

Nichols Portland: The world's first manufacturer of gerotors continues to innovate

As the world's first manufacturer of gerotors and gerotor pumps, Nichols Portland has more than 85 years of continuous experience in the manufacturing, design, application, testing and validation of these products. Although Nichols Portland is known globally for its fluid transfer technology, the company also supports industries with a range of PM components. In this report, Randy Lessard, the company's VP / General Manager, reviews the history of Nichols Portland and discusses its commitment to producing precision PM components.

Beginning in the late 1920s, the W.H. Nichols Company became the world's first manufacturer of gerotors and gerotor pumps. Working in partnership with the inventor of the gerotor, W.H. Nichols patented the first equipment capable of commercially producing the highly complicated gear shape. The company then put its equipment to use producing the world's first gerotor pump for an oil burner application. The pioneering

spirit that introduced this product to the world is still alive and well, and for more than 85 years Nichols has been promoting and innovating the design of gerotors and gerotor pumps in everything from foam packaging systems to automotive traction control systems.

At the heart of all this is said to be a genuine passion for its customers, their products, and the markets they serve. For more

than thirty years Nichols Portland has had product development and product validation teams focused exclusively on helping its customers develop and validate their products. To that end, the company has developed testing facilities and engineering capabilities to the point where Nichols Portland can conduct most of the pump validation testing required by the major OEMs in-house.



Fig. 1 The Nichols Portland facility in Portland, Maine, USA

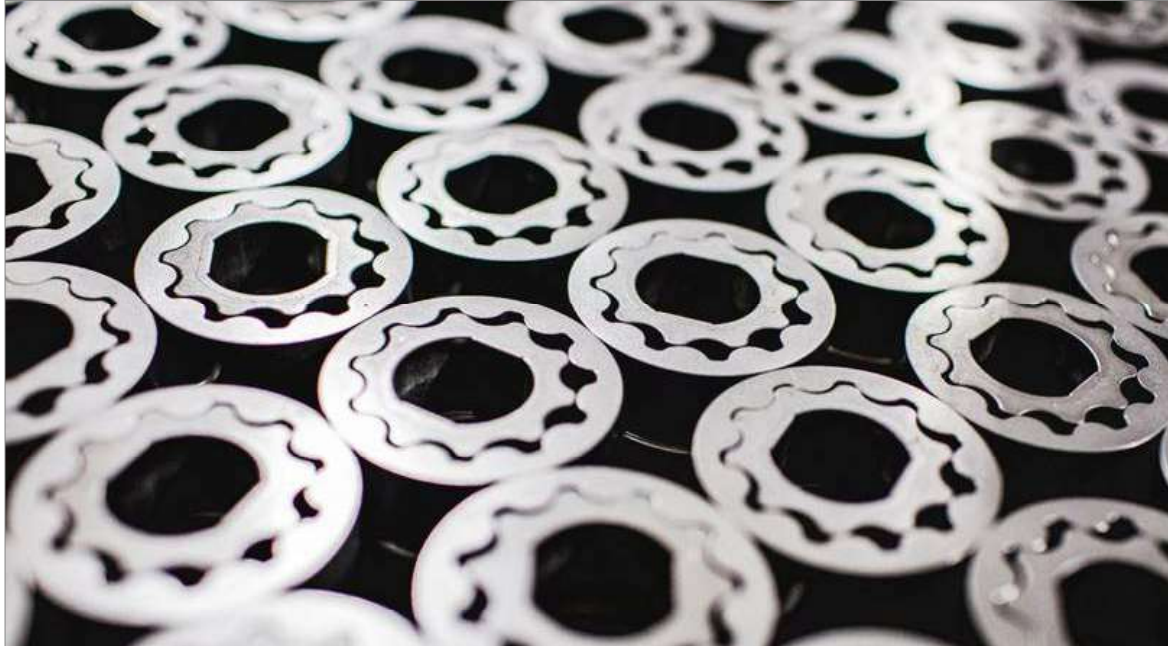


Fig. 2 Production of commercial PM gerotors began in the early 1980s

The company's interest in Powder Metallurgy dates to the early 1970s, when it recognised PM as a critical enabler in expanding the addressable market for its products beyond what was possible with traditional billet manufacturing processes. By the early 1980s, the company was awarded its first PM gerotor for a high-volume engine lubrication application. The decision to expand its product offerings to include PM manufacturing began a period of expansion and growth that continues to this day.

