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ARC MAGAZINE

Publisher
publisher@arcmagazine.pub

Editor
John C. Bruening
editor@arcmagazine.pub

Art Director
design@arcmagazine.pub

Advertising Manager
advertising@arcmagazine.pub

Entertainment Liaison
Scott Skrjanc

Digital Media Manager
apps@arcmagazine.pub

Circulation Manager
circulation@arcmagazine.pub

Production Manager
reprints@arcmagazine.pub

Designers
Brian Kitko
Travis Lefelhoc
Daniel Cromaz

facebook.com/LEArcMedia

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CONTRIBUTORS

John C. Bruening **Writer**

John C. Bruening is the editor of *Arc Magazine*. His career as a writer and editor spans three decades and a range of specialties: industrial safety and health, scrap metal processing, architecture and construction, music, film, the visual arts, history and various segments of the pop culture spectrum. Along the way, his feature writing has scored awards from the Society of Professional Journalists and the American Society of Business Press Editors.

Jimmy **DiResta** **Fabricator**

Jimmy DiResta is a New York-based artist, designer, master builder and video producer. His work has been showcased on Discovery Channel, HGTV, DIY and FX, as well as YouTube. His goal is to educate and inspire people to embark on their own home projects in an entertaining way. His unique builds are comprised of many different materials and processes. With his artisan skills and a shop full of power tools, he lets the build process speak for itself.

Mark **Prosser** **Instructor**

Mark Prosser is a Certified Welding Inspector/Educator (CWI/CWE) who has taught at the college level for 11 years. He has welded in the automotive and motorsports industries, for a governmental contract shop, and on high-pressure chemical piping and aluminum tubing. Mark has authored numerous instructional books, including *Full-Bore Welding* and *Full-Bore Sheet Metal*, both of which he co-wrote with Bryan Fuller.

Karl Hoes **Instructor/Welder**

Karl Hoes is a former welding instructor at Lincoln Electric, where he taught many aspects of the company's welding school curriculum, including basic and advanced motorsports classes. He has trained welders and instructors at multiple welding schools and national union training programs across the country. Karl is a Certified Welding Inspector/Educator (CWI/CWE).

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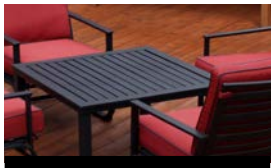

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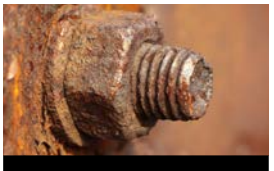

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LETTER FROM THE EDITOR

OBSTACLES AND OPPORTUNITIES

It's only early June as I write these words, but I'd already bet that 2020 will go on record as one of the most unusual and challenging years of the past century.

We all know the story because we've all been living it in some way or another. A global pandemic prompted statewide lockdowns throughout much of the country and the world during the spring, creating economic and operational challenges to small businesses and major industries alike.

But we here at Lincoln Electric – and welders, fabricators and related trades and industries around the country – have risen to the challenge. We've demonstrated that we are essential businesses by providing powered air purifying respirators and other PPE to help promote clean air and safety in the workplace. Many companies and organizations have used our equipment to build impromptu hospitals and medical facilities in areas experiencing high rates of infection. Together we've kept the manufacturing sector – and the economy in general – moving forward at a time when other business were at a standstill.

Even on an individual level, we've dug deep and found some good in all this. Many of us have enjoyed a rare opportunity to spend more time in our homes with our families. Maybe we're reflecting a bit on who we are and what we're about – as individuals and as part of a larger community. Maybe we're finding ways to reconnect with the things that are important – and let go of some of the things that aren't.

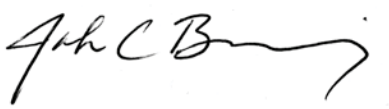
And yes, maybe this seemingly upside-down moment in time has prompted some of us to find meaning by tapping into our creative side and pursuing some of those projects we'd been putting off for the last several months – or maybe the last several years.

The second half of 2020 will likely present continued challenges, and the end game to all of this may not be clear at the moment, but one thing is certain: we will endure. We'll weather the storm and get through it, not just as individuals but as a nation and as citizens of an interconnected world. And we will be stronger and better for it on the other side.

We here at ARC are ready to help in any way we can. We're scaling back our publication schedule to two issues a year – and you might occasionally see us revisit some high-quality content from five years' worth of archives – but we'll continue to bring you stories about people and organizations that face challenges head-on and push the limits of what's possible. One of those people is gold miner Emily Riedel, the subject of this issue's cover story, who headed north to the Bering Sea off the coast of Alaska in 2011 in search of a summer job. She overcame some tough obstacles, and in the process, she turned that summer job into a high-profile and profitable career that continues nine years later.

Riedel's story is a perfect example of what discipline, patience and persistence can accomplish in the midst of seemingly overwhelming adversity. What better life lesson at a time like this? We can't promise that there will be gold waiting on the other side of the current struggle, but we're confident that better days are ahead.

Hang in there.



— John C. Bruening, Editor-in-Chief
Editor@arcmagazine.pub

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QUESTION MARK

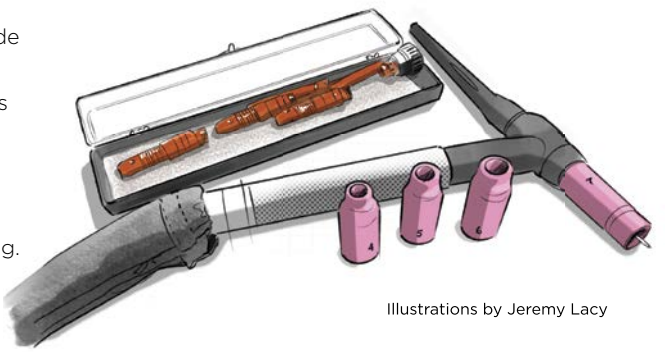
ARC taps into the vast experience of veteran tradesman, educator and author Mark Prosser (CWI/CWE). In addition to many years as a welder for the automotive and motorsports industries, Mark has also spent the last 15 years teaching welding at the college level, where he fields challenging questions from his students every day. He shares some of those questions – and his answers – with *ARC* in every issue.

What does the number on my TIG torch nozzle mean?

