Shunt currents in the secondary circuit of a resistance welding machine

How Kirchoff's Law of Distributive Networks applies

By Robert Cuff

An understanding of some of the basic laws of physics and mechanics is necessary to help make the resistance welding process work well consistently. One of these basic laws is Kirchoff's Law of Distributive Networks as it applies to the current flowing in the secondary circuit of a resistance welding machine.

This article discusses this law and how it relates to the creation of shunt currents in resistance welding machine secondary circuits.

Shunt Current Paths

By definition, joining metals using the resistance welding process requires clamping together the parts to be welded and passing an electrical current through them for a period of time. This definition of resistance welding assumes that all of the current provided in the secondary circuit of the welding transformer is flowing through the parts to be welded. However, this may not always be true. Some current may be diverted through other paths in the machine's secondary circuit.

In a machine that is set up properly, all of the current in the secondary circuit passes through the electrodes and the workpieces to form a proper size weld nugget at the interface of the workpieces (see **Figure 1**). There is only one current path through the parts.

If, for some reason, some current is flowing through other paths in the secondary circuit of the machine, there may not be enough current flowing through the welding electrodes to form a high-quality weld nugget between the parts to be welded. The other current paths in the secondary circuit—shunt current paths—may divert enough current to prevent the formation of a good weld nugget.

These shunt paths usually are formed unintentionally and often are not easily or readily recognized. The current through these shunt paths is described and defined by Kirchoff's Law of Distributive Networks :

> The magnitude of the current in a circuit is the sum of the currents in the respective branches of the circuit.

As an example, in a welding machine secondary circuit with a shunt current path across the welding electrode circuit, some current will flow through the shunt path, reducing the current through the welding electrodes. The shunt path may be formed by an electrode touching the part to be welded at a point other than the electrode face or a weld spacing that may be too short.

Kirchoff's Law is diagrammatically illustrated in **Figure 2**. In this figure, the total current in the circuit, I_T, remains the same; however, it is now equal to the sum of the current through the weld, I_W, plus the current through the parallel shunt path, I_{R1}.

In this example, the welding current selected is 10,000 amps for welding two 16-gauge mild steel parts. However, if a shunt path runs parallel with the weld, some current will flow through the path, reducing the current at the weld. Assuming that the shunt path is of a resistance that would cause 2,000 amps to flow through the shunt path, I_1, then only 8,000 amps would pass through the parts to be welded, possibly an insufficient amount to form a proper weld nugget.

The current in the secondary is the current in the secondary, but how it is distributed determines the quality of the weld being made. The weld control can provide switching only for the total current in the secondary circuit; it cannot redistribute the secondary current. The total current in both illustrations in Figure 2 is the same, but the weld current in the second illustration has been reduced by shunt current.

