



# Metalwork



WINDOWS



FENCES

**A** few years ago, we hired an inexperienced laborer to push a broom and keep our job site clean. One afternoon, we were discussing the custom steel toilet-paper holders that the architect had designed for the project. We didn't yet know where we would have them made or how much they would cost. Then the new guy spoke up. "I can make those," he said. "I've done some metalwork." We decided to pay him to work at home for a few days and see what he could do. He came back to work with toilet-paper holders that were exactly what the architect wanted.

Today, we have two full-time crews that work almost exclusively with steel. It's something that distinguishes us among the many builders here in Austin. While it takes experience to fabricate many of the more complicated details we're now regularly installing on our houses, if you have some general carpentry skills, the leap to basic metalwork isn't too big. There's a lot you can do with off-the-shelf steel stock and most metal yards will cut material and even do some fabrication for you. The big investment and the steepest learning curve is purchasing a welding machine and learning how to use it.

### The strength of steel

More and more often, the modern houses that we build include structural steel. Steel offers a ridiculous amount of strength for its

size and cost and opens design possibilities that would be much more challenging—if not impossible—with wood. Of course, these structural details are engineered and typically stamped before we build. Architectural metalwork is another matter. Fences, planters, awnings, railings, balustrades, and other non-structural details generally don't require engineering and, in our experience, are easily approved by the building inspector. This speaks to the strength of steel. As one architect put it, by the time you've made the details big enough to look proportional, the steel's strength far exceeds the structural requirements.

Still, it's worth talking with your inspector before you begin a project if you have any questions. Even if there's no concern about the strength of a deck rail, for example, the inspector may have an opinion on how it's fastened to the frame. In the case of the windows and doors we recently fabricated and installed in one of our projects, the inspector was not concerned with the steel frames, but did require a particular type of glass and specific flashing details.

We've done a number of different balustrades with stock steel panels; we've made porch skirts, built-ins, and planters from simple sheet steel; and we've made awnings, railings, porches, and fences with steel tubing. These stock materials are mostly common carbon steel. Though stainless steel and aluminum are durable and lightweight options for the right situations, carbon steel is the most commonly

## Bring the endless possibilities of custom architectural steel to your projects with readily available stock and some basic tools

BY MATT RISINGER AND BOB HOWELL

# for Builders



BALUSTRADES



PERGOLAS



AWNINGS AND PLANTERS



RAILINGS (see it built p. 58)

# MAKING A STEEL

used material for architectural metalwork. When it comes to bars, plates, strips, and rods, you'll often have a choice between hot-rolled and cold-rolled carbon steel, so it's worth knowing the difference between the two.

Like the names imply, hot-rolled steel is heated to extremely high temperatures in the manufacturing process, and cold-rolled steel is formed at room temperature. Due to the respective processes, hot-rolled steel tends to be less uniform and not as strong as cold-rolled steel. For this reason, hot-rolled steel is more affordable, and is sometimes the only option because it can be manufactured into a wider variety of shapes and sizes. But be aware that if you are working on a project with tight tolerances, the amount of "drops" (unusable pieces of material) can quickly add up to a lot of wasted money. These unusable pieces may be pitted, warped, or of ununiform thickness. For these projects, cold-rolled steel may be worth the extra expense. Also, hot-rolled steel more easily deforms when heated too much, which can be a problem for a novice welder.

There are instances in which a weld is not the best option for joining steel. Sometimes a mechanical fastener is a better choice. We recently installed built-in bookcases made from thin, powder-coated steel. In this case we put the parts together similarly to a wood-working project, drilling pilot holes slightly smaller than the stainless-steel screws that we used as fasteners. We also often bolt hinges to posts and frames for gates and doors. The bolts are plenty strong and allow a combination of precision and adjustment for getting the hinges right.

## Tooling up

The essential tool investment for beginning architectural metalwork is a welding machine and helmet. If you're a builder, you probably have a lot of the other tools and safety gear that you'll need to get started: a tape measure, clamps, an angle grinder, eye and ear protection, and protective work gloves. If your project demands precise square, mitered, or beveled cuts, you might consider investing in a chop saw. There are a lot of abrasive and dry-cut chop saws available in the \$150 to \$500 range. While abrasive blades are much less expensive to replace, dry-cut saws (metal-cutting saws with carbide-tipped blades) make faster and more precise cuts.

Ultimately, you might consider a plasma cutter or an oxyacetylene torch. These tools

This simple steel handrail is an excellent example of an approachable metal project for a novice welder to tackle. The handrail is made from hot-rolled steel bar stock and a couple of small pieces of plate steel for mounting feet. Welding foreman Luke Thomas Gaffney chose to MIG weld the handrail for a balance of strength, convenience, and precision (for more on Gaffney, see p. 98).



