

SUCCESS

**LINCOLN**  
**ELECTRIC**  
THE WELDING EXPERTS®

WAVEFORM CONTROL TECHNOLOGY®

# AC/DC Submerged Arc Welding

Manufacturing

Horsburgh & Scott Company of Cleveland, Ohio

The Horsburgh & Scott Company, a 120-year-old Cleveland, Ohio-based company, specializes in the manufacture of large industrial gears used in steel mills and sugar refineries throughout the world.

## - CHALLENGE -

Reduce up to two years of backorders.

## - SOLUTION -

- The Lincoln Electric Company's® Power Wave® AC/DC 1000™ power source with Waveform Control Technology® for submerged arc welding.
- Lincolnweld® L-61® submerged arc wire and 860 flux.

## - RESULTS -

- **A 20% increase in welding productivity** significantly reduced the welding production bottleneck.
- **50% total increase in productivity** is expected with the acquisition of a second Power Wave® AC/DC 1000™ and should resolve the backorders and eliminate the need to outsource.



**W**hen Horsburgh & Scott needed to increase productivity for manufacturing large industrial gears to keep up with demand, their engineering team took a hard close look at their current operations. After review, they determined that the welding stage in its current state could use some improvement.

When fabricating gears with diameters upward of 20 feet, turnaround time for the Cleveland, Ohio, manufacturer can run six to ten months. And, with backorders of two years or more, the company realized faster welding productivity would translate into greater put-through.

To resolve the issue, Horsburgh & Scott turned to The Lincoln Electric Company® 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,” said 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 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.

The future of welding is here.®

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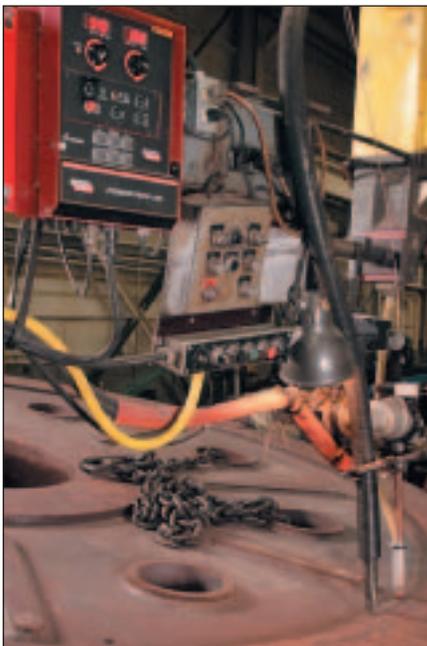
Manufacturing

Horsburgh &amp; Scott Company of Cleveland, Ohio

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 to 40 weld passes per side, each gear is a custom job, so no two projects are the same. 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 laid on a rotating table and tilted for circumferential welding. The gear is turned at the rate of the weld, which varies based on the job. Steel welding wire of 1/8-inch is generally used on larger projects, with steel alloys that include 4140, 4320, 4130, 4340 and 4330 and AISI materials.



**“We’ve been very pleased with this system and I anticipate this equipment will continue to perform well for the next 10 to 20 years”**

Both edges of the webs are beveled in J grooves for increased deposition and contact. The steel can range in thickness up to three inches, 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 up 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 said. “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 Electric® 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 issue 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 added.

The company’s welding team said Lincoln® representatives have helped customize the parameters to specifications.

The Power Wave® AC/DC 1000™ was designed as part of a modular welding system for single or multiple arc

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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 machines can be used to produce up to 2000 amps at 100 percent duty cycle. At the same time, each Power Wave® AC/DC 1000™ achieves a 95 percent power factor with 86 percent 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 Power Wave® 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 or high-travel speeds. For multiple arc set ups, any phase relationship can be achieved between the output waveforms regardless of the input connection – to reduce arc blow and virtually eliminate traditional Scott connections.

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**“We weren’t as happy with other brands. This equipment has performed very well for us, and it’s extremely versatile”**

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## Remote Monitoring

Since acquiring the Power Wave® 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 Palm® operating system 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.

They monitor wire feed speeds, amperages and other weld records. They 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.

Welder Ralph Mustachio can set welding limits from his office, collect and store

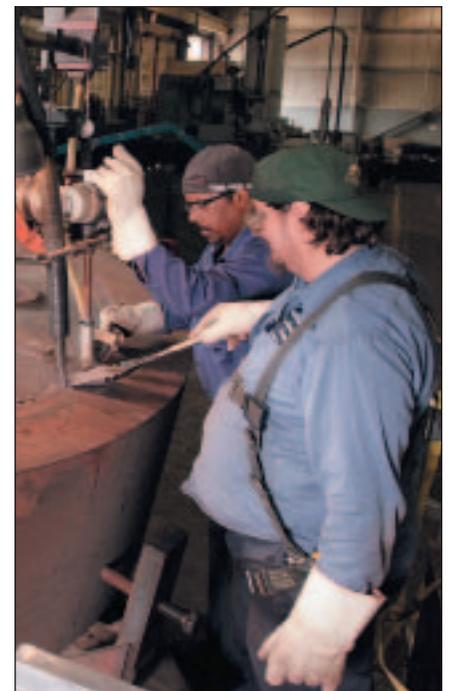
long- and short-term weld history, execute actions or develop communication alerts when out of limit. He can pinpoint work shift issues and evaluate production cycles and output using work shift timers and production reports.

“I really like the advantage of the production monitoring software,” Mustachio said. “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 percent per year. The \$40 million company employs 190 workers who have carried on a tradition of quality for more than a century.

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

“We are very pleased with how this has worked out,” Kiss said. “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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Automation

Horsburgh &amp; Scott Company of Cleveland, Ohio

## Featured Lincoln® Products



### Power Wave® AC/DC 1000™

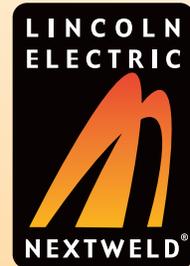
The Power Wave® AC/DC 1000™ is the first power source to introduce Waveform Control Technology® to submerged arc welding. Variable frequency and amplitude AC, DC positive or DC negative output allows the user to control the deposition rate and penetration. An operator can increase weld speeds, yield higher quality welds and improve efficiencies in a single or multi-arc environment. The phase angle and frequency of different machines can also be synchronized to balance the interactions between multiple arcs and minimize arc blow. Depending on the output, a welding arc may be driven by a single machine or multiple machines in parallel for applications that require more than 1000 amps of continuous operation.

Order K2344-1

### WHAT IS NEXTWELD®?

The challenges facing industrial fabricators today are growing in number and complexity. Rising labor, material and energy costs, intense domestic and global competition, a dwindling pool of skilled workers, more stringent and specific quality demands all contribute to a more difficult welding environment today.

Through our commitment to extensive research and investments in product development, Lincoln Electric® has established an industry benchmark for



applying technology to improve the quality, lower the cost and enhance the performance of arc welding processes. Advancements in power electronics, digital communications and Waveform Control Technology® are the foundation for many of the improvements.

NEXTWELD® brings you a series of Process, Technology, Application and Success Story documents like this one. NEXTWELD® explains how technologies, products, processes and applications are linked together to answer the important questions that all businesses face:

- How can we work faster, smarter, more efficiently?
- How can we get equipment and people to perform in ways they've never had to before?
- How do we stay competitive?

NEXTWELD® is the future of welding but its benefits are available to you today. Ask your Lincoln Electric® representative how to improve the flexibility, efficiency and quality of your welding operations to reduce your cost of fabrication.



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