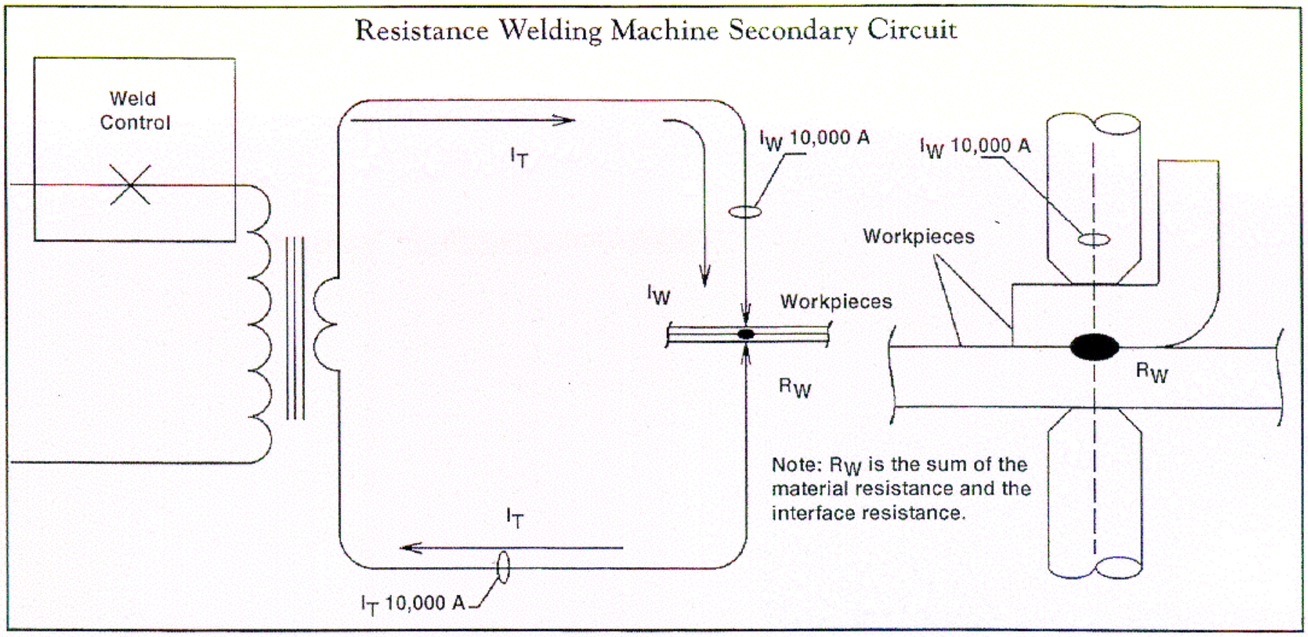

Figure 1

All of the current in the secondary circuit should pass through the electrodes and the workpieces to form a proper size weld nugget at the interface of the workpieces. No shunt currents paths are present.

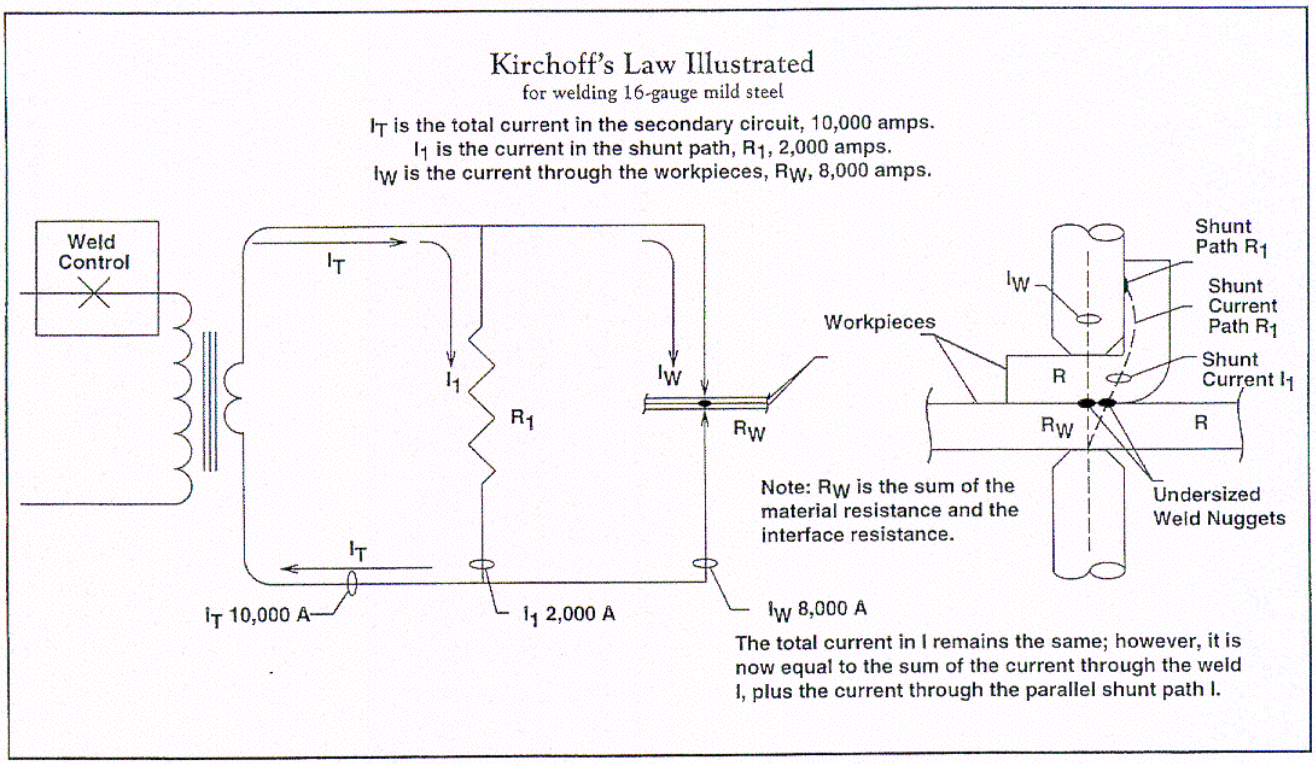

Figure 2

When the electrode touches the piece at a point other than the electrode face, a shunt current path exists that will produce a poor weld—even when the current is correct.