- Maintain a flame sufficient to penetrate the metal and manipulate it so that the molten metal is protected from the air by the outer envelope of flame.
- Keep the hot end of the welding rod in the weld pool or within the flame envelope.
- When the weld is complete and still in the red heat, circle the outer envelope of the torch around the entire weldment to bring it evenly to a dull red. Slowly back the torch away from the weldment to ensure a slow cooling rate.

Chrome Molybdenum

The welding technique for chrome molybdenum (chrome-moly) is practically the same as that for carbon steels, except for sections over ³⁄₁₆-inch thick. The surrounding area must be preheated to a temperature between 300 °F and 400 °F before beginning to weld. If this is not done, the sudden quenching of the weld area after the weld is complete may cause a brittle grain structure of untempered martensite that must be eliminated with post-weld heat treatments. Untempered martensite is a glass-like structure that takes the place of the normally ductile steel structure and makes the steel prone to cracking, usually near the edge of the weld. This preheating also helps to alleviate some of the distortion caused by welding along with using proper practices found in other sections of this chapter.

A soft neutral flame should be used for welding and must be maintained during the process. If the flame is not kept neutral, an oxidizing flame may cause oxide inclusions and fissures. A carburizing flame makes the metal more hardenable by raising the carbon content. The volume of the flame must be sufficient to melt the base metal, but not hot enough to overheat the base metal and cause oxide inclusions or a loss of metal thickness. The filler rod should be compatible with the base metal. If the weld requires high strength, special low-alloy filler is used, and the piece is heat treated after welding.

It may be advantageous to TIG weld 4130 chrome-moly sections over 0.093-inch thickness followed by a proper post-weld heat treatment as this can result in less overall distortion. However, do not eliminate the post-weld heat treatment as doing so could severely limit the fatigue life of the weldment due to the formed martensitic grain structure.

Stainless Steel

The procedure for welding stainless steel is basically the same as that for carbon steels. There are, however, some special precautions you must take to obtain the best results.

Only stainless steel used for nonstructural members of aircraft can be welded satisfactorily. The stainless steel used for structural components is cold worked or cold rolled and, if heated, loses some of its strength. Nonstructural stainless steel is obtained in sheet and tubing form and is often used for exhaust collectors, stacks, or manifolds. Oxygen combines very readily with this metal in the molten state, and you must take extreme care to prevent this from occurring.

A slightly carburizing flame is recommended for welding stainless steel. The flame should be adjusted so that a feather of excess acetylene, about ¹⁄₁₆-inch long, forms around the inner cone. Too much acetylene, however, adds carbon to the metal and causes it to lose its resistance to corrosion. The torch tip size should be one or two sizes smaller than that prescribed for a similar gauge of low-carbon steel. The smaller tip lessens the chances of overheating and subsequent loss of the corrosion-resistant qualities of the metal.

To prevent the formation of chromium oxide, a specially compounded flux for stainless steel, should be used. The flux, when mixed with water, can be spread on the underside of the joint and on the filler rod. Since oxidation must be avoided as much as possible, use sufficient flux. The filler rod used should be of the same composition as the base metal.

When welding, hold the filler rod within the envelope of the torch flame so that the rod is melted in place or melted at the same time as the base metal. Add the filler rod by allowing it to flow into the molten pool. Do not stir the weld pool, because air enters the weld and increases oxidation. Avoid rewelding any portion or welding on the reverse side of the weld, which results in warping and overheating of the metal.

Another method used to keep oxygen from reaching the metal is to surround the weld with a blanket of inert gas. This is done by using a TIG welder to perform welding of stainless steel. It is a recommended method for excellent weld results and does not require the application of flux and its subsequent cleanup.

Oxy-Acetylene Welding of Nonferrous Metals

Nonferrous metals are those that contain no iron. Examples of nonferrous metals are lead, copper, silver, magnesium, and the most important in aircraft construction, aluminum. Some of these metals are lighter than the ferrous metals, but in most cases, they are not as strong. Aluminum manufacturers have compensated for the lack of strength of pure aluminum by alloying it with other metals or by cold working it. For still greater strength, some aluminum alloys are also heat treated.