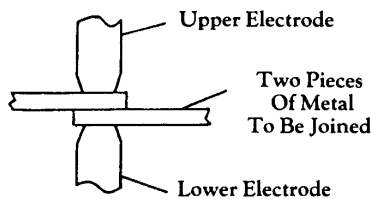


What is Resistance Welding? Resistance welding is one of many methods of fastening two or more pieces of metal together. Some of these methods are listed below in order to illustrate how resistance welding differs from the others.

1. Bolting
2. Riveting
3. Soldering
4. Arc Welding
5. Resistance Welding

Bolting, riveting, soldering and arc welding all require some additional material to be added to the metal being fastened together. Additionally, bolting and riveting require holes to be made into the metal for the rivets or bolts to fit. Resistance welding requires neither additional material nor holes in the metal.

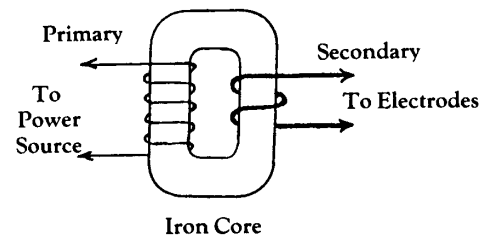
How is a resistance weld made? The two pieces of metal to be joined are squeezed together by the electrodes on the welding machine so they are in good electrical contact. Then electrical current is passed through them, heating them until they begin to melt at the spot where they are in contact. The molten metal from the two pieces flows together; then the current is turned off and the molten metal solidifies, forming a solid metallic connection between the two pieces. The term "Resistance Welding" comes from the fact that it is the electrical property of resistance of the metal being welded that causes heat to be generated when current flows through it.



What are the important factors in making a weld? Important to the proper formation of the molten area between the pieces of metal being welded is the magnitude of current, the length of time it flows, and the force squeezing the parts together. The optimum value of these parameters varies with the type of metal and its thickness. For commonly used low-carbon steel 1/16" thick, a typical value of current is 10,000 amps, for a time of 1/4 of a second, and 600 pounds electrode force. Resistance welding schedules are available through American Welding Society, Resistance Welder Manufacturers Association, and from most welding machine manufacturers.

How is adequate current obtained? A current of 10,000 amps is not readily available from any standard electrical outlet. Fifteen amps is the maximum current available from common household and office outlets. Even in factories where large amounts of electrical energy is used, 200 amps is typical of the current available from electrical distribution circuits. Therefore, to get the 10,000 amps needed for resistance welding, some device must be used to step the current up from the relatively low level available from the power line.

What device is used? The device generally used is a transformer. Transformers are usually thought of as stepping voltage up or down, but current can also be transformed in the same way. A transformer consists of two coils of wire, called the primary and secondary, wound around an iron core. Power is transferred from primary to secondary via the magnetic properties of the iron. The factor by which the current or voltage is stepped up or down is

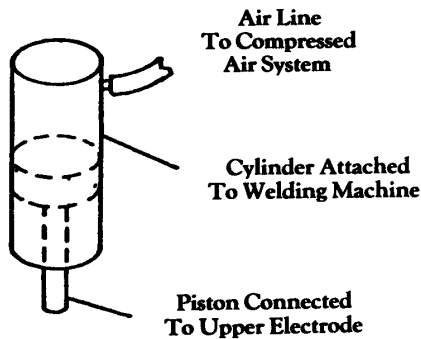


roughly equal to the ratio between the number of turns of wire in the coils forming the primary and secondary windings of the transformer. In the preceding example, where 10,000 amps was required, a transformer could be made with one hundred turns on the primary and two turns on the secondary; a "turn ratio" of fifty. A two hundred amp current in the primary would be transformed into two hundred times fifty, or 10,000 amps in the secondary, enough to do the welding job.

How is the time controlled? The length of time the welding current flows through the two pieces of metal to be welded is also important. Therefore, the device used to turn the current on and off is a critical part of the system. A relay or hand operated switch might be considered as a switching device, but either would be unsuitable because of the relatively slow speed of operation. In the preceding example the current must be on for only 1/4 of a second. It is very difficult to turn a switch on and off again in 1/4 of a second, and even more difficult to do it consistently. Therefore, some electronic device with no moving parts should be used. Two such devices are available. The ignitron tube, which has been used for many years, is one and the silicon controlled rectifier (SCR), a more recent

development, is another. Both operate by virtue of the fact that a small electrical signal applied to the device allows it to turn on in a small fraction of a second and conduct a large amount of current. Removing the electrical signal allows the device to turn off again. Fast turn-on and turn-off are possible because there are no mechanical moving parts. Ignitron tubes operate on the principle of ionization of mercury vapor, while silicon controlled rectifiers operate on solid-state semi-conductor principles similar to transistors.

How is the electrode force obtained? The third critical factor in resistance welding is the force squeezing the metal parts together (Electrode Force). This force is necessary to assure good electrical contact between the parts being welded, and to hold the parts steady until the molten metal forming the welded joint has time to solidify. Depending on the size and type of welding machine, various methods of developing the electrode force are used, but the most common is to use compressed air in a cylinder and piston arrangement.



The cylinder is rigidly attached to the welding machine frame, and the moveable piston is connected to

the upper electrode. Compressed air introduced into the cylinder develops a force on the piston which, in turn, pushes the electrode down against the metal being welded. The amount of force applied depends on the area of the piston and the pressure of the compressed air. In the preceding example where six hundred pounds of electrode force was required, a five inch diameter piston would require an air pressure of thirty pounds per square inch.

What is a resistance welding control? It may be concluded from the preceding paragraphs that it is important to apply the welding current at the proper time during the operation of the welding machine. This is the function of the welding control; in fact, the purpose of a welding control is to coordinate the application of welding current with the mechanical motion of the welding machine. More specifically, it tells the electrodes when to close and when to open, and it tells the welding current when to start and when to stop. The welding control may be thought of as the "brains" and the machine as the "muscle" of the overall resistance welding system.

How is a welding control connected to the welding machine? Since the welding control provides control of both welding current and machine motion, it must produce two control signals; one to turn the SCR's or ignitrons on and off (for current control) and one to turn an electrically operated air valve on and off (for machine control). The SCR's or ignitrons perform basically as a switching function and so are connected in series with the welding transformer in much the same way as any switch is connected in series with its load. Note also that they are connected in the primary rather than the secondary circuit of the transformer because the current requirements are lower in the primary.