Most TIG torch nozzles – or cups, as they are commonly called – are marked with an identification number. This number represents the inside diameter of the cup in 1/16-inch increments. For example, a number 5 cup has a 5/16-inch inside diameter. Cups come in various sizes, shapes and configurations for many different applications.

Cup selection is important because we always want our welds to be free of atmospheric gas contamination. Selecting the proper cup depends on a couple factors, including the type of joint you are welding. A multilayer weld may require a smaller cup, one that can fit further down into the joint and a larger nozzle as the joint is filled to protect the weld. The type of material being welded can also have a bearing on the proper cup selection. For example, any of the nickel-based materials – such as stainless, titanium, Inconel – require a great deal more protection from the air, so larger cups are used to deliver more gas to the area.

The important thing to remember is that larger cups deliver a higher volume of gas. Keep in mind that this doesn't work the same way as turning up the pressure with a small nozzle. Larger cups deliver more volume of gas, not more pressure.



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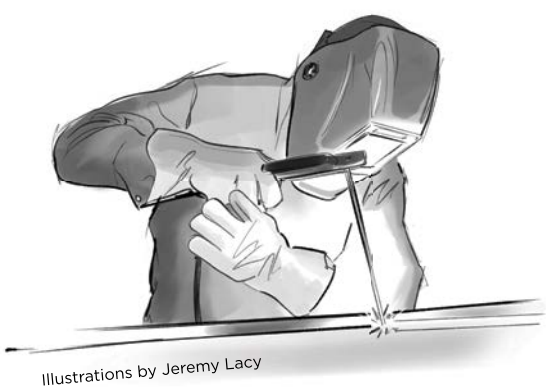

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Is stick welding as versatile as other welding processes?

Contrary to popular belief, stick welding – or shielded metal arc welding (SMAW) – is still a widely used and versatile process. When people think of stick welding, they usually think of pipeline welders, but various types of materials can be welded via the stick process. Stick electrodes are made in many different sizes, from 1/16-inch up to massive electrodes. The small electrodes can be used for thin materials – and even sheet metal, if the operator is sufficiently skilled. Electrodes are made for different steel types, castings, stainless steel and even aluminum.

However, stick welding does have drawbacks. It requires the added step of slag removal after the welding is finished, and it's a slow process in comparison to MIG welding. But the advantage to stick welding in many applications is that it produces a clean, strong weld. The flux helps to clean the weld, but more importantly, it allows the weld to cool in the protection of the flux.

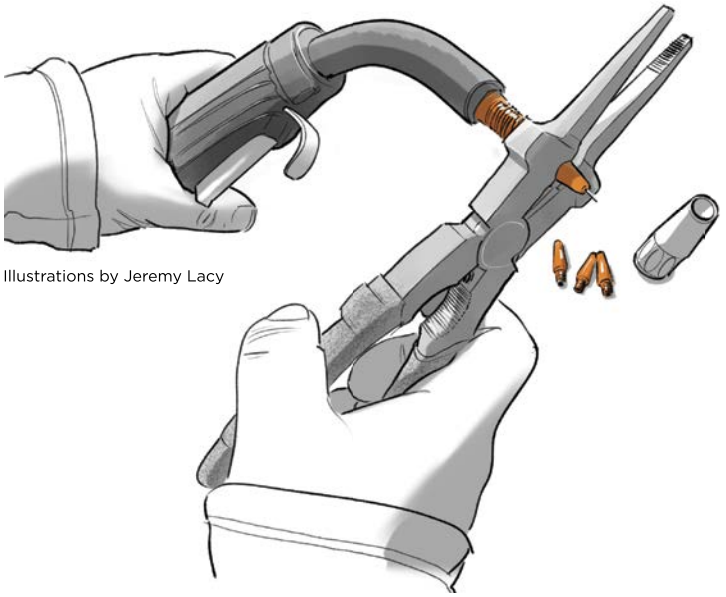
As always, much depends on the knowledge and skill level of the operator. In the right hands, that old stick welder sitting in the corner of the shop can do a lot of different types of welds on many different kinds of material.

I can't seem to get my MIG welder dialed in. What could be causing the difficulty?

When your welding machine performs well for many months, then suddenly becomes difficult to get dialed in, it's usually due to a lack of maintenance. Welding machines are exposed to shop dirt, grinding dust (metal particles) and in many cases, a lack of proper care. They require maintenance like any other piece of equipment.

It may be hard to believe, but the most common piece of equipment to cause a welding machine to be finicky is the contact tip. It can be that simple, and yet it is often overlooked. Remember that the contact tip is where the electrical connection is made to the electrode. The contact tip energizes the wire, and we know tight connections need to be made for electricity to work the way it's supposed to. But contact tips will ultimately wear out, and then must be replaced. That's why the tip is called a consumable. The contact tip can look fine in a quick visual inspection, but it can also be worn just enough to create a loose connection to the wire, which can create a variety of issues and problems.

In the end, there can be many reasons why you can't dial in your welder correctly, but the contact tip is a good place to start.



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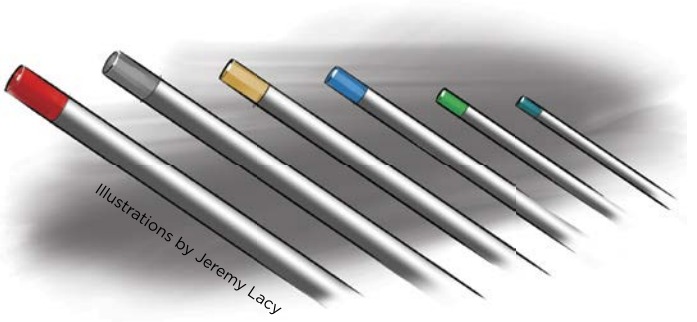
Why are there so many different sizes of tungsten electrodes?

Tungsten electrodes are manufactured in various diameters ranging from .40 of an inch up to ¼-inch for different applications. If we follow the general rule of 1 amp per thousandths of an inch of material thickness, we can more easily understand what size tungsten to use. Each diameter of electrode has an amperage operating range, and these ranges typically overlap.

The thicker the material, the more amperage needed and the larger the electrode needed. For thin materials, a smaller tungsten will initiate the arc at lower amperages. The tungsten will maintain a more consistent arc at lower amperages, which gives the welder more control of the arc on thin materials.

