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Applying precision stamping to endoscopic-instrument shafts

An automated rotary table feeds the laser seam-welding machine.

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Challenging manufacturing stereotypes brings with it risks and rewards. Our company understood this in the late 1990s when we set out to develop a proprietary process that stamps tubing for endoscopic-instrument shafts on a progressive die, thereby allowing the addition of features such as slots and holes, while reducing part cost by as much as 75%.

These were hardly uncharted waters for us as we had for years applied the high-speed, low-cost process of precision metal stamping to the automotive and electronics industries. It was a natural for us to apply these techniques to the medical industry.

Over the years, we have continuously refined our design-for-manufacturability process. Each new endoscopic instrument program had its own set of challenges. New technologies bring additional risks and new instruments have different functional needs that require different features.

Fortunately, our dedicated prototype department helped facilitate part development by the fabrication of high-quality samples for testing. Tubing diameters from 3 to 10 mm were developed along with different features to accommodate various trocar sizes. Instruments with wall thicknesses from 0.010 to 0.030 in. were also developed.

Almost any feature found in traditional tube forming is now feasible using the stamping method. Examples include flats, strengthening ribs, lancing, coining, and embossing. Process improvements let us apply features in a length of tubing up to 16-in. long without adding significant cost.

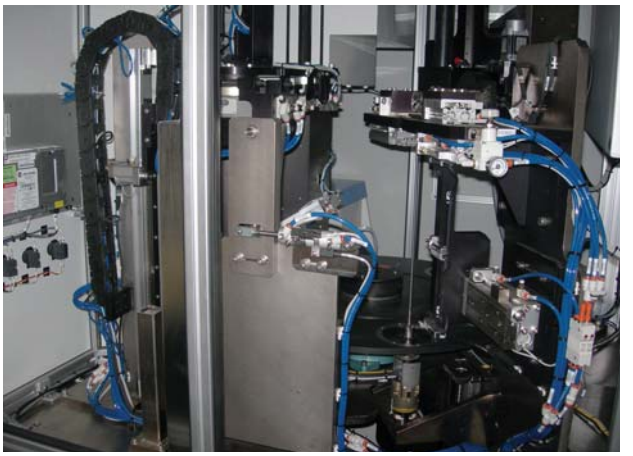
A downside we confronted to rolled tubing was its “seam.” Although seams were closed, the tubing could not be guaranteed to be air tight. This was problematic because in endoscopic surgeries the body cavity in normally insufflated with CO2 to provide working space for the surgeon. This pressure would tend to force body fluids up the tube and potentially escape the body cavity through the seam.

Until a few years ago, we addressed this problem by covering the tube with a piece of shrink tubing or spray-coating on a seal. This

corrected the sealing problem but added 0.010-in. to the tube diameter, thereby wasting valuable space needed for other instrument components. It also made retrofitting difficult because implementation into an existing instrument would require a redesign of its internal components.

Our approach to these problems combined metal stamping and laser welding. We conceptualized automated equipment that would laser-weld an entire 16-in. length of stamped tubing to seal the seam without adding thickness to the diameter. It's easy to see this was no simple task.

To prove feasibility, we fabricated large quantities of prototype samples eventually determining the optimum laser wattage, spot size, and feed rate. A major hurdle to overcome was the overall straightness of the tube. Welding imparts a stress to one side of the part causing a bow of up to 0.010 in., far above the 0.0007-in. maximum allowed. Also a concern: how to detect microscopic pin holes in the weld. Bench-top setups demonstrated the feasibility of a straightening station that included sensors and adjustability mechanisms to account for potential process variations. Leak-test equipment was also researched and tested.



The equipment automates the process of tube straightening and 100% leak testing.

After months of preliminary testing, the equipment was designed and built. Turntables automatically index parts to the laser-welding station where a full-length weld is done. The tubing then moves to the straightening station where it is straightened and 100% inspected. Finally it goes to the leak test station to inspect 100% for weld error.

This advanced rolled tube process probably does not make economic sense for many low-volume medical applications due to the relatively high capital cost. Other customers just want to get something quick to market to test acceptance. To meet these needs, we recently opened a new division that provides a lower initial capital expense and a reasonable part cost.

Currently Micro Medical Technologies is developing two new approaches. One approach uses Lean manufacturing techniques, with production slated for early 2010. The other is intended to further automate the welding process. Automation should drive costs even lower in anticipation of future pricing pressures that are probably inevitable.

A selection of shafts shows how the proprietary stamping method provides additional features such as holes. These parts have airtight laser welded seams.

EDITORIAL ADVISORY BOARD CONTRIBUTORS

Frank Jankoski is director of technical services for Micro Medical Technologies (Micro Stamping Group of Companies). He is responsible for all Research and Prototype activities and has extensive experience in the medical device industry, focusing on design for manufacturing and cost improvements. Included in those efforts is his feature topic this month, "Applying precision stamping to endoscopic-instrument shafts."

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