

General Comments On Connectors

Wherever there is a conductor carrying electric current, it is necessary to make a connection. This is true whether the conductor is a solid or stranded wire, a rectangular bus bar or a piece of copper pipe. This also is true whether the conductor is an inch in length, a foot in length, or several hundred feet in length. Conductors are joined by several methods. The oldest methods are the fusion of conductors by means of soldering, brazing or welding, with the very oldest being the blacksmith form of welding. Joining techniques of this type require special skill and special equipment, consequently, other means have been developed which are more generally applied. These are the pressure method which is divided between the bolted or mechanical type joint and the compression type connector which uses special tools to develop the necessary forces. One other joining technique that is frequently used is soldering. However, this has its limitations, because of the possibility of the joint's melting out during temporary overload conditions.

Connector Materials

Since most electrical conductors are either copper or aluminum, it also has become standard for the connector industry to make connectors of copper and aluminum. The category of copper connectors includes pure copper and alloys of bronze and brasses; these materials can be fabricated by casting, forging, extruding, punching, or any combination of these processes. The aluminum connectors are made of alloys used to provide the best electrical conductivity; however, in some cases, a compromise material is used to give optimum combination of electrical conductivity and mechanical strength. A general practice has been to use copper connectors for copper conductor and aluminum connectors for aluminum conductor. In some cases where a transition from copper to aluminum conductors must be made, it is advantageous to use a bimetallic connector, thus making the transition in the connector rather than in the junction of the connector and conductor.

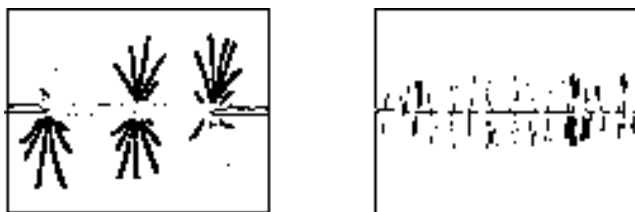


Figure 1. As force is increased the surface roughness flattens out creating a multiplicity of parallel paths.

Welding Connectors

Welding, particularly of aluminum bus, has become increasingly popular because the materials are united in a homogeneous bond. The bus can be joined directly, or through the use of weldments. Weldments eliminate the need for field cutting and matching. They also act as fixtures and help align the bus structure during erection. Tungsten inert gas (TIG) has become increasingly popular for joining of aluminum conductors.

Pressure Connectors—Bolted and Compression

The simplest and most widely used method of joining conductors is by means of externally applied pressure. This pressure can be developed by means of clamp type connectors using bolts and nuts or by compression connectors using special compression tools to develop the necessary forces.

As two surfaces are brought together to make a joint, the microscopic peaks touch each other as shown in Figure 1. As force continues to be applied, the relatively few peaks flatten out into a large number of plateaus and current is transferred across the interface. This relationship is clearly shown in Figure 2 in which resistance is plotted against force. The important thing about this relationship is that once sufficient force has been applied to establish a safe value of resistance, considerable relaxation can occur before the resistance starts to rise again. A well designed clamp or compression connector thus has some safety factor built into it right from the beginning.

All clamp type connectors depend upon the thrust developed by the bolts to deliver the force necessary for a sound, stable connection. For a bolt to do its job, it must have adequate strength so that it can be torqued up properly, it must develop correct thrust for the installation torque recommended, and above all, it must be reliable and not fail during service.

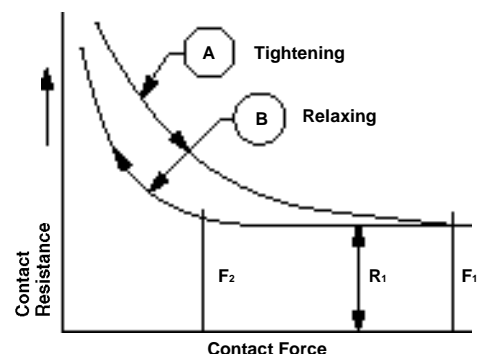


Figure 2. Contact resistance curves.