Larger tungsten requires more amperage to ignite and maintain a smooth arc. The best general size tungsten for small shop applications is 3/32-inch. This size is ideal for welding up to the 200-amp range, and works well on thin materials too. If the tungsten is too small, it will continually burn away and constantly need to be sharpened. At that point, it's time to move to the next larger size.



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Keep in mind that your welds and welding projects will always go more smoothly if you take the time to do a little research and find the most appropriate tungsten size for your application.

Gold Standa

EMILY RIEDEL ANSWERS THE SIREN SONG AND PURSUES A DREAM IN THE DEEP

STORY JOHN C. BRUENING | PHOTOS JOSHUA VELDSTRA

99.9

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Emily Riedel has spent the last decade digging deep to find her destiny. And when she does find it, she's fiercely committed to holding it in her own hands.

Riedel is one of the original cast members of *Bering Sea Gold*, the long-running reality TV series on the Discovery Channel. Created by the makers of *Deadliest Catch*, an equally popular show about crab fishing adventures in the same part of the world, *Bering Sea Gold* follows a fleet of miners who take their boats out to the shallow waters off the coast of Nome, Alaska, on Norton Sound to dredge the seabed for gold.

Now in its twelfth season, the show is divided according to the region's two dredging seasons: the summer season, which airs in the spring, and the winter season – with the modified title of *Bering Sea Gold: Under the Ice* – which airs in the mid-summer.

Separate and apart from the acquisition of the gold itself, the journey chronicled in *Bering Sea Gold* has been a life-changing experience for Riedel – one with plenty of challenges and setbacks as well as triumphs. The life lessons she's learned and the wisdom she's picked up along the way are things that no amount of precious metal can buy.

Emily Riedel is one of the original cast members of *Bering Sea Gold*, the long-running reality TV series on the Discovery Channel.

"Life is what happens when you're making other plans," says Riedel, borrowing a well-known quote from John Lennon. "I really expected to do just one summer in Nome."

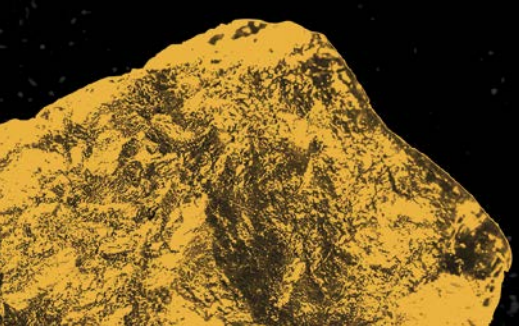
She'd earned a graduate degree in vocal performance from The North Carolina School of the Arts in 2010. A year later, during the summer of 2011, she was looking for a way to make enough money to attend graduate school in Europe. Given her family roots in Alaska, a place with plenty of unconventional but lucrative job opportunities – including gold mining – Nome seemed like a good place to start.

"A lot of people assume that I have some kind of gold mining history in my family," says Riedel, who grew up in Homer, Alaska. Her father was actually a bush pilot who did surveying work in Prudhoe Bay before he became part of the *Bering Sea Gold* team in the show's first season, and her mother is a music teacher. "I hear those things and I say, 'Nope. I was just a broke post-grad with no experience on boats, no experience with gold.' I just had this far-off fantastical notion. I just went up there to make some money for school."

One summer job has stretched into eleven seasons of television with a steep learning curve. She started out as diver, but her first day of diving off fellow miner Zeke Tenhoff's dredge ended in less than spectacular fashion. The exhaust fumes from the engines made her sick enough to vomit, and she ended her day before it even started by swimming back to shore.

But the setback was only temporary, and the allure of gold was – and continues to be – the same for Riedel as it has been for countless miners and explorers that have come before her over the centuries.

"The first time I ever dove and saw gold on the ocean floor, there was nothing like it," she says. "It really is as bright and as glittery as you always hear about. There's a mineral called pyrite. People call it fool's gold, but once you've seen both, you realize that pyrite doesn't look anything like gold. The only thing that looks like gold is gold."



Despite the immediate gratification of those first dives – or perhaps because of it – she was hesitant about the idea of TV camera crews becoming part of the daily routine later that same summer.

"Alaskans generally don't like the idea of people watching what goes on here," she says, "because we really value our freedom, our independence and our privacy. "

By the end of the first season, however, the TV crew had become part of the routine. But the routine changed during the second season after Riedel experienced a series of diving mishaps that warranted emergency ascents back to the surface. She describes the result as "a sort of PTSD" that has kept her topside ever since.

"I used to love being down there," she says, "but after a couple close calls, I didn't feel right in the water anymore, and I didn't feel like I could perform. That was a hard year for me, because I didn't know how I fit in the industry after that. I'm a hard worker. I like having a purpose, like everyone does. So I was really thrown off by that setback, because I really wanted to contribute, but I didn't really know how I could contribute anymore."

The solution was to buy her own boat and promote herself from diver to captain. She bought Tenhoff's dredge, then known as *The Edge*, and rechristened it *The Eroica* – a reference to the Italian operatic term, *sinfonia eroica* (heroic symphony), and a nod to her musical background.

In her new role as captain of her own ship and head of her own dredging operation, the good news was that she was now the master of her own destiny. The bad news was that she now had to manage every aspect of her own destiny.

"The first couple years of owning a dredge," she says, "were pretty chaotic in terms of personnel and figuring out the business, figuring out the equipment, getting the right advice, putting the right kind of setup together to optimize the gold dredging."

But anything done on a daily basis – no matter how many steps, no matter how many details, no matter how complicated – eventually falls into a routine. And in the gold dredging business, says Riedel, routine is one of the primary drivers of success.

"If things are boring, then you're making money," she says. "If things are exciting, it's because the weather has come up, you're having some kind of dive emergency, or you're having some kind of mechanical breakdown, and people are losing their minds because you're not making money. You never know what you're going to get out there."

"There's nothing that really feels as good as that connection – and that sense of achievement – as when you're holding treasure in your own hands, and it's found by your own merits."

She's confronted the adversity – and the not-so-subtle skepticism of some of her colleagues along the coast of Nome – with a steel-eyed resolve.

"I've been running my boat for seven seasons now, and not all of those seasons have been successful, but a lot of them have been. A lot of them have been more successful than many people who have come through in the last ten years. Because I work really hard and I run a good ship and I find good people to dive. So a lot of the people – locally at least – have kind of shut up about it, because they see that my boat is out there and it's working."

