General Instructions

Flame Adjustment: All the work described in this chapter should be done with the neutral oxy-acetylene flame. To secure a neutral flame, always start with an excess of acetylene, then increase the flow of oxygen (or decrease the flow of acetylene) until the excess acetylene feather just disappears. Check flame adjustment frequently. An excess of acetylene is easy to spot, but an excess of oxygen is not always evident to the eye, although it will usually cause the molten metal to spark excessively. When starting steel welding practice, do not use the strongest flame which your welding head can produce. (The strongest flame is the one which would separate slightly from the tip if the flow of each gas were increased only slightly.) Use the regulator delivery pressures recommended by the maker of your torch for the tip size in use, but do not hesitate to cut back the flame length slightly by adjustment of the torch throttle valves. Too harsh a flame will make it hard for you to control the weld puddle until you have acquired some skill. Better to have a flame which is a bit too soft than one which is too harsh. You will not be able to weld as fast, but you will have better control. Experiment with flame size as you move along, but start out on the soft side.

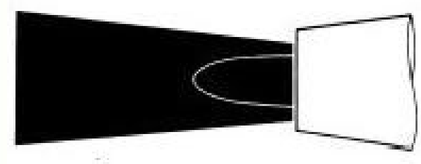


Fig 4-1. The neutral flame, which results from burning a mixture containing approximately equial volumes of oxygen and acetylene. The well-defined core of the flame (extremely bright pale blue) is known as the "inner cone".

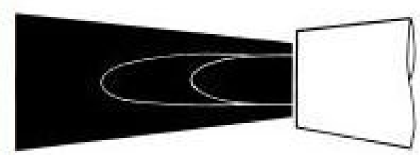


Fig. 4-2. The excess acetylene flame, which has a whitish feather around and beyond the inner cone.

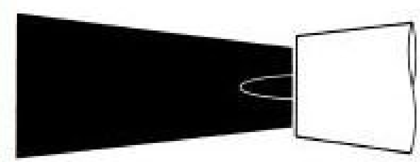


Fig. 4-3. The oxidizing flame, which results from an excess of oxygen in the gas mixture, has a shorter, more sharply-pointed inner cone than the neutral flame.

Flame and Rod Motions: If you watch an experienced oxy-acetylene welder at this work, perhaps the first thing you will notice is that he keeps both the flame and the end of his filler rod in almost constant motion. The flame moves back and forth across the line of the weld, edging forward almost imperceptibly. The end of the rod moves back and forth too, from one side of the puddle to the other. However, the motion of the rod is opposite to the motion of the flame, and often less pronounced. The inner cone of the flame is not pointed directly at the rod for more than a small fraction of each cycle. The neat little ripples that form on the surface of the solidified weld metal are in large part the result of puddle movement generated by the rod. You will also note that if the welder withdraws the end of the rod from the puddle momentarily, he does not draw it away from the puddle very far, but keeps it within the outer envelope of the flame.

Puddle Control: One of the nice things about carbon steel is the fact that it has a melting point range, not a fixed melting point. At temperatures within that range (approximately 1400-14350C) molten steel has a pasty or mushy consistency and is quite easy to control. The welder's aim must be to hold the molten steel within that range. If he does his work correctly, he adds heat to the puddle with the flame, withdraws heat from the puddle with the filler metal rod. While it may seem a bit far-fetched to describe the operation in this way, he has a heating device in one hand, a cooling device in the other.

Flame-to-Work Distance: As a general rule, the tip of the flame's inner cone should be kept about 1/8 in. (3 mm) from the surface of the work piece or weld puddle. Try to maintain that separation as well as you can, especially during your first practice sessions. As you gain experience, you will find that there are times when you can deliberately break that rule, to let the flame "dig in" to the puddle for a specific purpose, or to hold the flame farther from the work in order to weld a bit more slowly in a difficult position.

When the Rod Freezes to the Work: Until you gain good control over the motion of the welding rod, it is almost certain that at some point the end of the rod will "freeze" to the workpiece because it entered the very edge of the puddle, not the center of the puddle. When that happens, resist the impulse to pull it loose. Pulling simply won't help. Melt it loose with the flame.

