



Metal Bellows

INNOVATIVE COMPONENT AND ASSEMBLY SOLUTIONS FOR HYDRAULIC, PNEUMATIC, FUEL AND COOLING SYSTEMS





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Senior Aerospace Metal Bellows is dedicated to providing custom engineered solutions to our client's engineering and manufacturing challenges. By applying advanced engineering and manufacturing capabilities plus precision metal joining, processing, and fabrication, we deliver innovative solutions in a timely cost-effective manner.

Engineered component and assembly designed solution applications:

- Hydraulic/pneumatic systems pressure and flow control
- Fuel systems
- Thermal management
- Actuation
- Dynamic sealing
- Precision sensing
- Flexible coupling

Custom Engineered Solutions

A Breakthrough Process

Senior Aerospace Metal Bellows was founded on a breakthrough process for creating welded diaphragm metal bellows in 1955 and became a Senior Aerospace company in 1994.

Metal Bellows continues to refine and develop welded metal bellows technology and the integration of welded metal bellows into critical aerospace, semiconductor, medical, and industrial applications. The company operates in a 65,000 square foot manufacturing facility in Sharon, Massachusetts.

This is a vertically integrated plant incorporating all aspects of metal fabricating and joining as well as electromechanical fabrication and assembly. All metal joining processes are maintained in the facility with particular attention to our core competency, fusion welding technologies. This allows us to completely control the quality of the innovative solutions we offer our clients. We currently manufacture products across many different markets on both new and legacy programs.



ONE TEAM DEDICATED TO

Serving Our Customers Continuous Improvement Ethical Behavior

Sophisticated Engineering Capabilities To Meet Your Most Demanding Challenges



Our "Concurrent Engineering Team" provides "Solutions" that enable our customers to provide unique products that bring higher value to their customers and end users.

Senior Aerospace Metal Bellows' Engineers will work with you early in the design process to maximize cost efficiency and ensure product performance.

Welded Metal Bellows Designs

- Complex, precision bellows assemblies
- Diameters from 1/4" to over 20"
- · Materials to suit the application
 - Stainless steel, titanium, Inconel, and other exotic alloys
- Material thickness from 0.0015" to 0.020"
- · Bellows analysis
 - Proprietary, internally developed bellows stress analysis software
 - Optimize bellows to meet functional and environmental requirements
 - Predict fatigue life, spring rate, and natural frequency
- Higher Level assembly designs
 - Complex, integrated higher level assemblies

Engineering Design

Software - SolidWorks®

- Create 3D component and system level models
- Provide accurate weight and CG analysis
- Import and export models to/from our customers to facilitate verification



Structural Analysis

Pressure vessel and structural elements are analyzed using FEA software – COSMOS

- Perform stress and fatigue analysis
- Combine operational, environmental, and assembly loading conditions
- Identity areas for weight savings
- Predict high stress locations and fatigue life



Fluid/Gas/Thermal Analysis

- Compressible fluids analysis
- Incompressible fluids analysis
- Thermal expansion analysis
 - Gases
 - Fluids
 - Structural materials

Pressure Vessel Design

- Traditional all-metal designs
 - Stainless steel, Inconel, titanium
- Composite designs
 - Weight saving filament wound technology

Position Sensing

Various types of position sensors are integrated into our assemblies

- Electrical position sensors such as LVDTs
- Magnetic and fiber optic position sensor for sensing across a pressure boundary

Hydraulic Component Design

- Proprietary, internally developed sizing program for hydraulic accumulators and reservoirs
- Uses real gas properties for accuracy
 - Isothermal and adiabatic analysis
- Provides optimized design for the smallest envelope and lightest weight

Engineering Test Laboratory

- Design analysis validation
 - Compare predicted cycle life with actual test data
- Complete development and qualification testing
 - Impulse
 - Endurance
 - Vibration
 - Environmental
- Hydraulic test laboratory





At Senior Aerospace Metal Bellows we can provide innovative solutions for metal joining and fabrication applications. Our metal joining expertise covers a wide range of advanced welding, brazing and other metal joining technologies. In addition, our design and manufacturing engineering experience allows us to make complex assemblies more cost effective.

Manufacturing Engineering a

Manufacturing Engineering



- Develop and implement statistical process controls
- Solve process challenges through Design of Experiments (DOE)
- Weld development and qualification
- Implement continuous improvement for increased yields

Metal Finish and Processing



- Passivation
 Cleaning
- Etch
- Cleaning
- Ecological vapor degreasing
- Electropolish
- Fully automated aqueous cleaning and drying

Precision Fusion Welding



- In accordance with industry standard AWS D17.1
- Gas Tungsten Arc Welding (GTAW)
 - With and without filler material
 - Hand welding
 - Semi-automatic welding
- Laser Welding
 - CO2 1800W Class 4
 - Semi-automatic
- Electron Beam Welding
 - Max Power: 7.5 kW
 - Low and high power capability
 - Single pass welding, low distortion
 - Weld penetration capability up to 1-inch
 - Programmable XY table
 - Rotary (horizontal and vertical)
- Resistance Spot Welding
 - In accordance with industry standard AWS D17.2 and AMS W6858

Nadcap

- AC7110 for Welding
- AC7102 for Heat Treating
- AC7102/1 for Brazing
- AC7101/3 for Mechanical Testing
 AC7101/4 for Metallographic and
- Micro Hardness Testing
- AC7101/5 for Hardness Testing





and Precision Metal Joining and Fabrication

Vacuum Heat Treat and Braze



- · Heat treating of metal and metal alloys
 - Annealing and stress relieving
 - Hardening and tempering
 - Precipitation (age) hardening
 - Cryogenic quenching
 - Pyrometry in accordance with AMS2750 Rev D
- Braze Filler Materials
 - Copper Aluminum
 - Nickel Manganese
 - Gold Other

Metallurgical Laboratory



Our metallurgical laboratory is staffed with experienced engineers to perform research and qualification of new materials, material verification, weld sample analysis and failure analysis.