### 1 Mark your cuts.

*It's common practice to mark steel with French chalk, otherwise known as soapstone. For projects like this handrail, however, use a Silver-Streak metal marker or a utility knife guided by a square to make crisp lines for more precise cuts. ("Drop" is a welder's designation for the offcut.)*



### 2 Check your setup.

*Square and angled cuts are made easy with a dry-cut chop saw, but steel is hard on these tools, so when precision matters, take the time to recheck the saw setup before you cut.*



### 3 Clean and bevel.

*Prepare the steel with abrasive sanding discs, stripping the surface of any finish, glaze, oils, and other residue within a few inches of the weld. Bevel the edges of the steel to accept filler material during the welding process.*



# HANDRAIL



Watch a video of the process of making a steel handrail on [FineHomebuilding.com/magazine](http://FineHomebuilding.com/magazine).

**4 Prepare to weld.** After wiping all workpieces and the work surface clean with mineral spirits to remove any residue that could contaminate the welds, use magnetic clamps and/or standard woodworking clamps to hold the workpieces on the table in the position they will be assembled. Liberally cover the area with anti-spatter solution like Weld-Kleen to keep the melted steel and filler material from making a mess of your table or your project.



**5 Tack the project together.** Two small welds at each joint are analogous to a woodworker's dry fit. Not only are the small welds easy to take apart if something is off, but they allow you to move and reposition your work to get the best angle when making the final welds.



**6 Make the final welds.** With the workpiece repositioned and lifted off the surface of the table, make the final welds, which seal the bevels with filler material. With practice, your welds will need little touch-up.



**7 Clean up the welds.** Clean up—and, if desired for aesthetic reasons, round over—welds with an angle grinder and abrasive sanding disc and knock spatter from the workpiece with a cold chisel.

# Match the welder to the work

Deciphering the technical jargon necessary to choose a welding machine can be a daunting task. However, there are essentially only a few welding systems, and with a basic understanding of how each one works, your search may be easier than you expect.

The amperage of a welding machine determines the thickness of metal you can weld (a common guideline is 1 amp for every .001 in. of steel). The duty cycle is the percentage of time that a machine can run at a specific amperage without overheating.

Some welding machines are designed to work on a 20-amp, 120v household circuit, allowing you to weld just about anywhere. If you do a lot of continuous welding, you may need to splurge for one of the higher-voltage machines with a higher

duty cycle. If you expect to do a lot of job-site work in locations without reliable access to power, engine-driven welding machines are another option. One thing to note is that many modern welding machines are compatible with more than one voltage.

**Lincoln Electric AC225**  
Traditional stick welder  
MSRP: \$419



**Miller Syncrowave 210**  
TIG/Stick welder (MIG spool accessory available)  
MSRP: \$2839



**Stick** This simple, affordable welder has a handle that holds a consumable electrode (called the stick or rod) that melts and becomes part of the weld as you drag it across the surface of your workpiece. Each electrode is coated with flux, a material that protects and cleans the weld as it melts. The flux leaves behind a coating called "slag," which may need to be cleaned up. Stick welding is slower than other types, but because of the flux coating, stick works better in windy conditions where shielding gas would be prone to blowing away from the tip and on rusty, oily, or dirty metal. Many types of specialty electrodes are available, making stick welding ideal for joining dissimilar metals or resurfacing hardened parts on excavators and farm equipment. Entry-level stick welders cost between \$200 and \$300.

**TIG** If you're looking for precision, a tungsten inert gas (TIG) welder is for you. With a small electric torch in one hand, a filler rod in the other hand, and an amperage-adjusting foot pedal below, you have constant control of all of the variables that make a weld happen. TIG welding requires more skill and concentration (and more time) than just about any other type of welding, but results in beautiful joints in virtually any type of metal, and needs little to no finish work. Other types of welding may be okay for some architectural metalwork, but intricate or delicate pieces may require or be improved by a TIG welder. Because of the level of control it offers, TIG is mandated in some fields, such as industrial pipe fitting and high-tech manufacturing. TIG welders start around \$500.

## Modern machines handle multiple processes

Welding machines that do only one type of welding are becoming less common. Multiprocess machines, like Lincoln Electric's Power MIG 210, are capable of MIG, flux-core, stick, and TIG welding right out of the box. At about \$1250, this machine is worth considering—once you own a welding machine, not only will you want to use it, you'll begin to find uses for it everywhere you look. Beyond the Lincoln Electric and Miller machines shown here, look at welders from Hobart, Victor, Forney, and Lotus.