Unfortunately, but perhaps not surprisingly, Riedel's gender has factored into some of the misperceptions about her ability to do the work.

"People make a lot of assumptions about you," she says. "People turn away from you. People talk over you. People assume that you have nothing to say and you don't know anything. People assume things because I'm a woman…But I don't really care. I just do my job and I try to do it the best that I can. It doesn't really get to me. And I live in such a small world, and people are so used to seeing me in that world, and they know that I work hard, so it's gotten a lot easier. But at first, it wasn't that way at all."

"I don't work for anybody but myself. My achievement depends entirely upon me just getting up in the morning."

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"If a young girl sees someone like me doing something that is traditionally considered men's work, then that gives them an option, right?"

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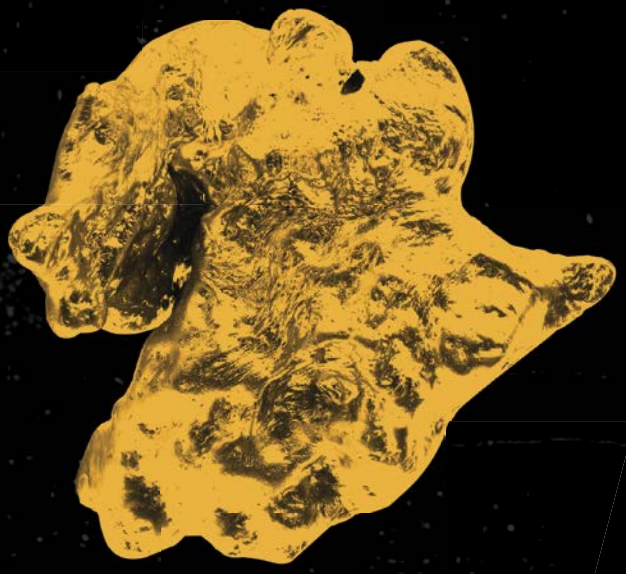


She's hesitant to call herself a role model for young women, or even think of herself as one. "But in general, when women are seen doing jobs like this, young girls can see those jobs as options," she says. "That's the most important thing. It's not about equality of outcome. It's about equality of opportunity. So if a girl sees someone like me doing something that is traditionally considered men's work, then that gives them an option, right? Not everyone should be a welder or a fabricator. Not everyone should be a gold dredger. That's not what's demanded of you. It's more about what you can see as options, and what options you want to pursue."

After nearly a decade on the Bering Sea, is there an endgame to Riedel's gold-dredging journey? Perhaps a pivot to dry land and something more in line with her musical training? She has found a way to do both, but the balancing act has its challenges.

"My schedule is very unpredictable," she says. "Sometimes we're summertime mining. Sometimes we're ice mining. But I've performed the Anchorage Symphony, which is great. I had a random, very moving opportunity last year to sing at Carnegie Hall. That was a fantastic opportunity. I'm getting better at managing the gold mining and the opera singing, but they're just two very different things – two difficult things – to hold in tandem, as you might imagine. My voice is my instrument, and if I don't take good care of my instrument, it doesn't perform as well."

For as unrelated as the two pursuits might seems, the sea and the quest for gold have taught her certain life lessons that translate to the performing arts.

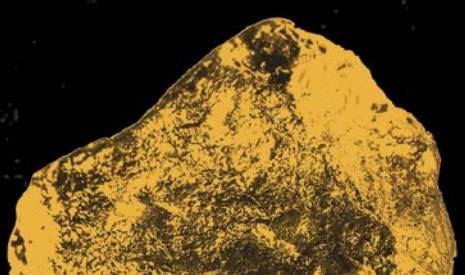
"The discipline of being focused and dedicated to a craft – taking care of your equipment and making sure you're doing things right – is not unlike being a competent musician," she says. "You have to know your stuff. You have to study a score, learn the music, learn the notes, learn the rhythms, the tempi. You have to spend hours and hours working out the notes in your body, learning the languages. It's all about discipline and attention to your craft."

For all of its visual appeal, the gold is merely a means to an end for Riedel. That glittering thing she's searching for on the floor of the Bering Sea every day has less to do with wealth and more to do with personal freedom.

"I think the most important thing in life is independence," she says. "Independence from debt, independence from having anyone telling you how to live your life or what to do. That's why gold mining is so appealing to me. It's absolute freedom. I think gold mining is the embodiment of the American dream. I don't work for anybody but myself. My achievement depends entirely upon me just getting up in the morning."

For Riedel, gold is a universal currency. What's more, the sense of personal fulfillment she derives from the process of search and discovery knows no price.

"There's nothing between me and the true value," she says. "The true value comes directly from my own hands. There's nothing that really feels as good as that connection – and that sense of achievement – as when you're holding treasure in your own hands, and it's found by your own merits. That's what the American dream is to me, and I feel like I'm living the American dream every day." ARC



"Gold mining is absolute freedom. I think gold mining is the embodiment of the American dream."

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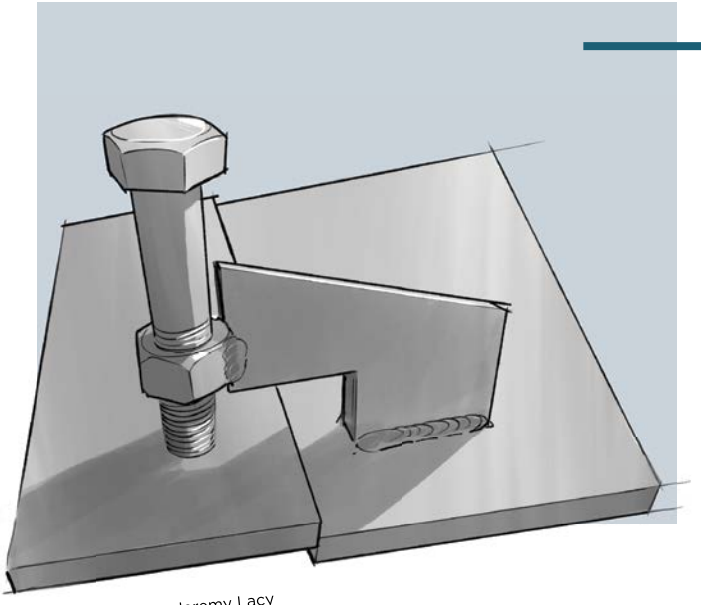


Illustrations by Jeremy Lacy

ALIGNMENT TOOL

An alignment tool can be a handy gadget in the shop, especially during repair welding. This simple tool can be created in a short time and provides a bit of pressure to ensure that your materials fit up properly.

