The Barden Corporation (UK) Ltd

Company Presentation – Dry Pumps

September 2020

Super Precision Specialists

- The global leader in the manufacture of super precision ball bearings and assemblies.
- Specialising in development of solutions for challenging and complex applications
- Industries include:
  - Aerospace & Defence
  - Energy Generation
  - Medical Systems
  - Precision Robotics
  - Vacuum Technology

Barden's History

1942 — Barden US formed in 1942 by Theodore Barth and Carl Norden

1947 — UK – Started life as EMO

1960 — EMO Acquired by The Barden Corporation

1966 — Company moves from Bracknell to Plymouth 1966 - 1992

1990 — Acquired by FAG in December 1990

2001 — Acquired by INA in December 2001

2016 — Barden celebrates 50 years in Plymouth

2019 — Acquired by German bearing manufacturer, HQW Precision GmbH

Partners in Precision

- Acquired by HQW Precision GmbH in 2019.
- Together, HQW & Barden manufacture many of the world's most sophisticated precision bearing products.
- The partnership has a shared focus on technology, innovation and quality.
- Customers worldwide can access the products and support they need to meet their individual operational and economic challenges.

Our Location

- Production facility in Plymouth on the South West Coast of UK.
- Future investment into production areas and technology planned across the facility.
- Full service location with all functions onsite:
  - **Engineering**
  - **Sales**
  - **Manufacturing**
  - **Service**

Our Location

Plymouth, UK

Barden at a glance

Production area

8000sqm

Total

Turnover

£32mio

2019

More than

1mio

bearings per year

Super Precision

ISO P4/2

ABEC 7/9

Over 350

employees

Approx.

1300sqm

ISO Class 7

Cleanroom space

2k bearing types

10k bearing variants

Functional Testing

100%

of product checked

Precision Products

- A wide range of standard metric and inch size deep groove and angular contact bearings.
- Super precision design to ABEC 7/9 (ISO P4/P2) quality standards.
- Size range of 1.5mm bore (0.8mm ball) to 180mm outer diameter
- Special bearing innovations range from standard bearings with modified dimensions and/or features, to complex assemblies and integrated components.
- Engineering teams work alongside customers to develop unique designs which meet application requirements and solve functional problems.

Quality Standards

- ISO 9001:2015/AS9100:2018 Rev D
- AS 9120:2018 Rev B
- ISO 14001:2015, OHSAS 18001:2007
- ISO 500001:2011
- Multiple customer approvals
- National Investor in People Award

Materials

Bearing Rings

- SAE 52100
- AISI 440C
- Cronidur 30
- M50
- BG42

Materials

Balls

- Silicon nitride
- SAE 52100
- AISI 440C
- TIC coated
- Zirconium Dioxide
- Tungsten Carbide

Materials

Lubricants

- Hydrocarbon
- Synthetic esters and hydrocarbons
- Silicone
- Perflouralkyploy ether

Materials

Cages

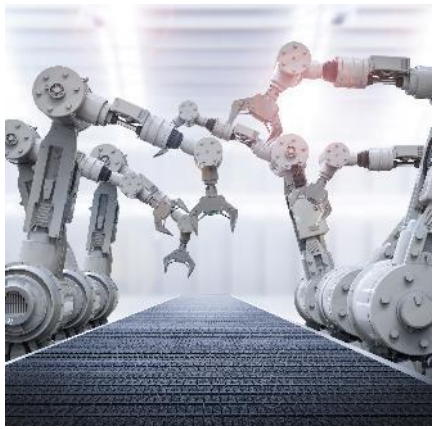
- Steel
- Bronze
- Phenolic
- Polyamide
- PEEK
- PTFE based
- T-Cage

Cleanroom Conditions

- High precision assembly of components in cleanroom conditions.
- Class 7 (Class 10,000) cleanroom with ISO Class 5 Final assembly benches for contaminant free assembly and inspection
- Highly skilled assembly personnel with extensive experience of handling miniature components