When Nichols was purchased by Parker Hannifin in 1984, Nichols Portland had divisions in Waltham, Massachusetts, Sturtevant, Wisconsin, Gray and Portland, Maine. While all the other locations focused on manufacturing pumps, the Portland Maine facility became the corporate home for gerotor manufacturing. The facility has been expanded many times over the years to support the inclusion of PM manufacturing and the global demand for PM gerotors in automotive applications. Nichols Portland is the only remaining entity carrying the Nichols name, as the other divisions were absorbed by other Parker operations.

A modern PM manufacturing facility

Today, Nichols Portland is a manufacturer and global supplier of Powder Metallurgy components, billet components, and niche pump assemblies for a wide range of platforms and applications. With two manufacturing facilities in Portland and South Portland, Maine, Nichols is continuing to expand into new markets and new applications.

With twenty-eight compacting and sizing presses ranging in size from 20 to 750 tons, and ten sintering furnaces, the company has the capability to produce a wide variety of shapes, sizes and material properties tailored to customer needs. In the coming months, NP will add four additional presses and another furnace. In addition to a state-of-the-art manufacturing line, the company offers:

- A large catalogue of standard product offerings to help smaller-sized customers find a product that meets their application requirements

- A team of dedicated application engineers which works with customers to design customised solutions to optimise application performance
- An advanced engineering team which provides computer-aided design and simulation support, utilising lessons learned from thirty-years of internally developed best pump practices
- A dedicated team to support its customers' product validation needs
- In-house tool and gage design and build, custom powder blending, heat treatment
- Automated part transfer, in-line crack detection and inspection, and end-of-line testing.

"Our business, originated in machined steel and cast-iron pump components, established a solid foundation for the extensive secondary machining capabilities that exist today," stated Rick Scott, Director of Engineering.

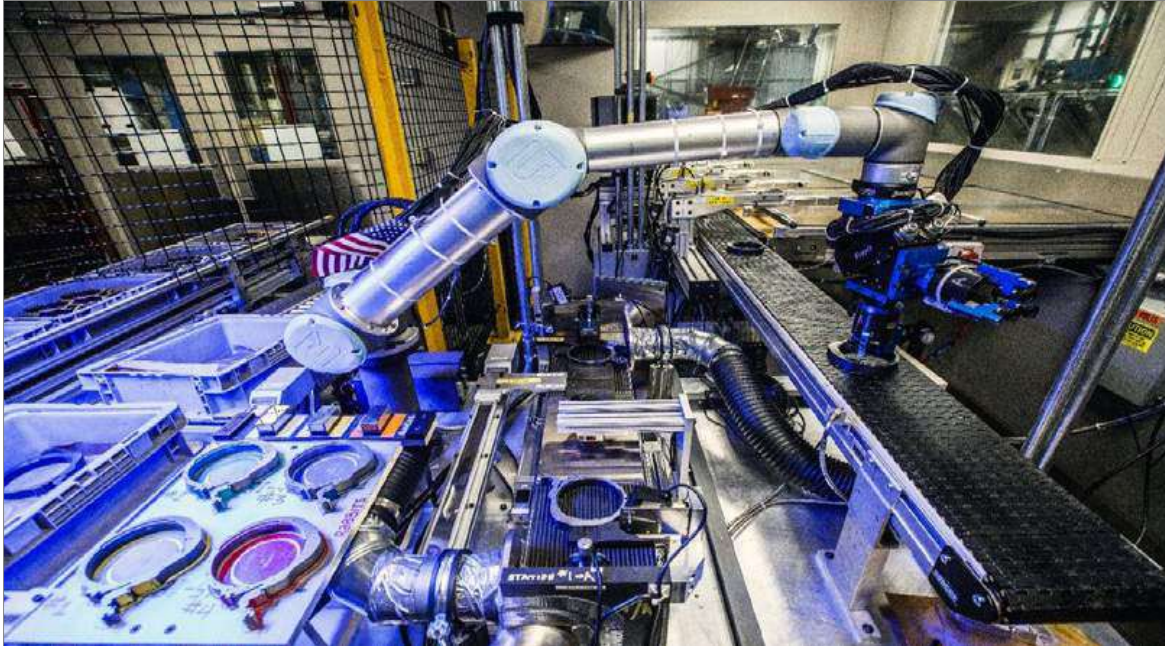


Fig. 3 Automation in the PM production line helps lower manufacturing time and increase speed to market

In-house secondary operations include heat treatment, surface treatment (including steam treatment and phosphate), CNC mill, turn, grinding, broaching, hobbing, hone and lapping.