Start by cutting the bracket out of material that's at least the same thickness if not thicker than what you're welding. The shape can vary, depending on your specific needs and the nature of your welding job.

Weld a nut at the end of the bracket to hold a bolt in place that will apply the pressure to the part. Be careful not to damage the threads of the nut while welding. Then weld the tool to one piece and thread the bolt through the nut until it pushes the other piece into position.

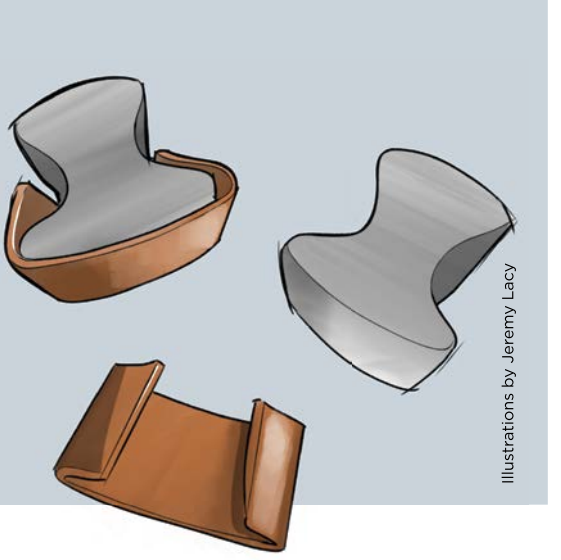
This tool can be constructed as a light-duty device for thin materials, or you can create a more robust version for thicker materials. Devices like this have been used for many years to align separate work pieces in the pipe industry, but they can be modified and welded in various configurations to accommodate your application.

COPPER COVER DOLLY

Welding sheet metal is always a challenge, especially when it comes to welding up holes. This can be a very difficult task, one that includes the constant risk of destroying the material. This sheet metal dolly wrapped with copper will make the process much easier and give you much better results.

Start with 1/8-inch copper bar and your favorite dolly and wrap the face of the dolly with the copper. Since welds don't fuse to copper, the copper-covered dolly acts as a backing bar to hold the weld in place. The copper covered dolly is placed on the backside of the hold with pressure and the weld is made. When completed, the copper covered dolly is simply removed.

The copper covering also serves as an excellent heat sink on the back of the weld, which gives you much more weld control. When this is done correctly, the welded hole is small and flat, with very little heat input into the panel. This results in less distortion, which is something every welder strives for.



Illustrations by Jeremy Lacy

TUBE CLAMPING TOOL

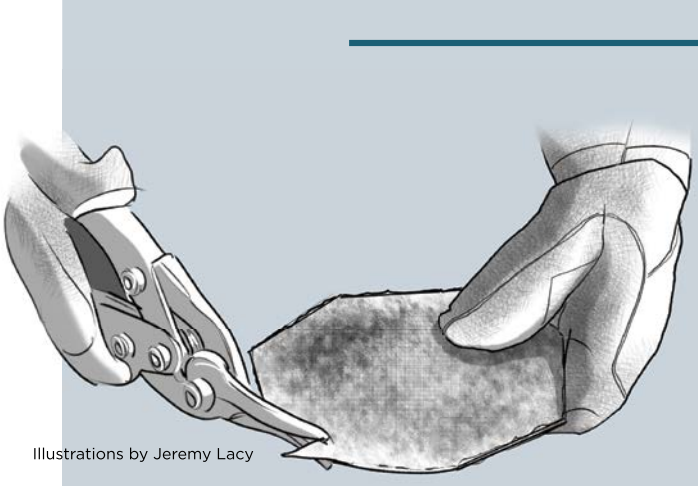
There are several tube clamping tools you can purchase, but you can also build one of your own to help hold pieces of tube in position for proper tacking.

Start by cutting two 4-inch pieces of angle. The size of the angle will depend on the size of tube you are welding. Cut two pieces of 1/8- to 3/16-inch flat bar with 45-degree angles on one end of each piece. On the other end, drill a ¼-inch hole that will serve as the swivel point between the two pieces. Weld a nut onto the end of two pieces of simple L-shaped flat, then weld the opposite ends to the angle pieces. A bolt threaded through each nut will clamp the two pieces of tube in place as you weld.

This tool can be helpful when tacking and welding tube together. It can be used during practice welds or to serve as a device to help control distortion while welding.

These simple tools will make better use of your time in the shop while lending that third hand that we always need.

Illustrations by Jeremy Lacy



Illustrations by Jeremy Lacy

TRIMMING SANDING AND GRINDING DISCS

We all use some kind of grinder or sander, and we all know how expensive sanding discs can be. Over time, the outer edge of the disc – anywhere from 1/8 to ¼-inch – generally gets the most use and wears out the most quickly.

When that happens, the discs can be trimmed into a star pattern using a pair of old aviation snips, which accomplishes a couple things. First, the edge of the disc becomes new again, so it lasts twice as long. The star pattern also allows the disc to fit into tight corners better than a round disc.

This trick will greatly increase the life of your grinding discs. You'll feel better when it does come time to throw them away, knowing that you've maximized their usefulness.

OLIVIA MCCLEERY

THE TEACHABLE MOMENT

By John C. Bruening

Some people are born to teach. Others evolve into the role over time, after various other life experiences. But like many who come to a teaching career more gradually, Olivia McCleery has developed an understanding of the education process that encompasses the perspective of the student as well as the teacher.

McCleery teaches welding – stick, TIG, MIG, ASME pipe – as well as plasma and oxyfuel cutting at Lincoln Electric's Welding Technology and Training Center, located on the company's main campus in Cleveland, Ohio. She originally hails from Hudson, a quiet northeast Ohio suburb that's not typically associated with heavy industry, fabrication or related trades.

"Where I grew up, I didn't even know about welding," she says. "I didn't get into it until much later in life. I went the traditional route. I went to art school and I got a degree in interior design that I never used."

Instead, she spent a couple years in sales and advertising, and then went to work for a friend's demolition company where she cut beams into small pieces. She transitioned to Lincoln Electric and took a job in production, and took classes at the weld school at the same time. Her original plan was to work in R&D when she finished her training, but when an instructor's position opened up, she took the job and never looked back.