Put a Bend in the Rod: For work in most welding positions, it is desirable to put a bend in the welding rod before you start work. Heat up a spot on the rod, about 8 in. from the end, and bend it by stubbing the end against the work table or the work itself. Bending the rod will generally give you better control, and keep your rod hand out of the path of hot air downstream of the flame. The angle of bend depends on welding position and personal preference. For work in some positions the bend is not required or helpful.

Eliminating Stub Ends: The arc welder, using stick electrodes, must discard part of each electrode. The economical oxy-acetylene welder can eliminate "stub ends" almost completely. When a length of rod gets too short for comfort, he can weld on another full length immediately (see Fig. 13-11) or he can set the short piece aside, and later weld it to other short pieces to make up another full length of useful rod.

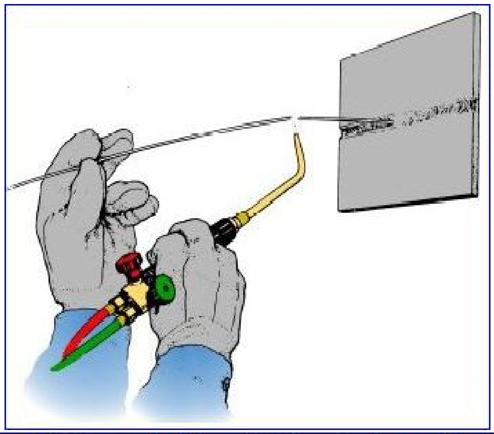


Fig. 13-11. Here's a good trick to learn. When your rod gets too short for comfortable manipulation, let it freeze in the puddle. Bring a fresh length up against the free end, and weld it to the short piece. Then reform the puddle, melting the rod free in the process of doing so, and continue your work. This works especially well in the horizontal position, as illustrated in this sketch, because in horizontal welding it is seldom necessary to put a bend in the rod in order to work comfortably, since both flame and rod are angled upward somewhat. However, you can do this in any position, first welding on the new piece of rod, then removing the bend in the original section and adding a bend in the new section.

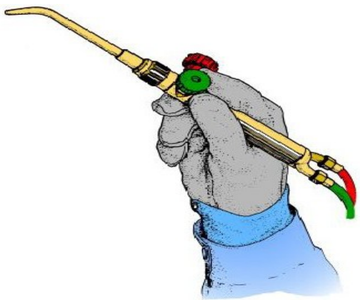
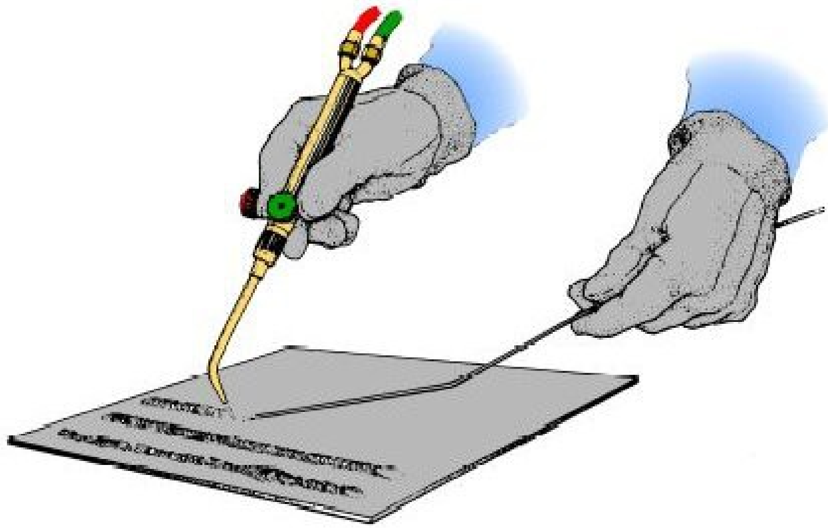


Fig. 13-1.