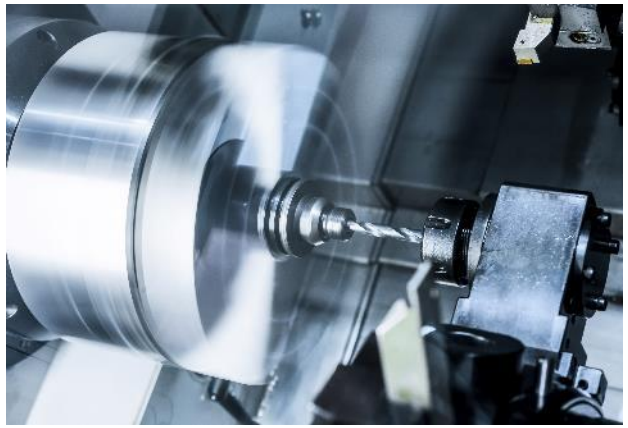







Markets & Applications

Barden bearings are found throughout industry where performance and reliability under challenging conditions is essential.




Vacuum Pumps

Typical types of Pump

Claw Pump

Roots Pump

Scroll Pump

Screw Pump

Turbo Molecular Pump

10mbar
Low Vacuum

0.1mbar

0.001mbar
High Vacuum

0.0000000001mbar
Extra High Vacuum

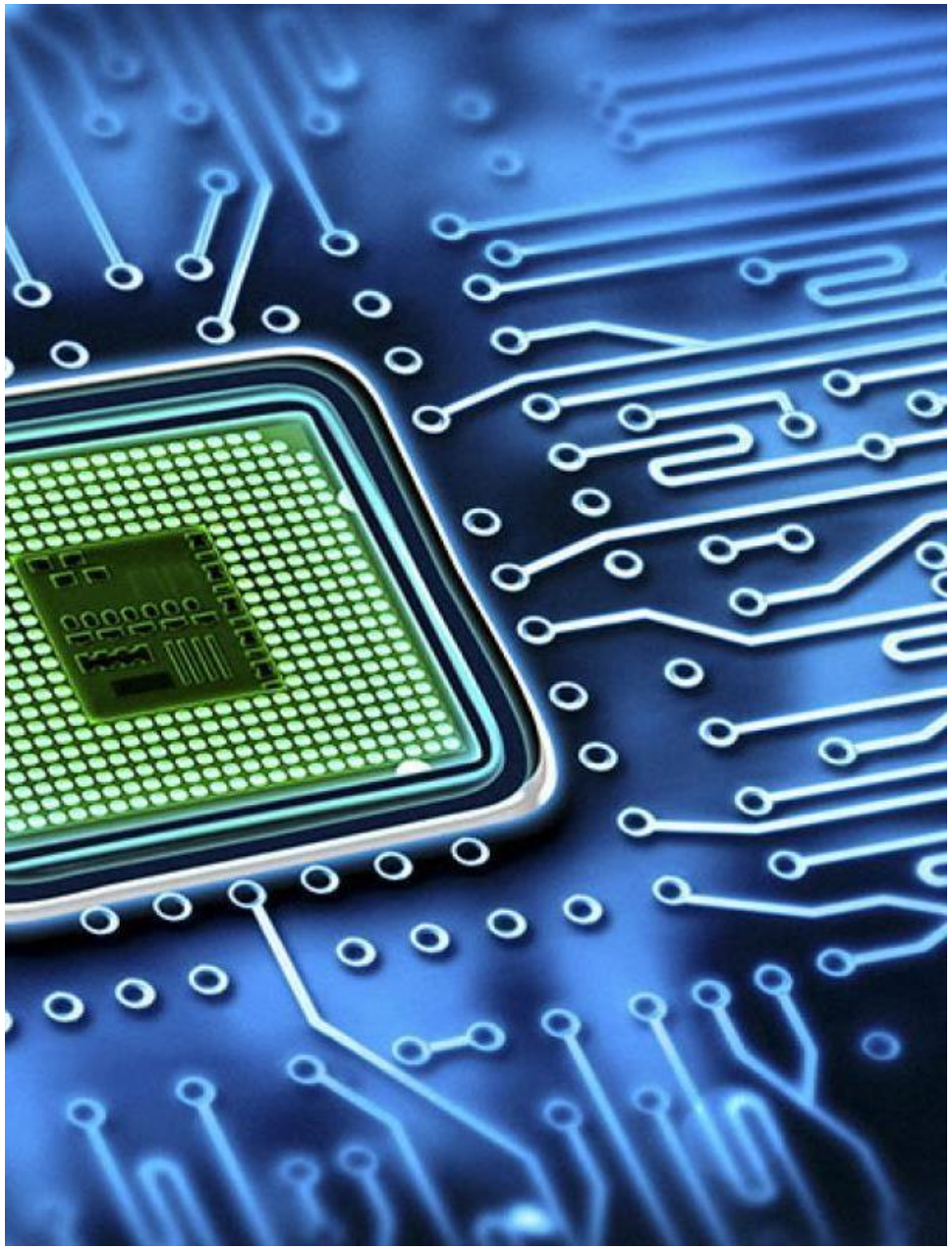
0.000000000001mbar
Ultra High Vacuum

Dry Vacuum Pumps

- Dry vacuum pumps operate in the 10^{-2} to 10^{-3} mBar region and are expected to exceed 40,000hrs life.
- Used for semiconductor production in applications such as load lock and process gas supply.
- Types include: Scroll, Claw, Roots and Screw

Benefits:

- No oil back streaming into the processing chamber
- No Contamination of the down stream process
- Lower maintenance costs
- More tolerant to Heat load
- Reduced energy / running costs (Efficiency)
- Used for UHV (Fore pumps)



Scroll Pumps

- The pump comprises 2 opposing scroll with one in a fixed position.
- Ultimate pressure approximately 10^{-2} mbar; pumping speed between 3 and 60 m^3/hr
- Progressive compression / low power – constant loads
- Seal wear occurs reducing efficiency and generating debris, regular seal maintenance required
- Clearances in the pump are critical to the efficiency – Stable geometry required

Bearing Solution

- Typically a super duplex pair at the Scroll head
- Flanged modular design – simplified assembly
- Polymer cage material
- High moment stiffness / precision geometry required to ensure parallelism of the mating scroll surfaces
- Grease lubricated
- Super clean bearing steels used to ensure long fatigue life

Claw Pumps

- Comprises 2 counter- rotating synchronised claws, the small gap between the claws compresses the gas.
