

## Geared Up for Better Welding Productivity

HORSBURGH & SCOTT INCREASES PRODUCTIVITY BY 20% WITH LINCOLN ELECTRIC



Horsburgh & Scott welders Barry McDowell (front) and Dave Evans (back) create fabricated gears from three components—the outer ring, from which the gear teeth are cut; the inner hub; and the internal webbing that acts as the spokes of the wheel.

**W**hen Horsburgh & Scott needed to increase productivity to keep up with demand for manufacturing large industrial gears, the company's engineering team took a hard, close look at its current operations. After review, the team found opportunities for improving productivity in its welding stage.

When fabricating gears with diameters of 20 feet or more, turnaround time for the Cleveland, OH manufacturer can run 6–10 months. And, with backorders of two years or more, the company realized faster welding productivity would translate into greater throughput.

To resolve the issue, Horsburgh & Scott turned to The Lincoln Electric Co. and its Power Wave AC/DC 1000 inverter power source for submerged arc welding. With one Power Wave now in use, the 120-year-old company has seen a 20% jump in welding productivity after eight months with the new equipment. Horsburgh & Scott plans to add a second Lincoln Power Wave in tandem process for further productivity gains.

“We needed to keep pace with the rest of the plant, and we really wanted to avoid outsourcing any of the welding work,” says heat treatment manager George Kiss. “This equipment works well for us and has helped increase production throughout the entire facility.”

### Unique Challenges

The massive open gears weigh up to 60 tons each. They are used in steel mills, sugar refineries and other heavy industries throughout the world. Costing  
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Horsburgh & Scott uses Lincoln Electric's Power Wave AC/DC 1000 power source with Power Feed 10A for submerged arc welding.

# CASE STUDY



Barry McDowell (left) and Dave Evans (right) welding one of Horsburgh & Scott's gears. When finished, these massive gear blanks can weigh 60 tons and have diameters of 20 feet.

upward of \$1 million each, they are assembled from three components—the outer ring, from which the gear teeth are cut; the inner hub; and the internal webbing that acts as the spokes of the wheel.

Much of the welding time is consumed by attaching the ring and the hub to the web plates. This process, which includes prep work and bringing in needed materials, can last four to six weeks before the gear is moved to machining, where the teeth are cut from the outer ring. With some 10–40 weld passes per side, each gear is a custom job. Each job requires a unique setup and must be certified to ASME Sec. 9 D1.1 standards.

To allow the welds to set slowly and consistently, spot-welded gears are pre-

heated in a box oven and then kept hot with gas torches throughout the final welding process. The temperatures vary depending on gear size and the type of steel, but exact specifications remain closely held trade secrets.

After the gears are heated to their desired temperatures, they are set on a rotating table and tilted for circumferential welding. Each gear is turned at the rate of the weld, which varies based on the job. Steel welding wire of 1/8" is generally used on larger projects, with steel alloys that include 4140, 4320, 4130, 4340 and 4330 and AISI materials.

Both edges of the webs are beveled in J grooves for increased deposition and contact. The steel can range in thickness up to 3", and because the welds are

always circular on the inside diameter of the gears, unique issues arise.

Welding the inside of a large circle at high temperatures can cause the outer ring to pull away from the webbing, compromising fit and specifications of the overall project. To overcome this, a high level of deposition is required, and control in amperage and travel speeds is tightly monitored.

"Uniformity and consistency are very important," Kiss says. "Most people weld on a straight line, but when you're welding in a circle, it presents new, unique issues."

## Welding Versatility

The Power Wave AC/DC 1000 produces a variable AC output, as well as straight DC positive or DC negative

output. The software-driven capabilities help controllability and, ultimately, welding performance. With Lincoln's Waveform Control Technology™, a Lincoln Nextweld® innovation, electronic regulation circuitry is used to control and shape the welding output waveform. As a result, a number of welding parameters can be tailored to each application.

Another challenge for Horsburgh &

Scott is an unusual collection of flux on the weld. Because the weld is always on the inside diameter, the angle creates a funnel effect, which collects flux around the weld, making it harder to break away after the weld has set. Careful adjustments to controls and travel speeds help resolve this issue as well.

Horsburgh & Scott had been using a DC 1000 amp welder before acquiring the Lincoln Power Wave AC/DC 1000.

The submerged arc welding in AC is considerably faster and offers a higher deposition rate, Kiss says.

The Power Wave AC/DC 1000 was designed as part of a modular welding system for single- or multiple-arc applications targeted at submerged arc welding. It is rated at 1000 amps for AC or DC. Each welding arc can be driven by a single machine or by a number of machines in parallel. For example, two

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George Kiss, chief metallurgist, and Ken Lonsberry, director of manufacturing, were able to increase welding productivity by 20% and reduce a two-year bottleneck at Horsburgh & Scott.

# CASE STUDY



Horsburgh & Scott, a 120-year-old company, manufactures gears used in steel mills, sugar refineries and other heavy industries throughout the world

machines can be used to produce up to 2000 amps at 100% duty cycle. At the same time, each Power Wave 1000 achieves a 95% power factor with 86% efficiency for lower electric operating costs.

The AC waveform can operate at any frequency between 0 and 200 hertz. Dialing in the frequency helps stabilize the arc. The amplitude and duration of positive and negative cycles are independently adjustable for bead shape control, higher deposition rates and lower heat inputs, helping Horsburgh & Scott maintain consistent welds despite their traditional issues with distortion and expansion.

Parameters of the AC/DC 1000 can be controlled and regulated automatically, and the machine actually makes synergic adjustments during welding. A variety of operating modes can be used to favor high deposition rates or high travel speeds. For multiple-arc setups, any phase relationship can be achieved between the output waveforms, regardless of the input connection.

## Remote Monitoring

Since acquiring the AC/DC 1000, Horsburgh & Scott has also taken advantage of Lincoln's *Production*

*Monitoring* software, which enables welder Ralph Mustachio to monitor weld data from his personal computer or handheld device. From an office away from the shop floor, he stays connected to welding data to ensure systems are working properly and the waveform is maximizing productivity for each job.

The software monitors wire feed speeds, amperages and other weld records. It can store and share files, monitor production tasks, set weld limits and tolerances and track consumable inventory. Welding machine faults can be logged and e-mailed, while diagnostic troubleshooting can be performed from any remote location.

Mustachio can set welding limits from his office, collect and store long- and short-term weld history, execute actions or develop communication alerts when out of limit. He can pinpoint work shift issues and evaluate production cycles and output using work shift timers and production reports.

"I really like the advantage of the production monitoring software," Mustachio says. "This has been a big help to our productivity, and when we add a second machine, we can interface both together

and compare results side by side."

Horsburgh & Scott now projects that it will grow its business by 10% per year. The \$40 million company employs 190 workers.

A 20% gain in welding productivity will likely enable the company to achieve its annual growth goals, company officials say.

"We are very pleased with how this has worked out," Kiss says. "We are very committed to providing our customers with the best products and service available, and these changes help us accomplish that." ■

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