"Having these in-house capabilities provides us with several competitive advantages, including a quick response time, complete dimensional control of the final product, and a cost-effective supply chain," added Stephen Madill, VP Sales & Marketing.

Working with its customers

Nichols Portland learned long ago that in order to be successful in the market place, it needed to provide its customers with system level solutions. For Nichols Portland, this means understanding the customer's applications to the point where they can act as a development partner.

"Our strategy is simple and steers our customers clear of any design-related problems. Our teams' extensive knowledge

and experience allows us to see red flags before they occur, resulting in a successful product for our customers," commented Glenn Mann, Product Engineering Manager.

Nichols Portland typically works with its customers during the advanced design stages of a programme. Its goal is to help customers avoid design related issues. This reduces the problem-related costs that are usually

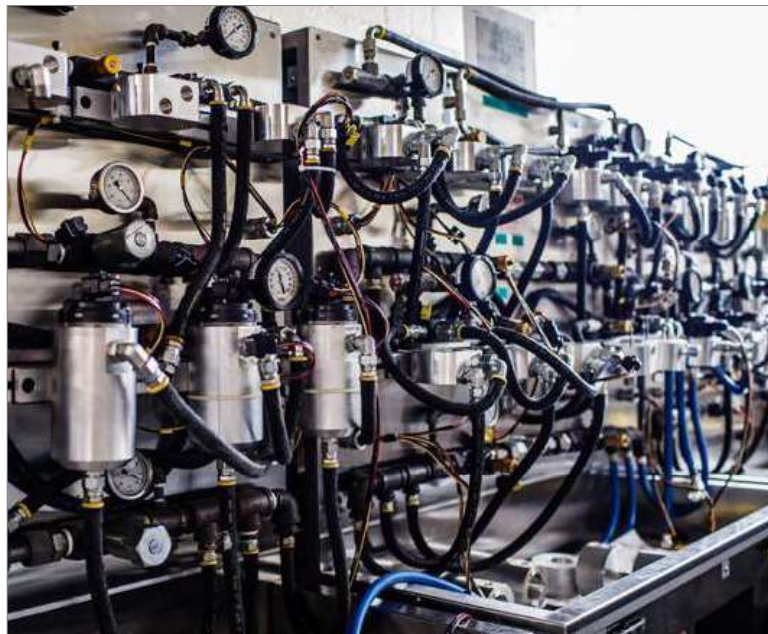


Fig. 4 Pumps are tested at Nichols Portland to ensure that components meet the high quality and performance expected



Fig. 5 Nichols Portland manufactures a wide range of PM components to high tolerances. Shown top is a VDP rotor, middle is a spur gear, bottom left a steel gerotor, bottom right a hubbed steam treated gerotor

not discovered until the testing and validation stages. The company does this by leveraging the accumulated experience of its application team, several of whom have been with Nichols Portland for more than thirty years. It has a large library of test data from benchmarking commercially available products in the markets it serves (Fig. 4). Quite often, that includes designing test fixtures and testing pumps in order to quantify performance, and the contribution of specific features to that performance. Nichols Portland's reports, which follow several SAE and ISO testing procedures, generally total more than one hundred pages.

Key products and applications

The products Nichols Portland produces can generally be classified into one of the following categories:

- Positive displacement pump components (gerotor, spur gear, crescent, etc.)
- Variable displacement pump components (bore rings, vane rotors)
- Structural components (plates, eccentric rings, etc.)
- Non-pump components (timing gears, speed sensors, VVT components, etc.)

Niche pumps

The company has design and simulation capabilities, and a library of test and analysis reports, for all types of pumps. "We also produce pumps for niche applications. Doing so helps customers who might otherwise be underserved by the market, and it provides us with a deeper understanding of the day to day issues customers go through. These experiences help Nichols Portland better serve all our customers," added Manasi Joshi Lakatos, Business Development Manager.

Gerotors

The word 'gerotor' was coined by the inventor of the gerotor, Myron Hill, and is a merger of the two words, GErated ROTOR (GE-ROTOR, or Gerotor). Made up of two components, a gerotor is a positive displacement device consisting of an inner and outer rotor. In most applications, the rotating action of the outer gear will trace the profile of the much more complicated inner gear. When done correctly, the two gears will roll past one another with very little sliding friction. This is one of the reasons that gerotors are known for their long life and smooth operating characteristics.

