AXIAL-LOAD BULGE FORMING

Innovations in Superalloy Forming and Fabrication
Unique Advantages

Axial-load bulge forming differs from conventional metal forming methods and offers the following outstanding advantages:

**Produces Complex Shapes**
Axial-load bulge forming uses internal hydraulic pressure and segmented dies that move simultaneously with the material during forming to generate complex shapes that cannot be produced in one step by any other forming method. It is ideal for producing intricate parts with negative draft angles, convolutions, sharp details, and close tolerances.

**Minimizes Wall Thinning**
Under hydraulic pressure, the dies are forced together and, with simultaneous radial and axial load on the material, the metal flows into the contours of the dies. Material thin-out is minimal, which is critical in highly stressed turbine engine parts and other parts subject to extreme operating conditions. Using heavier gage material to compensate for metal thinning in bends is not necessary.

**Cost Effective**
Axial-load bulge forming is, in most cases, a one-step operation so that annealing and machining are rarely necessary. Tooling is less costly than the several sets needed for comparable draw forming. Additional benefits include material savings and stepped-up production speed. The cost effectiveness of bulge forming makes it ideal for low-cost prototypes.

Let Voss Aerospace Be Your Source for Aerospace Formed Parts!

Our unique bulge forming capabilities, plus nearly 50 years of metal-forming expertise, have enabled Voss Aerospace to become a leading supplier of a variety of complex shapes made from metals such as Hastalloys, Inconels and titanium for airframe, jet engine, rocket motor, torpedo, and other applications.

Voss’ extensive experience and expertise with this state-of-the-art technology will allow you to achieve closer tolerances, manufacture complex shapes, minimize wall thinning, with a superior finish at a cost effective manufacturing method.

For assistance with your bulge forming projects and to integrate axial-load bulge formed parts into your production requirements, contact Voss Sales or Engineering.
A Unique and Unequaled Metal Forming Process

The part shown here demonstrates bulge forming's ability to create tight reverse angles in a single operation and still maintain uniform wall thickness and close tolerances throughout.

The illustrations below show the radial and axial forces simultaneously applied during bulge forming to force the material into the contours of the dies.

From this... this part starts as a 5 inch dia., 4-1/2 inch long tube. To this... in one simple bulge forming operation!

Bulge forming reduces production steps and minimizes finishing operations...

A Boeing 747 pneumatic ducting component is formed from a 9 inch diameter Voss rolled and seam-welded tube of 0.032 inch, 321 stainless material. The flange is bulge formed at a 45 degree angle in one continuous operation as shown in these sequential photos. The edge of the double-layered flange is then ground away to separate the halves... ...thus forming two identical parts from one forming operation. The flange is then trimmed and holes punched.
Bulge forming is ideal for producing parts from many of the high strength, high temperature superalloys. Its features of part uniformity, extremely close tolerances, and weight reductions make bulge forming unsurpassed for manufacturing critical parts for the airframe, aerospace, turbine engine, and many general industries.

Typical applications for these critical components are illustrated here and include jet and turbine engine burner cans, outer casings, exhaust pipes, tail and acoustical cones, bellows, flanges, transitions, combinations of ducting components, and similar parts.
Precision Bulge Formed Components

Bulge forming lends itself to very close tolerances...

Both the flanges shown above and the heat shield shown here are examples of parts bulge formed to very close tolerances.

The heat shield is made from 0.032 inch thick titanium, rolled and seam welded to form a 7 inch diameter tube. The center portion of the tube is then bulge-formed to 8-1/4 inches with tolerances of plus 0.015 inch and minus 0.000 inch.

Voss Sheet Metal Ducting Flanges

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Sheet metal flanges used on pressurized pneumatic aircraft ducting start as circular discs - diameter varies according to final flange size; thickness ranges from 0.020 to 0.080 inch. The disc is first deep-drawn into a cup.