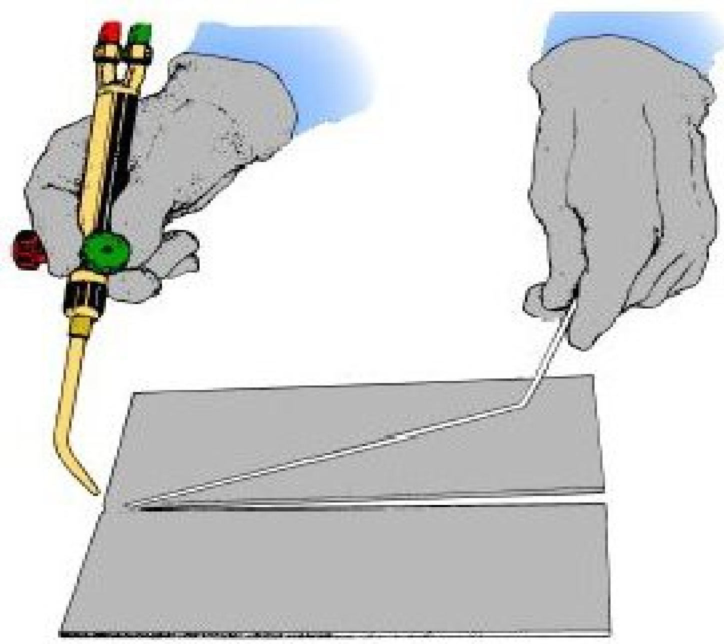
First find a way to hold your torch comfortably with good control over tip movement. If you have a small torch, with valves at the front end of the handle, holding it much as if it were a large pencil is a good idea. With a larger torch which has valves at the rear end of the handle, you will probably find it necessary to modify this grip somewhat. Try to find a way to support the hose so that it interferes with free torch movement as little as possible. Some welders bring the hose over their right shoulder.

Fig. 13-2. Before trying this, light the torch and practice running a puddle across the 1/16” thick sheet without using welding rod. Start by holding the torch still, with the inner cone of the flame about 1/8 in. (3 mm) from the surface of the metal, until a small pool of molten metal has formed. Then start to move the flame back and forth in a series of short arcs or semi-circles, advancing the puddle as steadily as possible from right to left. You may find it difficult to avoid melting a hole through the sheet. If necessary, cut back on flame size, increase clearance between inner cone and work, or move puddle forward at a faster rate. Practice until you can run a reasonably uniform bead for a distance of several inches. Now take a length of 1/16-in. welding rod and try to do what the operator in this sketch is doing. Bend the rod so that you can hold it comfortably. Keep the end of the rod within the outer envelope of the flame, but about a half-inch from the inner cone, until you have formed a puddle with the flame. Move the rod into the puddle enough to melt off a drop or two of metal. Withdraw the rod slightly, advance the puddle again. Repeat this sequence until you have crossed the sheet. Try again, and yet again, until you can run a bead which stands above the sheet surface for its full length, and is quite uniform in width. Experiment with rod and flame angles; those indicated in the sketch may not be best for you. When you melt a hole through the sheet, practice filling in that hole by adding filler metal, a bit at a time, first to one side and then to the other side, until the gap has been bridged.



Running a bead of weld metal across the surface of sheet steel.

Fig. 13-3. Place two pieces of sheet side by side on the work table, spacing them 1/16 in. (1.5 mm) apart at the weld starting end, 3/16 in. (5 mm) at the other end. Make a tack weld at the starting end. Play the flame in small circles, heating each side evenly until first evidence of melting appears near the corners. Then add a little metal from the welding rod (already heated in the outer flame envelope) to bridge the gap. Do not build up the tack above the sheet surface. Allow the metal a few seconds to cool, then swing the pieces around so that you can make the finishing-end tack weld from the same position you used for the first tack. Because of the greater gap, the second tack-weld will be harder to make. A little metal must be added to each side, and allowed to cool



slightly while the flame is directed toward the other side, before the gap can be bridged. After bridging the gap, make this tack-weld definitely larger than the first one. Return sheets to original position. Melt a small puddle on top of the first tack-weld, add filler metal to build it up above the sheet surface. Start moving the flame back and forth, in a series of short arcs, adding filler metal regularly by moving the end of the rod into the puddle, then retracting it slightly. Advance the puddle with the flame as you move it back and forth across the joint line.