All welding systems need to do three essential things: create an electric arc to melt metal, protect the molten metal from oxidation, and feed filler metal into the weld. Here's a rundown of how each type of system works and what it's best suited for.



**Millermatic 211**  
MIG/flux-core welder  
MSRP: \$1179

**MIG** Popular because they are versatile and easy to use, metal inert gas (MIG) welders feed filler wire (steel, stainless steel, or aluminum) and shielding gas into welds via a trigger-operated gun. The filler wire doubles as an electrode, providing a path for electricity to jump to the workpiece and melt it. MIG machines quickly lay down welds on anything from thin sheet metal to thick steel plates. With experience, you can make clean, attractive joints, but welds on decorative projects typically require some grinding and finishing. Most MIG welders also allow you to run flux-core wire through the gun as a substitute for shielding gas. The flux allows the machine to excel in dirty or windy conditions, much like a stick welder, making it a great option for job-site work or machinery repairs. Flux-core welding makes a lot of smoke, though, and it leaves a crusty layer that may need to be chipped and wire-brushed off as you go. It also doesn't make as good-looking welds as MIG or TIG welding. The most basic MIG welders can be found for \$200 to \$400.

cut through most steel instantly, so they are great for cutting thick material quickly and roughing long cuts. A trained hand and the help of a straightedge can lead to nice cuts with a plasma cutter or torch, though even the best work will require some cleanup. Plasma cutters aren't very portable tools, so more often a torch is used in the field.

We have a very expensive, very heavy, very flat, and very useful welding table from Strong Hand Tools. Not many people have the luxury to make the investment in a \$4200 table that takes up a lot of shop space and is essentially immovable, but there are many decent tables available for under \$1000—craigslist.org is worth a try. Make sure the table you choose is big enough to support the types of projects that require welding, and be sure it has a nice flat surface, otherwise your work will suffer. If shop space is limited, consider a rolling table.

Though metalworking is no more dangerous than woodworking, there are some different dangers, the obvious being sparks and flames. You need eye protection whenever cutting or grinding metal and a helmet for welding. Protect yourself from burns with long-sleeve work shirts and work pants and have a fire extinguisher nearby. Keep in mind that steel is heavier than wood. Steel- or composite-toe safety boots are a wise footwear choice for metalwork. And make sure to use hearing protection for all cutting, grinding, and welding tasks.

### Rust happens

Steel comes with finishing and maintenance requirements, just like wood. If you are after a natural patina, you can let your work oxidize and rust. There are some professional finish options like powder coating. You can also have your metalwork finished in an auto-body shop where they are experts at applying flawless and durable finishes. Otherwise, you'll need to paint it yourself.

As with wood, prep is the most important part of painting steel. Before priming, remove any rust and clean the surface of the steel to remove any oils or glaze. For primer, we like Multiprime Low VOC from PPG (and we prefer to spray it), though we've had good results with the ubiquitous Rusty Metal Primer from Rust-Oleum too. We like PPG's two-component urethane Spectracron 360 for our topcoats.

Like virtually all finished surfaces, architectural metal will require periodic main-

## Get an auto-darkening helmet



If you watch a professional welder, you'll notice the moment of zen when they nod their head, dropping the helmet to protect their eyes and simultaneously beginning to weld. It's a cool move. But it's out of date.

Traditional passive welding helmets protect the welder's eyes with a dark glass lens that is too dark to see through until the workpiece is illuminated by the light from the torch or welding gun. That light is so bright it can burn your eyes instantly, which is why the dark lens is necessary. There are different shades of lenses—passive helmets usually have a #10 lens—but all should have filters to protect your eyes from ultraviolet and infrared light.

For a beginner, coordinating the action of lowering a helmet while keeping the torch or gun in place and simultaneously starting to weld has a steep learning curve, and, thanks to auto-darkening helmets, is unnecessary.

Auto-darkening helmets have an electric filter lens that allows you to see the workpiece through the lowered helmet while you prepare to weld. The lens darkens nearly instantly when sensors identify the welder's arc. Auto-darkening helmets can be adjusted for sensitivity, usually from #9 to #13 shades. It's useful to be able to dial in just the right lens sensitivity, enough to protect your eyes while offering the clearest possible view of your work.

If you insist on the old-school option, you can pick up a welding helmet for under \$20. For a quality auto-darkening helmet, expect to pay about \$100 to \$250.

tenance to protect the finish and will eventually need to be repainted. Still, we think it's an excellent option for all sorts of different projects—sometimes because it has the strength to do what other materials cannot; sometimes for the modern, industrial aesthetic; and sometimes just because it's fun to work with. □

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