As the rotors rotate about their respective axes, fluid is drawn into an enlarging chamber that is created between the inner and outer rotor. As rotation continues, the chamber will reach a maximum volume which defines the displacement of the rotor set. As rotation continues, volume decreases, forcing fluid out of the rotors. This process occurs for each pumping chamber, resulting in a smooth pumping action.

Other products

Although Nichols Portland is best known for its gerotors, the company also makes PM components for just about every positive and variable displacement pump used in the automotive and on/off-highway industries (Fig. 5).

A recent success was the development of a PM rotor vane used in an high-performance automotive engine.

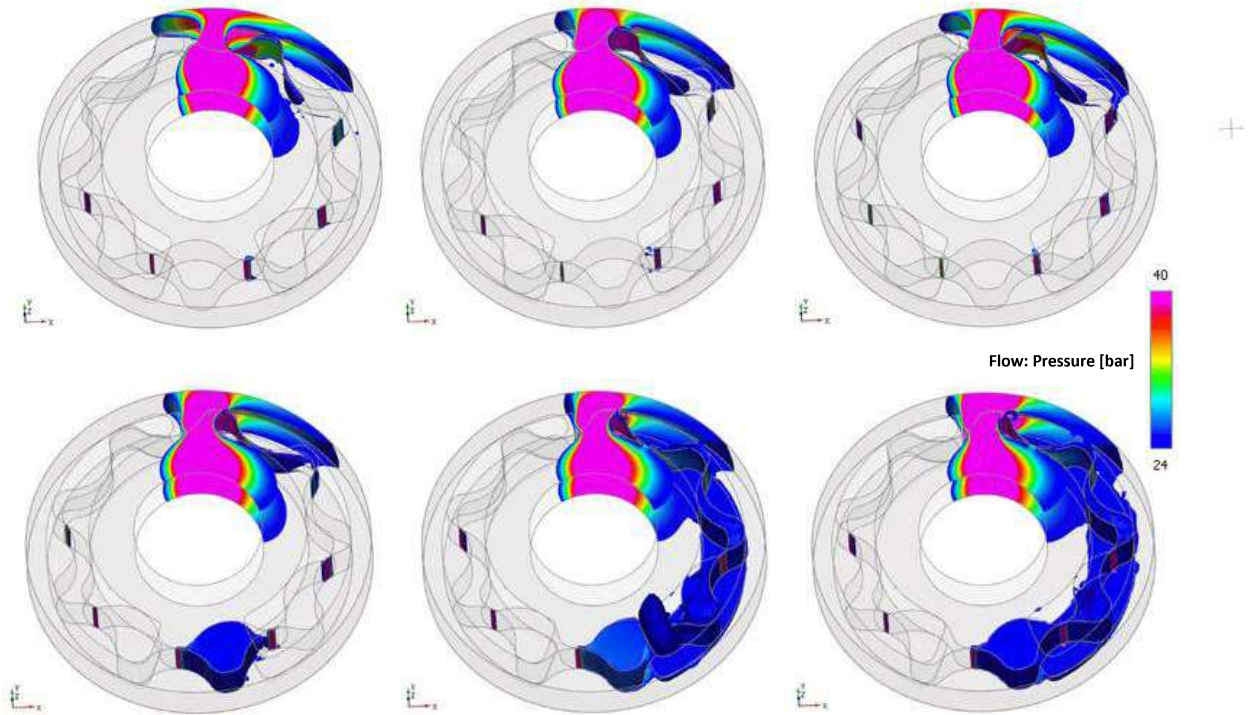


Fig. 6 CFD is used to identify the high pressure zone in this gerotor simulation

The company recently received a Metal Powder Industries Federation (MPIF) award of Distinction for this part in the association's annual PM Design Excellence Awards competition. The rotor vane is discussed in more detail on the following pages.

Improving products, supporting customers

Design support

Nichols Portland offers its customers two levels of application support; standard and advanced. Standard support is free of charge and includes recommendations for gear geometry, material selection, fluid porting, and internal pump clearances. The company also provides analysis of gear stresses, flow ripple, and power draw as a function of temperature, internal clearances, speed and fluid type.

Advanced support services include finite element analysis (FEA), computational fluid dynamics (CFD), and physical testing. FEA analysis can be conducted on either the gear or

the pump housing and can be used to predict how both can be expected to react to real-world forces such as fluid pressure and mechanically-induced vibration. CFD is a branch of fluid mechanics that uses numerical analysis and data structures to analyse and solve complex problems related to fluid flow (Fig. 6). It enables

the simulation of the free-stream flow of the fluid, including the entrained oil vapour and air, allowing users to predict aeration, cavitation, temperature rise, cooling capabilities, and valve resonance.

