MANUFACTURING TECHNOLOGY, INC.

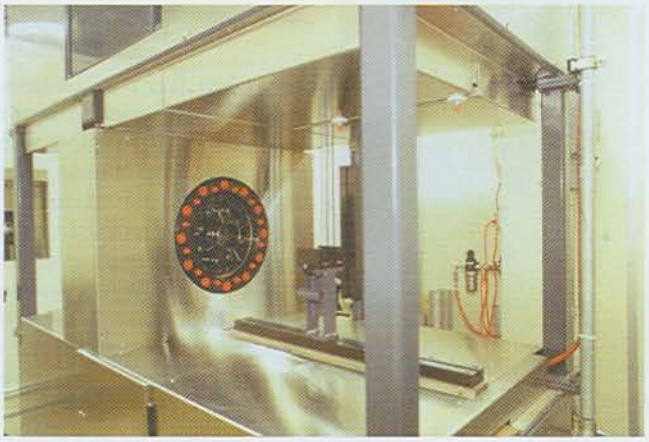
The magnetic impulse welding machine featured in the following article was the first of its kind, designed and manufactured by Manufacturing Technology, Inc. (MTI) in 1996. Although traditionally a manufacturer of inertia and direct-drive friction welders, MTI worked closely with Dana Corporation on this project. MTI and Dana scientist Dr. Boris Yablochnikov worked together at MTI facilities in South Bend, Indiana to develop this machine. MTI is continuing to further research and develop the magnetic impulse welding process and machines. MTI believes that this technology can compliment its own line of friction welders, and expand the opportunities for designers and engineers to develop creative solutions to their product challenges.

TECH BRIEFS

Magnetic pulse welding is Dana original

The big bang sound signals a ferrous and nonferrous material bond. "The new magnetic-pulse welding process allows us to weld steel and aluminum components to create a wide variety of innovative driveshaft designs," explains Jim Duggan, chief engineer of advanced design at Spicer Driveshaft Division, one of six units of Toledo, OH-based Dana Corp.'s Automotive Com-ponents Group.

A conventional weld adds a glob of melted material at the joining site. But the magnetic pulse welding process leaves no significant bump. Because the new welding method is without heat, there is less distortion of the shaft/tube. "The resulting connection is a metallurgical attachment that out-performs conventional MIG (metal inert gas) welding and other competing mechanical attachment processes," Duggan says.



The magnetic-pulse welding machine at Dana's Spicer Driveshaft Div.

When an intense magnetic field is created in a machine, large amounts of electrical energy are downloaded into a specially designed coil. As an example, an aluminum tube is inserted into the machine's mid-section through an open cylinder. When the aluminum tube enters the magnetic field, it collapses inward with enough force to weld itself onto a stationary component, such as a steel or an aluminum shaft.

With conventional welds, meeting performance characteristics for specific operating situations proved challenging. "Reliably joining different components to take advantage of each material's properties was difficult, and in some cases, impossible. This Dana-developed technology allows us to push the envelope on power transmission designs for passenger cars, light trucks, and sport utility vehicles," Duggan notes.

Variations of magnetic-pulse welding and magnetic-pulse forming are more than 60 years old, but the processes were limited to attaching small diameter capillary tubes for refrigeration applications or for mechanically connecting large diameter tubes to end fittings. "While the new magnetic-pulse welding process is truly a team success story, a great deal of the credit goes to Dr. Boris Yablochnikov, the Dana scientist who developed the lion's share of the new technology," Duggan says, adding, "Jerry Myers, also of Dana's driveshaft division, was instrumental in tailoring component and assembly designs to make the process a robust, practical manufacturing science."

The magnetic-pulse welding process can handle more than a million amps and up to 5000 volts of electricity to give the resulting weld super strength. "In testing, the tube failed before the weld. Right now, we're testing to see if that's a repeatable failure mode," says Kelly Moore, marketing communications manager for Spicer Driveshaft Division.