She admits that the rigors of teaching can be daunting at times, but she takes pride in the quality of instruction that she – and the school in general – are able to provide.

"The students are here six hours a day, five days a week, several weeks at a time, and the majority of time they spend here is very hands-on," she says. "Plus, if anyone has a question about anything, ever, that we can't answer, I can go ask an engineer in R&D or a product manager or a metallurgist. I can find the answers."

And at the end of those six hours, McCleery is convinced that the students are the best part of the day and the best part of the job.

"You meet so many interesting people from all over the world," she says, "and everyone has their own reason for being in the school. The fact that people are coming here to learn about something we love to do is inspiring. Some days you might not feel motivated about welding, but when it's new to someone else and they're excited about it, you do it and it reminds you of how exciting and important welding really can be."

Like so many teachers – not just welding instructors but educators in any discipline – McCleery derives great satisfaction from the "ah-ha" moment, the turning point in the learning process when the student makes the transition from "I don't get it" to "I've got this."

"It happens all the time, and it never gets old," she says. "Students who keep an open mind, who are willing to accept help, and who realize that they will not be the world's greatest welder on day one will have the best experience in welding school. Some people do know how to weld when they get here, but they can always learn something new. Brand new students who have never welded before are my favorite, though. I really love introducing people to welding and being a part of those very important moments of teaching and learning." ARC


THE FACT THAT PEOPLE ARE COMING HERE TO LEARN ABOUT SOMETHING WE LOVE TO DO IS INSPIRING.
STACK IRO Since 1911
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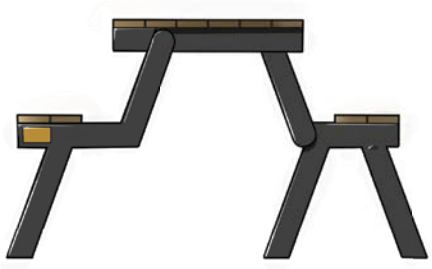
FOLDING BENCH-TO-TABLE FOR OUTDOOR SEATING AND PICNICKING

By Jimmy DiResta

Illustrations by Jeremy Lacy

Watch exclusive footage at arcmagazine.pub

Our ability to gather in large numbers has been somewhat limited in recent months. Sometimes our best options are quiet moments of isolation in an outdoor setting. In this issue of *ARC*, Jimmy DiResta builds a multi-purpose folding structure designed for communing with nature. In one position, it's a comfortable bench for relaxing in an open, outdoor space and enjoying the fresh air. In another, it's a table that seats four to six people for a backyard picnic or other small gathering outdoors. However you use this versatile bench-to-table unit, *ARC* wishes you a safe and healthy summer.



Illustrations by Jeremy Lacy

SAFETY FIRST

Before you start any project involving welding, make sure you have the right Personal Protective Equipment (PPE), which includes, at least, an ANSI-approved welding helmet, safety glasses, appropriate welding gloves for the process you're using, and a flame-resistant shirt, jacket, or sleeves to protect from UV rays and burns. You should also keep a fire extinguisher close at hand. Use adequate ventilation when welding. Use an approved respirator if exposure to welding fume cannot be controlled, or if welding outside and natural air movement is not sufficient to keep welding fume out of your breathing zone.

MATERIALS

1 x 3-inch tube steel with 16-gauge wall (approx. 30 feet)
1 x 1-inch tube steel with 16-gauge wall (approx. 30 feet)
(10) 6-foot lengths of 1 x 4-inch hemlock (or other wood of your choice)
1 x 1/8-inch steel strips (approx. 10 feet)
3/8 2-inch bolts (4)
(56) 2-inch zinc-coated screws
Rust-resistant paint (black, gray or preferred color)
Wood varnish
Metal body filling compound

WELDING/CUTTING EQUIPMENT AND TOOLS

Lincoln Electric Power MIG 210 MP
Lincoln Electric Power MIG 140 MP
CNC cutter
Grinder
Band saw
32-inch double-sided sander

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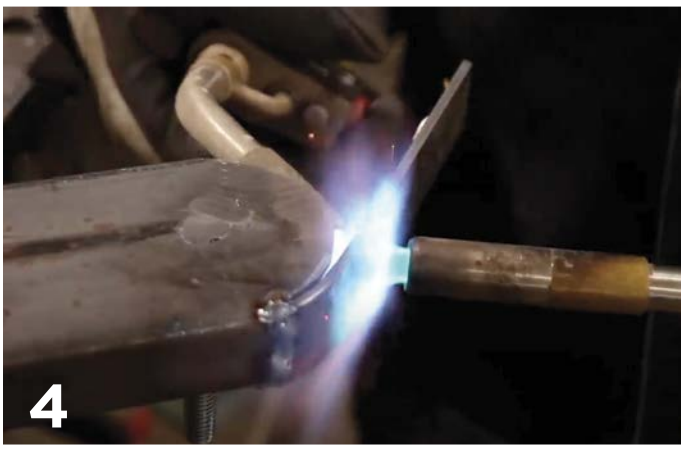


Imagery © Jimmy DiResta

Step 1:

Start with a wood pattern model to test all angles and pivot points to ensure balance and freedom of movement. Rough cut the 16-gauge tube steel. Keep in mind as you lay out the parts and cut them that you'll need two sets – one left, one right – and each one needs to be a mirror image of the other. Use a band saw for the finer cutting, and a large double-sided sander to smooth out the edges. Remember that with most welding projects like this, the cuts don't have to be perfect. You have leeway.

Step 2:

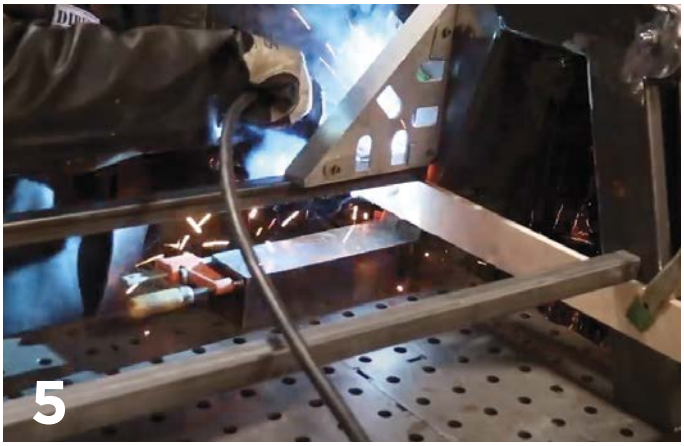
Tack weld the legs and horizontal supports for either side of the table and bench structure. Use the band saw to do the finer cuts. Use the wood pattern for the initial tack-up, then use the initial tack-up as a guide for the subsequent tack-ups. Once you've done the tacks and tested the folding mechanism, you may need to do a bit of trial-and-error cutting and tapping to get the angles to align properly.