Over the years, many major automotive OEMs from around the world have contracted Nichols Portland's



Fig. 7 Nichols Portland has a wide range of in-house testing and analysis available to ensure components meet customer requirements



Fig. 8 The vane rotor is used in an engine lubrication system. Of importance is the accuracy of the rotor radial dimensions, ID spline and vane slot features

testing services for both advanced work and product development and validation testing. The company has developed the capabilities to conduct nearly every testing requirement of every major OEM. That includes valve and spring endurance testing, contamination resistance, thermal cycle, vibration, performance, and durability testing (Fig. 7).

Award winning components

As previously mentioned, a recent Award of Distinction in the 2019 MPIF Powder Metallurgy Design Excellence Awards was presented to Nichols Portland in the Automotive-Engine category for conventional PM components. The winning part was a vane rotor used in a lubrication pump for a high-performance engine (Fig. 8).

"The customer needed a very compressed product development timeline and approached Nichols Portland because of our reputation for producing consistent quality in a high tolerance part," added Rick Scott.

The rotor is a two-level component that must achieve tight tolerances on several features critical to the performance of the pump. In order to minimise the requirements for secondary machining, the tooling and process were targeted to minimise manufacturing variation. Process steps include compact, sinter, size, thickness grinding, deburring and cleaning.

The product application requires high accuracy of the rotor radial dimensions, the ID spline and vane slot features in order to reduce the pump's internal leakages and meet the long-life requirements.

High principle stresses from the compact pressures required the use of FEA analysis to refine the tooling strategy and construction methods in order to avoid premature tooling compaction failures. "In order to meet the critical spline perpendicularity requirements, we leveraged our machining knowledge to properly balance part holding during the grinding operation with our compaction control strategies," continued Scott.

The requirements for material projections (burrs) and cleanliness also necessitated special care during the tool cleaning and sharpening process in order to ensure burr free features during compaction.

The part application is highly sensitive to process variation and therefore has multiple features requiring critical process control. Rigorous application of the PFMEA process resulted in a carefully designed manufacturing process which allowed Nichols to achieve the Cpk requirements for the part.

"In order to be considered a success, we needed to satisfy multiple objectives including technical, manufacturing, and commercial feasibility. Our development of a highly capable and stable manufacturing process allowed us to achieve the tight manufacturing tolerances for most features in our PM processes. This allowed the customer to realise the full advantages of PM in driving their programme to a successful market introduction," stated Scott.



Case study: Niche Pump Assembly

This pump assembly was custom-designed by Nichols Portland. It is used in a foam packaging application.

The components require extremely tight positional and size tolerances to enable precise flow output at very high pressures and with little variation.

The assembly includes an application-specific gerotor, purposely designed for low rolling stresses. The entire pump also has surface treatments which support long life and robust journal bearings.



Case study: Niche Pump Assembly

This pump assembly was custom designed by Nichols Portland for use in the cooling of power electronics where extremely long-life in a very low lubricity environment is a requirement.

The specified fluid was R134a and R245fa. Flow requirements were 0.25, 0.5, and 2.6-gpm at 50-psig.

The solution included stainless steel spur gears, coated pump surfaces and a brushless DC motor and controller with variable speed control.

Future success

Nichols Portland has evolved many times since the late 1920s and plans to continue to do so. The company's leadership continues to focus on innovation and technology as drivers of success.

"Nichols Portland's utilisation of advanced technologies, such as artificial intelligence, robotics, and vision systems illustrates our vision for the future. Nichols Portland is a great example of bringing additional capabilities to the market, in order to be a solution provider and problem solver for our customers," stated Thomas K Houck, President and CEO of Nichols Portland.

With a reputation for precision components and a commitment to

delivering quality in the Powder Metallurgy process chain, the company is looking to build on its position as a leading supplier of fluid transfer devices.

"Our mission is to provide our customers with a positive vendor experience that is unequalled anywhere else in their supply chain. Nichols has been a standard when it comes to fluid transfer technology. Whether it is providing design input, highly precise PM or billet components, or niche pump assemblies, Nichols Portland has a global reputation for excellence. We look forward to utilising those strengths and expanding into adjacent markets in the Powdered Metal and Niche Pump space," concluded Madill.

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