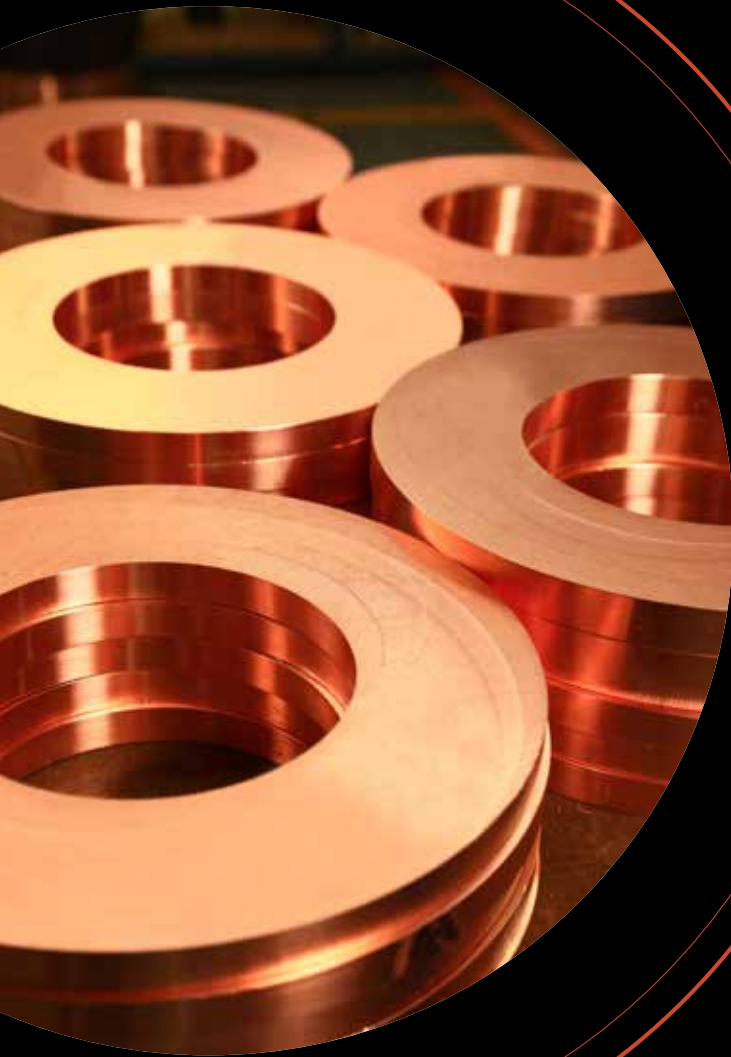


Indo German Industries Rolled Ring
Forging Process Delivers a Better
Product in Less Time.



INDO GERMAN INDUSTRIES

Overview

With the right material selection, proven forging processes, and proper tools, IGI has all the ingredients to manufacture seamless rolled rings in less time, with less material wastage, and with a more uniform grain that ensures the strength and reliability of your product.

The goal of this technical paper is to help you determine which forging process is right for you in meeting your seamless rolled ring needs. Because when you fully understand the differences between each forging process, you can improve your design and, ultimately, the quality and performance of your product.

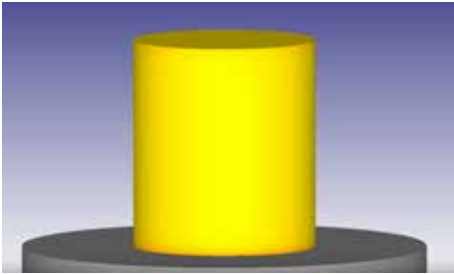
Introduction

IGI offers complete forging capabilities to a variety of industries such as Aerospace, Power Generation, Electronics and others using copper, aluminum, and other non-ferrous forgings. We manufacture seamless rolled rings using the open die forging process, closed die forging process, and rolled ring forging process.



Seamless Rolled Ring Forging Process

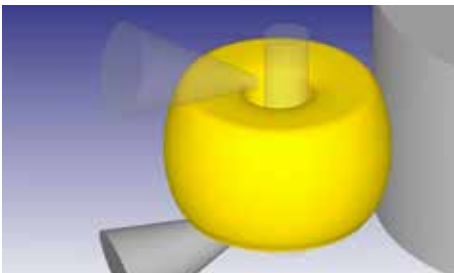
With our 40-ton ring rolling machine, IGI has the capability to manufacture seamless rolled rings using most of the metals we offer. This process provides significant flexibility allowing for various sizes, and provides a more uniform product that is stronger, more reliable and made in less time and with less material waste than traditional forging processes.