The cup is then bulge formed to make the flange; the center is blanked out and the flange face is precision machined to provide a sealing surface.
This torpedo pressurized accumulator begins as a 8 x 15-3/4 x 0.090 inch sheet of 17-4PH material which is rolled to near tubular shape.

The rolled piece is then seam welded to form a 5-inch diameter tube; the weld is planished and weld tabs cut-away.

Seam welding... Voss Aerospace has the capability to join conventional or exotic alloys with aircraft-certified seam, resistance and fusion welding.

The tube ends are cut away at an angle to complete the part.

The piece is bulge formed to produce this angled tube within very critical dimensions. Weld integrity is tested and ensured since welds are subjected to many times greater pressures during bulge forming than when in operation.

CNC Machining... Voss’ machining capabilities encompass state-of-the-art CNC machining centers enabling Voss to provide precision, one-of-a-kind prototypes through high quantity production runs.

Shown here is the completed accumulator after the flanged, hemispherical ends are CNC machined and welded to the bulge-formed section. Voss has CNC capabilities, as well as all required secondary and finishing operations.
Voss Bulge Forming Provides Quality and Variety

Bulge forming... Voss designed and built bulge forming presses have a maximum capacity of 320 tons and can maintain uniform wall thickness up to 0.250 inches thick with tolerances of ±0.001 inch, depending upon material. Current presses can produce bulge-formed components up to 24 inches long and 24 inches in diameter-and even larger capacity bulge formers are being manufactured. Intricate parts as small as 1/4 inch diameter and 0.008 inch material thickness can also be bulge formed.

Axial-load bulge forming has the unique feature of increasing the "stretchability" of a metal, enabling the formation of a wider range of shapes. Shown here are just a few more shapes and uses of bulge-formed parts.

Quality Assurance

Extensive product and qualification testing, destructive and nondestructive testing capabilities, and a complete metallurgical laboratory ensure the highest quality bulge formed components. Voss Aerospace has a Quality Assurance program that meets FAR 21.303 (FAA/PMA) and ISO-9001:2000, AS9100A and customer specific quality systems to further ensure product quality and timely deliveries. Voss manufacturing quality is a result of innovative engineering, extensive in-house tooling capability, refined production processes, supplier management, and a company-wide quality management philosophy. This ensures that we not only meet contractual specifications and requirements, but also satisfy our own rigid standards of quality and performance.
Additional Voss Aerospace Capabilities

Roll Forming and Stamping
Voss has been producing roll-formed shapes for nearly 50 years. Custom roll-formed rings and straight shapes are made from stainless steels, Inconel, and titanium from 0.020 to 0.156 in. thick for aircraft exhaust rings, jet engine tail pipe clamps, and other V-retainer clamps. A variety of stamped parts can be produced in-house on one of over 100 presses as well as performing secondary operations for punching, forming tabs, and swaging ends of components.

Cold Headed Aerospace Fasteners
Voss has in-house capabilities to head and thread to almost any fastener requirement and complete secondary operations such as cross-drilling, press bending, and knurling. Special T-bolts, studs, set screws, clevis pins, thumbscrews, knurled bolts and more are manufactured to industrial and aerospace specifications.

Tooling/Prototyping
Being able to produce high quality bulge formed components time after time is due primarily to Voss total in-house design, tooling, prototyping, and testing capabilities. Voss Aerospace uses state-of-the-art CAD/CAM and CNC machines to design and produce the special tooling required for the bulge forming presses. Voss tooling designers have the experience and expertise to meet unique aircraft component design and manufacturing requirements.

Welding
Voss offers certified MIG and TIG welding to meet your most stringent quality needs. We also have the area's largest certified resistance spot welding capability with machines of all types for volume production of components.

Protective Coatings
A variety of in-house finishing and coating operations include dry film lubrication, passivation and painting.

Combine Voss Aerospace’s bulge forming expertise with welding, machining, fabricating and assembly, and finishing capabilities, plus complete QA and SPC support, and you have one of the best single-source, aerospace quality component manufacturing facilities in the country.