- 3 Metallographs
- Up to 1000X
- Macrosection
 - Weld evaluation
 - Grain structure evaluation
- Hardness testing
 - Standard testing
 - Superficial testing
 - Micro hardness testing
- Instron Tensile Tester

Laser Marking

- Human readable
- UID (2D Data Matrix)





Senior Aerospace Metal Bellows has incorporated the Lean Enterprise system into its manufacturing processes. This supports two interrelated goals: job skill certification and cross training to promote work and flexibility; and implementing lean techniques to promote operational improvements in all departments. This system will help increase customer satisfaction while improving all internal measures of company performance.

Implementation of lean concepts including Value Stream Mapping, 5-S, Kaizen events and Continuous Flow has resulted in dramatic improvements in facilities utilization, work flow, process improvements and a strong cultural shift towards continuous improvement.

Functional Test Inspection



- Envirotronics Environmental Chambers
- Helium Mass Spectrometer Leak Check Machines
- Dosey 24P Comparator with Quadreach 200
- Zeiss Contura G2 CMM



Bellows Products

Maintenance free Accumulators and Bellows Reservoirs

Typical Applications

- Hydraulic, fuel and cooling systems
- Energy storage/pulsation damping
- Fluid storage/compensation
 Reservoirs for electrohydrostatic actuators (EHA)

Principal Advantages

- Completely maintenance and service free
- Absolute leak tightness
- High reliability
- Impervious to temperature extremes
- Zero friction repeatable performance with no wearing parts
- Long predictable life under operating conditions
- Indefinite storage time
- · Contaminant free storage and operation
- Compatible with normal, exotic or corrosive hydraulic fluids

Construction Features

- All welded construction
- · Elimination of elastomeric seals
- Fabricated from Stainless Steel, High Nickel or Titanium alloys as required by operating parameters

Bellows Compensators

- Absorbs volumetric expansion and contraction of coolant fluid
- · All welded metal bellows construction
- Zero leakage

Heat Exchangers

Typical Applications

Cooling systems for field mounted laser guidance systems

Construction Features

- Plate-fin heat exchangers
- Air-to-air and air-to-liquid
- Aluminum fins vacuum brazed to an aluminum or titanium core
- Ability to integrate into zero leakage, thermal management subsystem



Thermal Actuators

- Provides precise movement for a specified temperature range
- Withstands harsh operating environments
- High reliability and long life
- Accurate, repeatable performance
- All welded stainless steel construction

PRIME MOVER Actuators



- Designed to deliver precise, repeatable linear actuation when bellows assembly is pressurized
- Superior reliability, contamination free operation, compact design and maintenance free operation
- · Leak tight actuation
- Operates in harsh environments
 - Corrosive gasses
 - Extreme temperatures (cryonic to 450F)
- Operational cleanliness meets ISO 14644 Class 1
- Ideal wherever hermetic actuation across a pressure boundary is required

Pressure & Temperature Actuators



- Accurate repeatable response to changes on pressure or temperature
- Superior linearity and low hysteresis
- Applications
 - Aircraft engine hydromechanical fuel controls
 - Aneroids for environmental control systems, ejection seats, etc







Bellows Vacuum Pumps & Compressors



- Long Life Capable of a minimum of 10,000 hours continuous operation
- Stainless Steel Construction All wetted surfaces are corrosion resistant stainless steel except for valve assembly gaskets that are either Teflon or Viton
- No Maintenance No wearing surfaces and no lubrication required. Motor and driver assembly contain permanently lubricated bearings
- Hermetically Sealed Employ welded bellows that provides positive containment and contamination free sampling. Every pump is tested to assure leak tight integrity to mass spectrometer levels
- Infinite Number of Cycles Bellows and valves are designed with stress levels below defined endurance limits of materials allowing for an infinite number of cycles

Applications

- Aircraft potable water system pressurization
- Aircraft vacuum waste system
- Hazardous gas handling
- Radiation monitoring systems

Senior Aerospace Metal Bellows can also design other Custom Products to meet your application.

If you don't see a product that meets your specific requirements, we look forward to providing you with a "Solution".

Bellows Couplings



- Torsionally rigid
- Low wind-up (rotational deflection between driver and load)
- Low backlash (from reversing or varying loads)
- Constant rotational velocity
- Low inertia
- High corrosion resistance
- Ability to withstand extreme temperature conditions
- Provide reliable axial and angular characteristics

Application

- Aircraft brake systems
- Encoder couplings

Flexible Seals and Joints



- Provides a flexible interface for engine nacelle applications
- "Kiss Seals"
- Fuel drain seals
- Stainless steel or Inconel construction
- Able to withstand temperature
- and vibration extremes

Welded Metal Bellows



- Constant effective area with change in pressure
- Excellent spring and pressure deflection characteristics
- Ability to withstand high pressure
- Long stroke per unit length Short nestled length
- Corrosion resistance
- Leak tightness to less than 1x10-9 scc/sec
- A wide range of operating temperatures

Human Implant Bellows



- Extremely thin gauge titanium construction
- High cycle life
- · Zero leakage

Bellows Mechanical Face Seals



Used as engine shaft seals or engine gearbox seals, the bellows type mechanical face seal offers advantages including

- All welded hermetic construction
- Bellows replaces the secondary o-ring seal
 - Zero secondary leakage
 - Uniform (360°) face loading
 - No sticktion or hysteresis
- Accurate and repeatable load at length
- Longer axial stroke capability
 Bellows versus wave spring
- Suitable for extreme temperature environments - -65F to 900F



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