The process starts with raw material (a blank) being cut to size, then rounded to a disk shape.



The blank is punched then pierced in the center, using the open die forging process, to create a preform in the shape of a donut.



The donut shaped preform is then placed on the ring rolling mill for rolling.



The axial rollers control the height of the ring. The idler roller, or mandrel, applies pressure to the preform by pressing it against the drive roller to decrease wall thickness and height and increase ring diameter until the correct diameter is reached.

The seamless rolled ring forging process, when done properly, produces a superior ring containing a more uniform grain, more repeatable mechanical properties, and a truer/rounder shape, which makes more efficient use of materials (less waste) and produces rings in less time. After rolling, the product can be sent on for heat treatment and machining to achieve the tolerances and specifications for the finished product.

Whether your order is 10 rings or 100 rings or more, the seamless rolled ring forging process minimizes the variation from ring-to-ring.

Forged rolled rings can be configured in various sizes as shown in the table below. Specialized orders can be produced to manufacture seamless forged rolled rings in customized configurations.



Table 1: Rolled Ring Forging Process Capabilities

ITEM	SPECIFICATION
Minimum Outside Diameter	10"
Maximum Outside Diameter	40"
Maximum Height	8 1/4"
Maximum Weight	500 lbs.
Tolerance Range	± 1/8"

Open Die Forging Process

In the open die forging process, a piece of metal is deformed by placing it between dies that do not completely enclose it. The dies hammer or deform the metal through a series of movements to achieve the desired shape and form. From here, the product can be sent on for heat treatment and machining to achieve the tolerances and specifications for the finished product.

The open die forging process is used to produce forgings that are simple in shape and made in smaller quantities. This process works well for producing products that:

- **Are too large to be produced using other manufacturing methods**
- **Require mechanical properties that cannot be achieved in other metal forming methods**
- **Have a small quantity requirement that would not justify tooling costs**
- **Have a short delivery requirement that will not allow time to make proper tooling**

Rings that have special mechanical requirements or that may require warm work or cold work, or are too large to be produced on a ring rolling mill can be open die forged.



Table 2: Open Die Forging Process Capabilities

ITEM	SPECIFICATION
Maximum Thickness	20"
Maximum Weight	4,500 lbs.
Maximum Diameter	72"

Closed Die Forging Process

The closed die forging process (also called impression die forging) uses pressure to force or compress a piece of metal to fill an enclosed die impression of a predetermined shape and form. Depending on the product's size, shape, or specifications, several impression dies can be used to form the finished product.

This process is best suited for producing rings that are smaller in size and in higher quantities and do not have difficult mechanical property requirements.



Table 3: Closed Die Forging Process Capabilities

ITEM	SPECIFICATION
Minimum Inside Diameter	5"
Maximum Outside Diameter	10" to 19"
Maximum Thickness	Contact Weldaloy to discuss

The Weldaloy Advantage is Clear

Weldaloy's vertical integration system provides significant advantages in meeting your seamless rolled ring forging needs:

- **Cost savings** – No added transportation expenses from moving products between suppliers. Everything done under one roof.
- **Consistent quality** – Leads to higher profitability for our customers
- **One supplier** – Simplifies the whole process and keeps costs down
- **No hidden fees or charges** – We hold our prices to what was agreed upon
- **Technical and engineering expertise** – With 70 years of metal forging experience, Weldaloy has the knowledge and skills to help you achieve your metal forging goals
- **Reliability** – With a Quality Management System (QMS) that is AS9100C and ISO9001: 2008 certified
- **Customer first approach** – We work with you every step of the way to ensure your product exceeds your expectations
- **Flexibility and customization** – Our vertical integration process means we have the equipment, knowledge and material to customize your product to your specifications.

Weldaloy has the equipment and forging processes to accommodate a wide range of sizes to meet your ring needs. Below is a summary of each process. We also have the expertise to help you with custom and/or unique product orders.

Table 4: Summary of Each Forging Process

OPEN DIE FORGING	CLOSED DIE FORGING	ROLLER RING FORGING
Larger ring sizes	Smaller ring sizes	Smaller ring sizes
Lower quantities	Higher quantities	Higher quantities
Little or no tooling costs	Cost savings/less raw material needed	Little or no tooling costs
Can achieve mechanical properties other forging processes may not	Best on complex shapes with closer dimensional tolerances	Consistency in parts produced