alloys mainly used for these highly stressed applications are from the 2000, 6000 and 7000 series.

**Further information about aluminium and aluminium alloys, their production, fabrication, and end use can be obtained from**:

- Aluminium Federation www.alfed.org.uk
- European Aluminium Association in Brussels www.european-aluminium.eu