



## Diesel Fuel Injector Application

“Above & Beyond Honing”



### Executive Summary

Sunnen Products Company was founded in 1924 in the U.S. by Joseph Sunnen, a man who was truly “ahead of his time” in many ways. His initial creative genius was geared toward the repair of automotive engines to improve the productivity of the automotive repair shops of his era. Over the ensuing years Joe sought to improve the performance of industrial manufacturing. This work led to the development of honing tools, gages, machines, and processes which obtain incredible accuracies! Today Sunnen Products Company is the world’s largest vertically integrated manufacturer of precision bore sizing equipment and tooling. With more than 700 employees worldwide and global Sales & Service through 50 distributors, Sunnen Products Company has become a leader in fully automated flexible honing systems for medium to high-volume production. Standard products are also available from the extensive Sunnen Honing Supplies catalog for high, medium and low-volume production. Sunnen Products Company delivers ‘*the best total solution*’ for our customers. No matter what the production requirements, Sunnen Products Company has a honing solution that is right for you – *all from one supplier!*

*Precision Abrasive Bore Sizing and Finishing Systems...Worldwide*



## **Application Summary – Fuel Injection Systems**

Sunnen Products Company has '*cracked the code*' for high volume fuel injector production! Diesel fuel injection systems require a precise fitting plunger within a cylinder to achieve the performance needed in today's demanding fuel system engineering designs. Roundness and straightness below 1 micron (.000040 inch) are routine, along with tight control over Rpk, Rvk, and Rk values for exceptional bearing surface texture requirements.

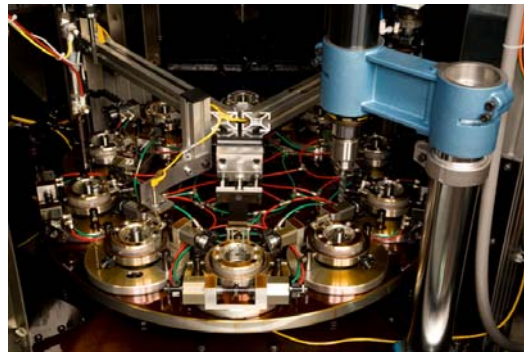
Fuel injection systems more precisely control the air/fuel ratio to achieve better engine performance, speed control, lower emissions, and better fuel economy. Fuel Injectors are used in gasoline and diesel engines to deliver a fine mist of air/fuel mixture into the engine cylinder. Diesel fuel is injected directly into the engine cylinder. As a result, diesel fuel injectors must be able to withstand the high temperature and pressure of the combustion process while delivering fuel in a fine mist to the cylinder. The extremely high pressures required by diesel fuel injection system designs are necessary to achieve complete atomization of the fuel-air mixture. This helps to obtain complete combustion of the carbon and hydrogen in the diesel fuel with the oxygen available, lowering emissions and improving fuel economy.

Several Diesel Fuel System manufacturers recently purchased complete turnkey honing systems from Sunnen Products Company. These systems automatically hone the fuel injector barrel with in-process air gauge feedback. The 3 step honing process involves a rough honing step, a semi-finish honing step, and a finish honing step. The 3 step process is used to generate a specific set of surface texture parameters needed for the proper function and product life required. Three honing columns are arranged around a rotary servo index table. A brushing station cleans the bore in the last position.

There are many designs of fuel injectors that have evolved as engine designs have been improved over the last several decades. The requirement that these injector designs have in common is that the fit of the piston and the cylinder must be precisely controlled. The degree of precision in the assembly has been increased as emission controls have become more stringent and operating pressures have increased. The surface texture characteristics of the cylinder bore are also precisely controlled to extend the life of the plunger and cylinder assembly before requiring service. The answer to both of these common requirements is "honing" – more specifically, Sunnen Products Company honing solutions.



## Diesel Fuel Injector Application



***The Sunnen Products Company 3 spindle solution to Diesel Fuel Injector production resulted in a 50% improvement in the production rate for the customer! 50%! Total savings per year of over \$500,000! WOW!***

The Diesel Fuel Injector manufacturer's goal is to produce injector barrels within close geometric tolerances (less than 1 micron /40 millionths roundness and straightness) with less operator skill at the lowest cost per part. Current designs use hardened alloy steel for the barrels and plungers. The plunger reciprocates without seizing during high pressure operation due to the precise fit of the two components and the control of surface texture. Expensive repairs are needed to replace a fuel injector that has seized in an engine. Fuel injectors that are prepared with the correct surface texture generated in the 3 step honing process run for many thousands of miles without failures!

This special surface texture generated is a "plateau honed" surface finish. Plateau honing involves a carefully engineered process combining the abrasive and tooling selection needed to generate a consistent and measurable surface texture result. The final honing step removes just enough material to simulate the break-in period that would result during diesel injector startup, only without the resultant wear within the cylinder bore. Plateau honing generates a surface texture that has a typical honing crosshatch pattern in the bore. In addition, Plateau Honing generates a surface texture with better load bearing characteristics and allows better lubrication along the cylinder bore surface. A similar process is used in the combustion engine cylinder design for automotive applications, and has extended engine life by thousands of miles per engine block!



The manufacturing process previously used to hone these hard steel diesel injectors required labor intensive honing operations. Typical production resulted in about 400 parts per shift. The machine previously used required the operator to constantly monitor the bore geometry results and make adjustments to the stroke position. The turnkey honing process from Sunnen Products Company produces 600 parts per shift with minimal operator adjustments – **a 50% improvement in production with better quality!** Assume the manufacturer produces fuel injectors on 3 shifts for the entire year. Assuming a 50 week year and 5 days per week, 300,000 fuel injectors are completed at 400 parts per shift. At 600 parts per shift, the 300,000 parts can be completed in just 33 weeks of 3 shift production! **Assuming labor costs of \$50 per hour (with fringe benefits included), a labor savings of \$230,790 can be realized on 300,000 parts! In addition, parts that would be scrapped on the existing process can be salvaged on the Sunnen system. This savings plus the reduced downtime saves more than \$300,000 per year! \$530,790 total savings per year! WOW!**

In many applications for fuel injectors the bore has annular grooves and cross holes that intersect within the bore. For other honing manufacturers these features present an extremely difficult problem to overcome. Sunnen Products Company, however, is a vertically integrated honing solution provider. The complete Honing System - Machine, Honing Tool, Honing Abrasive, Work piece Fixture, Gauging, and Coolant are all supplied by Sunnen Products Company. All these elements are combined into a honing system that can generate the desired tolerances automatically and unattended. The bore tolerances are less than 1 micron roundness (.000040 inch) and 1 micron straightness (.000040 inch). Production parts honed on the Sunnen Honing System are well within these tolerances, resulting in high Process Capability (**Cpk values over 2.3!**) with dependable production day-in and day-out!

## Summary

Sunnen Products Company is the world's largest vertically integrated manufacturer of precision bore sizing equipment and tooling. Our team of dedicated research and design engineers provides solutions for our customers. Providing solutions to improve the performance of our customers fulfills our corporate mission. Honing is applied to all materials from Alnico to Zinc! Diesel fuel injectors, no matter the size or material, can be processed on Sunnen Honing systems. Better production quality and lower costs are the result. Sunnen Products Company has the solution!

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