MIG welding technique.

(The following was submitted by James Swonger on May 4, 1993)

The quality of a MIG weld is controlled by gas flow, the qualities of that gas, the "heat" and feed rate settings. While getting a quality weld is less dependent on "touch" than gas or arc welding, it does depend on the right combination of the settable machine parameters.

There are three modes of material transfer in a wire feed machine. One is "blob mode", where the wire sticks, then melts locally, then breaks. This occurs at the lower end of the heat/wire feed range. I say heat/feed rate as a ratio, because this pretty much determines which deposition mode you will see. Blob mode welds are the lowest penetration and lowest transferre heat, because there's almost no real arc action, just mostly resistive heating of the wire and contact point.

The second mode as you move up the range is a soft arc with the metal being pushed through it. You'll recognize this mode when it happens; there's no more "wire push", the sound changes from a random snapping to a more uniform sizzle and everything just gets smooth. This is what I consider the ideal mode. The arc is stable but most of its energy is transferred into melting the fed wire and a localized area of the workpiece. In this mode I see about 1/4" of heat affected zone around the weld (automotive sheet metal thickness), and by proper setting I can get perfect penetration which I define to be some backside protrusion but no sag or burn-through. The handpiece ("gun") in this mode may have a buzzing feel to it but none of the bucking you get in blob mode.

The third mode is when heat is much higher than the wire feed rate needs. This mode is akin to traditional arc welding, except with a fed wire. The arc energy now is biased more into the workpiece, with attendant heating and penetration. The wire still adds filler but there is more tendency to undercut, eat back and blow through especially on thin pieces. In this high heat/feed mode the buzzing/sizzling sound is replaced by a more purely electrical arc sound (whispering/crackling). This mode is desirable when welding pieces much thicker than the wire, especially when you haven't taken the bother of grinding proper chamfers and need to get penetration.

Gas flow provides an important cooling effect. This is one reason why flux cored wire is harder to use on sheet metal; there's no place for the weld heat to go except the workpiece. Argon, A75 and CO_2 have different welding characteristics. Argon will make the weld "sit up" higher, CO_2 gives the most penetration and A75 is in the middle somewhere. Only Argon is suitable for aluminum; A75 is sort of marginal for stainless (leaves some carbon) but pretty ideal for general mild steel use.

An adjustable regulator provides more latitude in balancing arc heat/feed and cooling. A high flow of gas can reduce warpage while allowing faster material transfer. I have a cheap preset flow regulator which is a compromise setting, compromise price type deal.

To minimize panel warpage you must apply some technique as well. The MIG machine does not eliminate the need for skill; it just lets you apply your attention to more important things and lets you slide on some of the basics. Warping results from too much differential heating and expansion in the workpiece. By understanding the material and equipment you can keep this from being a problem.

Duty cycle is one simple way of further reducing overall heat input. By welding in short, spaced beads you can join panels without overheating any large areas. First the piece should be "tacked" every few inches, with bead lengths of 1/2" or so. Make several passes after that, filling in the gaps bit by bit and not working any one region for long. The workpiece's thermal spreading will cool the small HAZ (*) pretty quickly if the total heat deposited remains small. A spot cools much more rapidly than a line.

The edge of a thin metal piece presents a special case, a "boundary condition" which behaves differently than the bulk. With half the heat dissipation ability of the bulk, the edge will tend to burn back, distort and so on. This can be addressed by reducing heat (although this may force you into running blob mode), by different choice of metal overlap configuration and by carefully running the arc.

A true butt joint in thin material is difficult to make. A -perfect- butting is hard to do on formed sheet metal, and any gaps will tend to enlarge in the welding process. For this reason a lapped weld is often preferred. A panel can be flanged to let the two pieces overlap but keep the final surface flush. The flange provides a backup as well in case of erosion of the edge on the top piece.

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A second sort of joint is a butted-V which protects the edges as the weld hits the sidewalls without necessarily reaching the bottom of the groove.

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Places like Eastwood sell specialty tools for making both types of flanges on sheet metal. Of course, you need to be careful not to cause deformation from the flanging process itself. I have made my own flanging tool for the first form out of an extra pair of Channel-Loks with extra jaw material brazed in and ground to shape. The Eastwood tool is Vise-Grip based and looks like it's a bit better as far as force required to make the flange due to the compound action. I think a pair of beat up sheet metal shears might be a better basis for making a new one.

(*) HAZ = Heat Affected Zone; the area where you see thermally-induced material changes in the workpiece. This is basically the extent of any visible surface discoloration when using the MIG, although if you run the gas after stopping the arc you may not even be able to see anything because oxygen is excluded. If you remove the gas and arc together you will get the normal thin oxidation layer like you see when grinding or heating to temper. The outside of the blue oxide region is the periphery of the HAZ, although the material effects there are probably negligible.

The following was submitted by mrehmus@ix.netcom.com

Use of MIG for body work. A bad idea fostered on us amateurs by our ignorance. If you look at the available wire for MIG, you don't find anything much softer than S60 or higher wire. In general, the higher the yield strength of metal, the harder it is to work. (Try forming tool-steel as a test). The weld bead left by a MIG is very hard relative to the body sheet metal and is almost impossible to work. It also cracks very easily even if one trys to anneal the metal in the weld. In restoring a 1967 Mercury Cougar I finally had to teach myself hammer welding using a welding torch. The results were much better!!
1. The seam is the same thickness as the parent sheet metal.
2. The seam is as soft or softer than the parent sheet metal.
3. The seam and the surrounding sheet metal are easily worked to remove any defects caused by the welding process.
Should anyone want to equal the hammer welding process but with an electric source of heat, TIG is the only way to go. The filler metal selection is much, much wider and the TIG can be run way down to 10 amps or so which would probably let you weld aluminum foil if you wished. Oh yea, in the professional welder's world, the common opinion is that a TIG weld is superior to MIG.

So why do the professional body shops like the MIG? It is necessary for the welding of high-strength steel that is commonly used in the structural parts of the modern automobile. Not, I repeat, NOT for the external sheet metal. The external sheet metal (the part we can see) is still mild steel because of the expense and difficulty of making sheet metal forming dies that would last and give good results with high-strength steel. Remember that body shops replace whole panels, they rarely "patch" a panel. The high-quality restoration shops use TIG or (usually) a torch and hammer welding.

GOOD video tapes to know about:

"Learning MIG Welding" by SIP (one source is J.C. Whitney, their # 12VL7580P, $26.99; their phone number is (312) 431-6102)
"Hammerwelding Techniques" by Car Guy Videotapes
"Patch Panel Installation" by Car Guy Videotapes

I have watched these tapes many times, always learning more at every session.

The tape on MIG welding uses a good visual filter technique to show every type of weld puddle. After viewing the tape, my MIG welding has been much better.