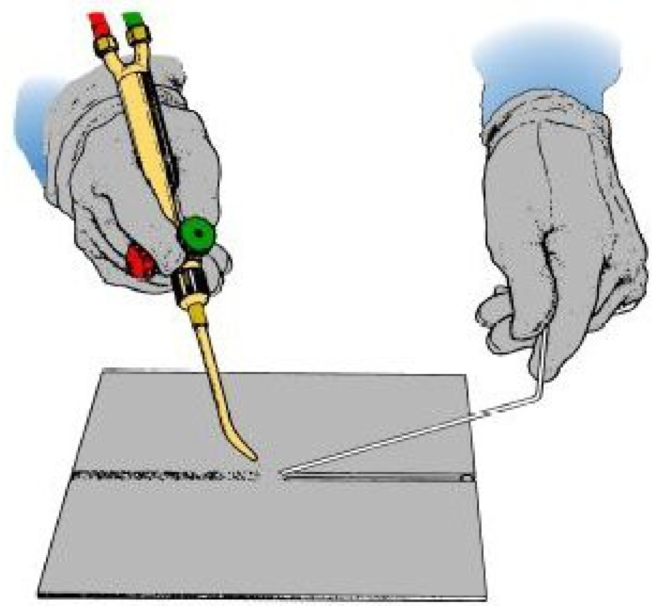


Fig. 13-4. Here we are at the middle of the weld. By now, it has become quite evident that making a weld between two pieces isn't as easy as running a bead across the surface. But a rhythm should be developing. You learn that the flame must linger a bit at each end of each arc, to avoid overheating the center of the puddle, and you get the feel for the timing of the movement of the rod in and out of the puddle. (Later, you will do work which calls for keeping the rod in the puddle at all times, but you can't do that with sheet metal.) In this first weld, do not worry too much about appearances. Try to avoid adding more filler metal than necessary to bridge the gap. The first aim should be to get complete fusion at the bottom of the weld. To achieve this, the metal ahead of the puddle must be brought to melting point before the puddle itself reaches it. That's not easy to accomplish without getting frequent burn-through. After you have completed your first weld, turn the piece over and examine the bottom of the weld carefully. If it appears that you have achieved rather complete penetration (if you have, there will be a definite "droop" all the way along the weld line) make a second weld and pay more attention to the top surface. Keep at it until you make a weld that looks good on both top and bottom. Then test it (see Fig. 13-22). If you are working on sheet that's thinner than 1/16 in., you may find it very difficult to avoid melt-through, or excessive sagging of the weld, when using the flame motion recommended at the start of this chapter. If that is the case, move forward in this chapter to Fig. 13-23, where a quite different (but more difficult) technique is described.

Testing Sheet Metal Welds: To test a sheet metal weld that appears satisfactory to the eye, clamp the specimen in a vise, with the weld metal parallel to the jaws and just above them. Then hammer the top portion of the specimen to bend it 90 degrees away from the bottom side of the weld. Remove the specimen and reverse it so that the lower half can be similarly bent. The "folded" specimen should then be placed in the vise so that the ends can be pulled up flush against each other, with the weld just above the jaws of the vise. If the weld has normal ductility, and the work has been done well, there should be no visible cracks in the weld metal, or between the weld metal and the balance of the specimen.