Developing a weld process for joining mixed or same materials is invaluable. "Steel components can withstand the high stresses associated with small diameter splines, and aluminum provides the advantages of light weight and corro-

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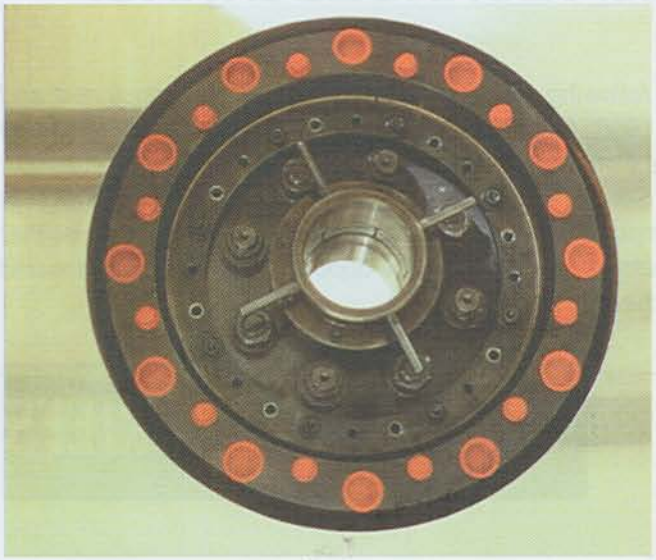
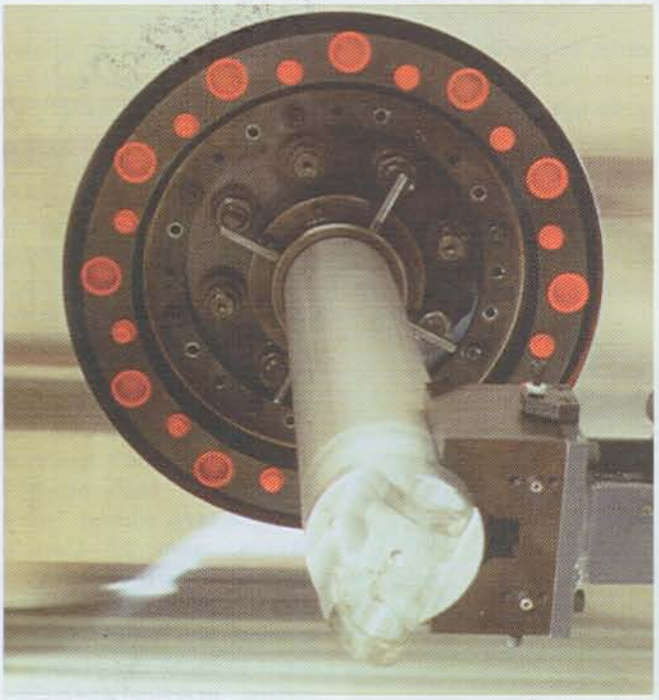
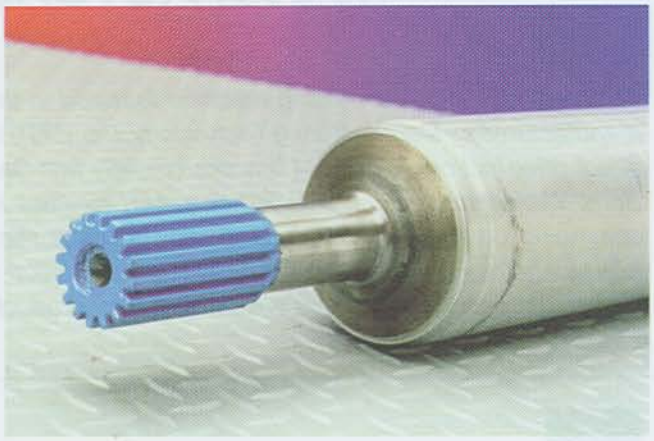


Midsection cylinder on the machine.



Cylinder with an inserted structural element.



A resulting steel to aluminum bond.

An aluminum to aluminum bond.

sion resistance. Marrying these materials with our improved magnetic- pulse welding process allows us to design lightweight, compact driveshafts with the best of both worlds," Duggan notes. Dana's Parish Division, based in Reading, PA, is using the magnetic-pulse welding process in prototype trials for structural pieces, such as automobile frames.

The National Institute of Standards and Technologies (NIST) in Gaithersburg, MD, awarded Spicer Driveshaft a $2 million grant via its Motor Vehicle Manufacturing Technology focus program. "When we evaluated this proposal, we viewed it not just from a scientific and technical point of view, but from a business/financial/economic point of view. The magnetic-pulse welding process has the potential to be an application of choice as it's a very quick way to join dissimilar metals," says Jack Boudreaux, program manager for the advanced technology program at NIST (which is part of the U.S. Department of Commerce).

The manufacturing welding process also has application implications for nonautomotive industries. "Automotive frames, the chassis, and certain other body parts can be made of peculiarly shaped tubular elements, but any tubular application can benefit from this process," Boudreaux says.

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