- Multiple-stage claw pumps reach a vacuum level of 1 x 10^{-1} Torr (1.4 x 10^{-3} mbar) and pumping speeds up to 425 m^3/h (250 ft^3/min)
- Pumps are robust and efficient – long lifetime requirements
- Low maintenance - reliable
- Suited to harsh environments – extreme operating conditions
- Abrupt compression / noisy and pulsing operation – transient loads

Bearing Solution

- Typically deep groove design - predominantly radially loaded
- Rings specially heat treated to ensure low retained austenite levels, stable over high temperature ranges
- Ceramic balls used to ensure maximum oil film thickness and optimum tribological properties
- Oil Lubricated – PFPE
- Super clean bearing steels used to ensure long fatigue life
- Ceramic balls used to ensure low contact pressures and optimum tribological properties

Roots Pumps

- Comprises 2 counter-rotating ‘lobed’ rotors in a chamber / housing, the gas is isolated and
- Operating pressure range between atmosphere down to the low 10^{-5} mbar range
- Impressively high pumping speed of between 40 and 200m^3/hr
- Good performance when used to pump light gases
- Very low noise levels (even at high rotational speeds), and virtually no vibrations

Bearing Solution

- Typically deep groove design - predominantly radially loaded (similar to claw)
- Single seal – Non contacting
- Typically Stainless steel ribbon cage
- Rings specially heat treated to ensure low retained austenite levels, stable over high temperature ranges
- Ceramic balls used to ensure maximum oil film thickness and optimum tribological properties
- Oil Lubricated – PFPE
- Super clean bearing steels used to ensure long fatigue life
- Ceramic balls used to ensure low contact pressures and optimum tribological properties