Step 3:

Drill a hole to accommodate the 3/8-inch bolt at the pivot points on each side structure. Attach a nut to each bolt to serve as a stopper. Join the side pieces at their pivot points by lining up the holes, inserting the bolt in each hole, and tacking the bolt in place. Again, you may have to tweak the pivot points and the angles to make each side assembly true to itself and to its counterpart on the opposite side. Once you're confident that both assemblies are properly balanced and pivoting smoothly, finish the welds that you tacked in the previous step. Smooth out the finish by grinding at the joints.

Step 4:

Cap the curves on each side assembly by heating, bending and tacking the 1 x 1/8-inch strip along the contour of the rounded cut. The square ends can be capped the same way (minus the bending), although another option (as shown here) is to cap them off with a layer of metal body filler and then grind down the filler after it has dried and cured. Use the larger sander for the finer grinding on the curved ends.



Step 5:

Attach the side assemblies by inserting the pins into the pivot holes and welding them at the opposite ends. Test the alignment and pivot range of each assembly, and weld stoppers to the planks as needed. If you tested sufficiently in the earlier steps, there should be little if any need for stoppers. Finish capping off the square ends with the 1 x 1/8-inch metal or metal body filler that can be sanded later.

Step 6:

Weld horizontal 1x1-inch steel tubing underneath both bench seats to connect and reinforce the overall structure. Weld two additional 1x1's to connect and reinforce the legs of the stationary bench. Seal off the last of the squared edges using either of the techniques explained in steps 4 and 5.

Step 7:

Coat the entire structure with exterior glossy paint. Be ready to apply a second coat, at least on the metal body filler spots if not the entire structure.

Step 8:

Cut the hemlock planks to length for the benches and tabletop. Age the wood by applying a light coat of spray paint and then sanding it off. Follow with a coat of varnish (both sides, all edges) as protection against the elements. Bolt the planks to the folding structure at either end with zinc-coated screws. Bolt the 1 x 1/8-inch steel strips to the underside of the tabletop and bench planks to provide further support and reinforcement.

A detailed drawing and cut list for this project can be downloaded at **arcmagazine.pub.**

UNDEFINABLE REWARDS

By John C. Bruening

At some point in the early years of his architectural career, sculptor Paul Lashua decided he wanted to spend less time conceptualizing, calculating and planning and more time making.

"The idea of actually being an artist, or a career in art, was never presented to me when I was young," says Lashua, who spent several years in the late 1980s and early '90s working at architectural firms in Ft. Lauderdale and Cincinnati. "Like so many young people, I had an affinity for drawing and a creative drive, but lacked the direction as to where that could possibly lead as a career."

He eventually gave up on the notion of being part of someone else's plan and got busy building things that were more consistent with his own vision.

Since then, Lashua has set up his own shop in Cincinnati were he builds small- and large-scale sculptures that have made their way to various places around the country. They range from modest-sized ornamental pieces in people's living rooms to majestic and thought-provoking installations in more public settings.

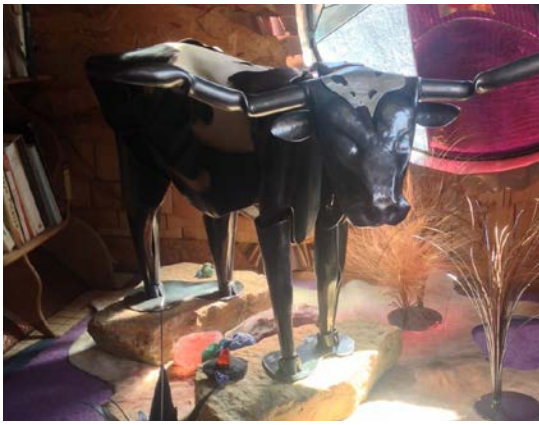
"Larger work presents a certain physical energy, in terms of design, fabrication and finished piece," says Lashua. "Also, with larger pieces, that energy, represented in the form, has an ability to interact with the viewer/client in a more physical manner than a smaller piece that tends to work on a more intimate level. Another aspect of larger work is its relationship to the surrounding space, be it architectural, natural, personal, or in many cases, a combination of all those things."

But creative satisfaction doesn't rest entirely in the bigger pieces, he says. "Smaller work often presents opportunities to explore more tactile relationships, such as texture, both visual and physical. I don't feel I have a preference, so much as I enjoy the unique set of challenges that working in either scale – or often somewhere in between – can present."

In just the first half of this year alone, Lashua's project list has been diverse. The highlights include a series of large steel and stained-glass tables with hand-hammered copper light fixtures and forged steel seating; an interior custom wall sculpture for a new client; and the restoration of a mid-20th century cast-iron gazebo. And that's not counting various residential deck and porch projects, including the one on the back of his own house.

Through it all, he opts for tradition over technology, with an eye on the intangible dividends derived from the simple, hands-on act of making.

"The craftsperson was once revered for his or her technical skill and abilities," he says. "Today, someone might look at me and ask why I would spend the time and energy to make something by hand when a machine or modern process can produce a similar product in a fraction of the time and cost. The best answer I have to that is, 'Make something yourself, and discover the reward.' It can't be measured in time and money. The reward is internal and often undefinable." ARC



Master Class

A discussion of advanced materials and techniques for the seasoned welder.

SELECTING FILLER METAL FOR ALUMINUM ALLOYS

By Karl Hoes, Welding Instructor (CWI/CWE)
(Reprinted from the ARC Magazine archives. Originally published Spring 2015.)

Whether you're a rookie or a veteran, welding aluminum can be tricky business. The selection of the most appropriate filler metal is a key consideration, and it's based on numerous variables and criteria. We'll examine how to choose the proper filler metal when welding aluminum alloys.

Aluminum alloys are made by combining aluminum with other elements. The resulting material will have improved mechanical properties compared to basic aluminum. The alloys present also determine how the mechanical properties can be further improved by mechanical cold work or heat treatments. The wrought aluminum alloys that we are working with today are identified and numbered according to their chemical composition (see chart at left).