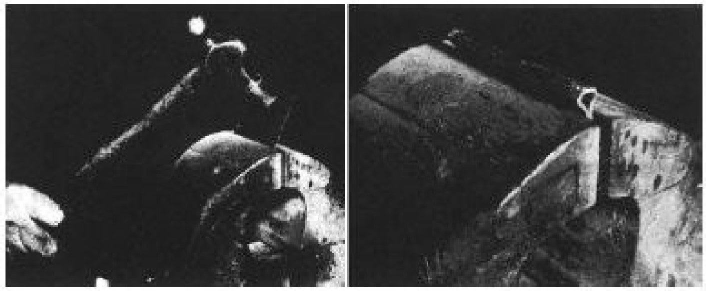
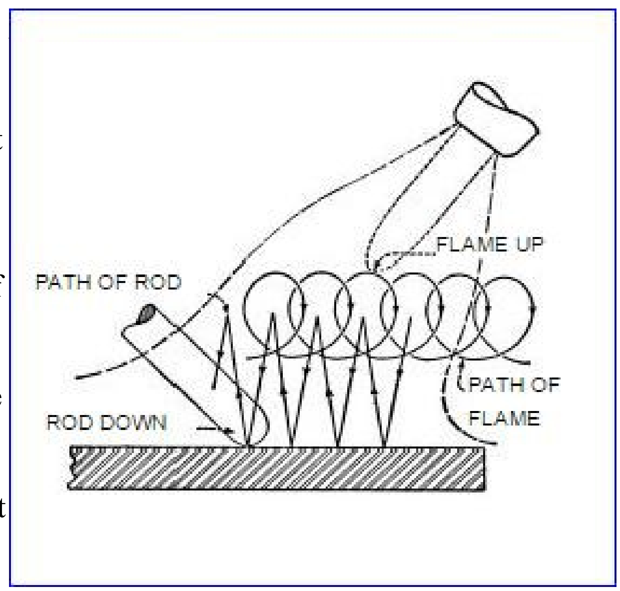


Fig. 13-22. To test a weld between two pieces of sheet metal, place specimen in vise, with weld just above jaws of vise, and hammer it 90 degrees away from the back of the weld, as shown at left. Then bend the other side as far as possible (not shown). Finally, as shown at right, bring the two halves of the specimen together.

Alternative Sheet Metal Technique: On sheet steel less than 1/16 in. (1.5 mm) thick, the torch and rod motions described earlier in this chapter may give trouble. It may be hard to avoid frequent melt-through if flame motion is limited to arcs described back and forth across the weld line. If that proves to be the case, an alternative technique, sketched in Fig. 13-23, should be used. This technique is not easy to master, but with it a skilled welder can handle sheet steel as thin as 1/32 in. (less than 1 mm). The flame must be moved chiefly up and down, in a series of over lapping ovals, while the end of the rod is moved up and down in opposite sequence, so that rod and inner cone are close to each other at one point in each cycle. There must be some slight motion of the flame from side to side – enough to bring the edges of the metal to fusion temperature – but the dominant flame motion must lie in the vertical plane. Before attempting to use this technique to make a weld, use it to deposit beads on thin sheet, practicing until you can put down a bead of uniform width and contour.



Review:

✔ 1. Flame. Keep it neutral. If the weld metal seems to be sparking more than usual, check your flame. It may have become slightly oxidizing.

✔ 2. Penetration and Fusion. You can achieve what appears to be complete penetration (when you take a quick look at the back side of your weld) without having achieved complete fusion. "Cold shuts" – places within the weld, between root pass and finishing pass, or between weld metal and the original surfaces of the base metal where there is lack of fusion – are difficult or impossible to spot visually.

✔ 3. Keep the filler metal rod in the flame. By that, of course, we mean in the outer envelope of the flame, not necessarily close to the inner cone. The outer envelope preheats it and protects it from undue oxidation.

✔ 4. Use both flame and rod to control puddle size. If the puddle gets too large or too fluid, withdraw the flame slightly, but generally keep the rod in the puddle and keep it moving.

✔ 5. When making a fresh start, get the puddle formed before you add filler metal. That also applies to working over tack welds. For a few seconds, withdraw the rod and make sure the tack is melted. Haste can lead to cold shuts.

✔ 6. Take time to make tack welds right. Unless the tack weld is thoroughly fused to both sides of the vee, it's worse than useless.

✔ 7. Don't yank the rod if it sticks unexpectedly. Melt it loose with the flame.

✔ 8. Practice, practice, practice. Few people become proficient welders in one day – even a full eight-hour day. But if you stick with it, you have a good chance to become proficient within a week.

✔ 9. Test your work as you practice.

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