Screw Pumps

- Comprises of opposing synchronous rotating screws trapping the gas between the screws.
- Screw pumps can reach ultimate pressures of ~ 1e-3 mbar. The operating pressure range is 10^{3} to10^{-2} mbar. Various sizes with pumping speed ~ 60 - 1200 m³/h are available
- Very robust and efficient due to frictionless operation
- Very high pumping rates – High loads
- Operational costs and maintenance requirement are low – High reliability required

Bearing Solution

- High precision ring geometry
- Rings specially heat treated to ensure low retained austenite levels, stable over high temperature ranges
- Cages material typically Stainless Steel ribbon riveted
- Super clean bearing steels used to ensure long fatigue life
- Hybrid design - good resistance to contamination (from gears)
- Ceramic balls used to ensure maximum oil film thickness and optimum tribological properties
- Special seal designs incorporated in the design
- Modular design – reduced customer parts count and simplified assembly
- Oil lubricated - PFPE

Turbo Molecular Pumps

- Turbomolecular vacuum pumps work on the principle that gas molecules, when struck by a solid surface, will move in a specific or deliberately biased direction.
- Operating pressures are in the high to ultra-high pressure range between 10^{-3} and 10^{-11} mbar, employing pumping speeds of between 10 and 4,000 l/s.
- Low vibration levels, quiet running requirement
- No down stream process contamination – no lubrication losses
- Cannot work at atmospheric pressure (require backing pump)

Bearing Solution

- Ultimate precision - controlled roundness and harmonic amplitudes of raceways
- Exceptional surface finish
- Bespoke designs and modular design possible
- Special low outgassing lubrication
- Ceramics balls for high speed operation and dynamic performance and long life
- Typical sizes: 4mm – 12mm bore diameters
- High cleanliness materials including SV30

Touch Down Bearings

- Used for various active magnetic bearing high speed vacuum pumps
- Often referred to as emergency support bearings and prevent costly catastrophic pump damage during magnetic bearing failure
- And support through critical speeds where the Magnetic bearings do not provide sufficient stiffness
- Extremely high acceleration from static to a speed of 2.5 million n · dm (Speed in rpm x PCD)
- Very unpredictable touch down forces

Bearing Solution

- Typically deep groove and angular contact bearings with full ball complements
- No cage – Due to extremely high accelerations
- Ring material SV30
- Si_3N_4 Ceramic rolling elements
- Very high capacity
- Solid lubrication
- High precision and controlled raceway roundness and harmonics
- Typically able to withstand 10 hard touchdowns

Design & Innovation

- Barden‘s reputation for excellence in pump bearing design and manufacture spans many decades of specialism in this field. We have developed precision bearings to accommodate the entire pump market.
- Barden works and develops bearing solutions with all manufacturers of vacuum pumps globally satisfying OEM & aftermarket requirements

Contact Barden for product availability, interchange of competitors part numbers, product enhancement and solutions to all new and existing applications

Development Support

- Engineering teams work alongside customers to develop unique designs to meet application requirements and solve functional problems.
  - Providing detailed calculations
  - Optimised geometry / bearing scaling to ensure low parasitic losses
  - High capacity design
- Products can incorporate specialised features designed to reduce assembly time, lower operating costs and improve performance
  - Flanges for precision / repeatable fitting
  - Anti rotation features to prevent ring procession where unbalance is difficult to eliminate
  - Extra bearing width to accommodate additional grease for extended life
  - Bearing calibration, allowing matched fits
- Ancillary component supply
  - Wave springs
  - Precision ground spacers

HQW Precision GmbH
Wachtelberg 23
97273 Kürnach
Germany

Tel: +49 9367 98 40 8-0
E-mail: info@hqw.gmbh
Internet: www.hqw.gmbh

The Barden Corporation (UK) Ltd
Plymbridge Road, Estover
Plymouth, PL6 7LH
United Kingdom

Tel: +44 (0) 1752 735555
E-mail: info@bardenbearings.co.uk
Internet: www.bardenbearings.co.uk