The large majority (about 80% or more) of the aluminum alloys we typically weld can be successfully joined with either 4043 aluminum alloy or 5356 aluminum alloy.

Alloy Series	Primary Alloying Element
1	99%+ pure aluminum
2	Copper
3	Manganese
4	Silicon
5	Magnesium
6	Magnesium and silicon
7	Zinc
8	Lithium, other elements

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ALLOYS AND FILLERS

Unalloyed aluminum is seldom used in structural applications because it lacks strength and is extremely ductile. It's easy to bend a 99% pure aluminum rod without using any hand tools for assistance. However, the fabricated part used for this demonstration is made up of three different aluminum alloys: 3003 for the bulk of the part, 6061 for the threaded bungs and 5052 aluminum for the bottom rail.

Given this variety of alloys in a single part, the choice of filler metal for the weld depends on several service conditions:

1. **Strength:** Will fillet welds be subjected to shear loads?
2. **Weldability**: How does the filler metal rate relate to preventing hot cracking?
3. **Ductility:** Will the weld metal be subject to deformation after welding?
4. **Corrosion Resistance:** Will the weldment be used in a seawater or freshwater environment?
5. **Thermal Conditions:** Will the weldment be subjected to sustained temperatures of 150° F or higher?
6. **Anodization:** Will the weldment be color anodized after fabrication?

To illustrate the decision-making process that goes into the choice of a filler metal, let's look at two commonly used filler materials that we may have to choose from for the project – ER 4043 and ER 5356 aluminum – and then walk step-by-step through the choice of filler metal most appropriate for the job, based on service conditions. (See the table below for some criteria and general guidelines).

Both filler alloys may be a fit in terms of weldability, but 4043 might be a slightly better choice to use on the somewhat crack-sensitive 6061 and 5052 base metal. 5356 will provide a slightly stronger weld, but for the part we're welding in this demonstration – an automotive valve cover – the fillet welds will not be subject to excessive shear loads in service, so shear strength is not a big concern. Corrosion resistance in salt and fresh water is not a concern for this performance automotive part. However, it would be a factor in marine applications. The piece will not be subject to deformation after welding, so ductility is not a requirement. In this case, the part will not be color anodized after welding. If color matching after anodizing were important, a filler metal such as 5554 would be a good choice, as it would color match well and be suitable for the sustained service temperatures anticipated.

The deciding factor in this choice is that the part we're welding will be used in a vehicle, where it will be subject to sustained thermal conditions well above 150° F. Consumer automobile engines run about 190° F for extended periods of time. Aluminum alloy 5356 is not suitable for use in a sustained high-temperature environment. Therefore, of the two, alloy 4043 is the choice for welding this aluminum valve cover and other aluminum auto parts such as oil pans, radiators or cooling parts that are not intended to be color anodized.

If there are any doubts, your best bet is to consult a manufacturer's filler metal chart to properly match the filler metal to the base metal and get the best understanding of the service conditions.

Commonly selected filler alloys	Weldability	Shear strength in a fillet weld	Corrosion resistance in salt and freshwater	Sustained temperatures above 150°F	Color match needed after anodizing
4043	Slightly better	OK	NA	OK	NA
5356	OK	Slightly stronger	NA	Not suitable	NA

CLEAN IT UP, SET IT UP

As always, the parts must be cleaned free of all lubricants and shop dirt before assembling and welding. In this case, a quick wipe with a clean rag soaked in acetone is sufficient. In some cases, such as with aluminum that has been laying around the shop for a while, you may need to do some brushing with a clean stainless wire brush in order to remove excessive contaminated oxides from the surface of the aluminum. When using a power wire brush, be careful not to burnish the aluminum and embed oxides into the surface.

I used a Lincoln Electric Precision TIG® 375 for the job. Shielding gas was 100% argon at a flow rate of 20 cubic feet per hour. I used a number 20 torch with glass lens collet body and a number 7 nozzle with an intermediate back cap. The following settings were preset on the machine, but current was adjusted remotely as needed:

Starting current:	14 amps
Current setting:	Remote control (this is important for aluminum welding, because amperage can be varied as the piece warms up)
Top current:	146 amps
Balance control:	Manual
Polarity:	AC (65-70% negative polarity for cleaning and penetration)
Ground:	Auxiliary

During any welding process, safety is always the first consideration. When TIG welding, the operator should wear the following:

1. **A good-quality welding helmet.**
2. **Safety glasses underneath the welding helmet. These serve two purposes: to protect the eyes from flying objects and to filter out any additional ultraviolet light that might get behind the helmet – possibly as the result of errant arc strikes.**
3. **TIG gloves to protect against electric shock and ultraviolet light. Keep in mind that all the metal on the bench is part of the welding circuit.**
4. **Skin protection from ultraviolet light and burns. Any combination of fire-retardant shirt, welding jacket, sleeves, and other protective layers will help keep your arms and neck covered.**

FIVE STEPS TO SUCCESS

Aluminum is one of the most challenging materials to weld efficiently. Choosing the proper filler metals will have a direct bearing on the quality of your aluminum alloy welds. You'll get better results when you address all the items on the following checklist:

1. Determine what aluminum alloys you are welding together.
2. Understand the service conditions under which the welded piece will be used.
3. Use a manufacturer's filler metal chart to select the proper filler metal for the base metal and the service conditions.
4. Thoroughly clean all parts prior to assembly.
5. Fill craters at the end of the weld to a convex shape to minimize crater cracks. ARC

The Lincoln Electric Company thanks Moroso Performance Products, a supplier of automotive equipment for racing and street performance applications, for supplying the part used in this demonstration.

Buckeye Powerhouse

March 1939

A worker at Otis Steel Company in Cleveland, Ohio, fabricates a pinch roll housing built with 1 ¼-inch flame cut plate. One of the first major steel companies in Ohio, Otis built the first open-earth steel furnace in 1875. The company was one of many entities of the era that helped make Ohio the second largest producer of steel in the United States during the late 1800s and early 1900s. **ARC**

Have any vintage (pre-1975) photos you'd like to share? Email them in jpeg format to editor@arcmagazine.pub with a date the photo was taken (actual or approximate), a brief description (three or four sentences), and an email address where we can reach you for additional information.

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