

SPOT WELDING TECHNICAL INFORMATION

Resistance Spot Welding is the joining of overlapping pieces of metal by applying pressure and electrical current. These joints created by resistance spot welding form a “button” or “fused nugget.” Resistance spot welds are found typically on flanges, staggered in a single row of consecutive welds. Vehicle manufacturers use resistance spot welding in the factory because they can produce high quality welds at a very low cost.

How a Spot Weld is formed. Spot welds are formed when a large amount of current is passed through the panels for the correct amount of time and with the correct amount of pressure. In a typical spot welding application there are two electrodes, opposite each other, which squeeze the metal pieces together. This squeezing pressure is controlled. The pieces to be welded are heated by passing welding current through them. Several thousand amperes of welding current are applied for a specified period of time. As the temperature is elevated, the metal is heated to a plastic state. The force of the welding tip will deform the metal and form a small dent as the metal gets hot. As the heat builds in the metal, a small liquid pool of metal is formed at the interface. This pool is typically the same size as the face of the welding tip. When welding temperature is reached, the timer should expire. The weld zone cools very quickly because the copper welding tips pull heat out of the weld zone. Heat also escapes as it flows into the surrounding metal. The TITE-SPOT Welding Pliers should be held closed for at least one second to cool the weld. **WARNING:** Care must be taken with an air closed apparatus that instantly releases after the weld is formed.

There are 4 variables to consider with resistance spot welding;

Pressure, Weld Time, Current, and Tip Diameter.

Pressure: the amount of pressure that is applied to the weld is important. If too little pressure is applied, the joining area will be small and weak. If too much pressure is applied, then cracking can occur in the weld because of the quenching effect of the welding tips. Also, high pressure can cause thinning of the metal and cause a weakness. The depth of depression on the sheet surfaces caused by welding electrodes should never exceed 25 percent of the sheet metal thickness.

Typically a body shop welds steel between 16 gauge and 24 gauge. If a spot welder has adjustable length tongs, a pressure gauge should be used to properly set the pressure. The pressure is important and should not be guessed at. (NOTE: The pressure of the TITE-SPOT Pliers is set to the middle of this range and is not adjustable.)

Three types of spot welding timers:

A standard weld timer controls the amount of time the current flows into the welding transformer. The inherent problem is that if welding is not taking place the timer is still ticking. Therefore, if welding current is only flowing for part of the cycle, a weld may not be formed before the timer runs out. What generally happens is, the technician increases the length of time the timer will run. This can cause overheating of the welding tools and transformer! Double cycling on the weld zone is also a technique which is used, but it also causes overheating.

Manual control: Sometimes the timer is bypassed by the operator and he times the welds manually. Good welds can be produced in 1/2 to 1 3/4 seconds this way. This probably puts less thermal stress on the welding tools and transformer than the “standard weld timer”.

A digital timer control verifies welding is taking place. This type of timer checks all cycles of a 60 cycle second and will not increment the timer unless welding current is flowing! The digital timer has a precise interface for selecting and adjusting the power and timer settings. The digital control that verifies welding puts the least amount of thermal stress on the welding tools and transformer.

Weld current and weld time are inversely proportional. Welding current and time are used to bring the metal to welding temperature (2550 Degree F.).

$$\text{Weld Temperature} = i^2 \times t \times R.$$

Welding current in a body shop environment has a range of 3000 to 5000 amperes. Welding current (i) and weld time (t) are to be controlled by the technician.

Resistance (R) is determined by the gauge of the parts being welded. Since welding current is squared, changes in weld current are much more dramatic than changes in weld time.

Welding current settings are very important when welding today’s vehicles. If weld current is at the low end of the range, weld time must be increased. (NOTE 1: Using low current on the welds can cause overheating of the welding tools and the welder’s transformer.) Conversely, if weld current is high then weld time is decreased. (NOTE 2: Using high weld current increases the problem of expulsion. Expulsion is molten metal squirting from between the layers of steel. The galvanized coatings found on today’s automotive steel aggravate the problem of expulsion.) So we can see, welders that do not control weld current will be more difficult to use.

There are two types of weld current controls, **Analog:** uses a knob and it is set like a radio knob. **Digital:** uses a LED display that tells the technician the exact power setting. The usual interface is a push button.

The Ideal Welding Controller is digital with a preheat timer and weld current verification.

The digital interface is so precise that the operator can set the machine easily. Very small changes in power or time can be made quickly to make perfect welds while eliminating expulsion. Timer verification is letting the timer “tick” only if the correct amount of current is flowing into the welding transformer.

A verified preheat timer is the best way to minimize expulsion. Preheating allows the primers that we want to leave between the layers of steel, to be burned out of the way, slowly. Galvanized coatings can be vaporized (@ 1350 Degree F.), eliminating it from the weld zone before the welding takes place. The temperature is determined by the length of time we preheat the weld zone. Preheating also allows the steel to bend a little and fit perfectly before the welding power is turned on. All these things can happen only if we have preheat current verification!

Verification is the magic that makes the job go faster. The ideal welding controller validates the welding current, eliminating the problem of overwelding. The technician is able to produce good welds every time without overwelding and reduce the heat stress on the welding tools and transformer.

Welding tip diameter is very important. The TITE-SPOT Pliers has the welding tips sharpened to 3/16" diameter when new. The tips can be allowed to fatten to 1/4" diameter before they need to be sharpened. Welding tips have a flat face when new. This face crowns quickly with use, and this crowning effect should be encouraged. The crowning radius should be about 1.5 to 2 inches. A sharpening tool is provided with the TITE-SPOT Pliers. (NOTE: The closed height of the welding tips is 1 1/2" when new.) Discard welding tips when closed height is 1 3/8". DO NOT SHIM WELDING TIPS.

TABLE 1

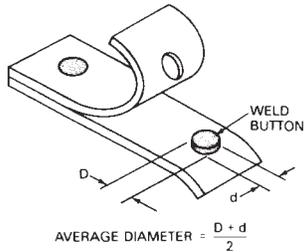
STEEL GAUGES			weld spacing		weld diameter
			2 pieces	3 pieces	
GAGE	IN	MM	in	in	in
16	0.060	1.524	1.06	1.31	0.22
18	0.048	1.219	0.94	1.18	0.2
20	0.036	0.914	0.72	1.06	0.17
22	0.030	0.762	0.62	0.88	0.16
24	0.024	0.610	0.38	0.62	0.15

Spot weld spacing should equal or exceed the minimum standards in table.

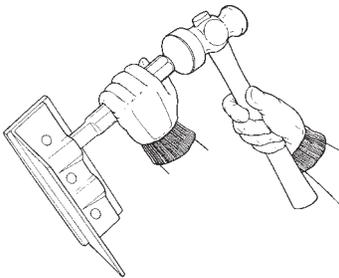
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WELD INSPECTION:

There are three forms of weld inspection. First there is a visual inspection; the welds should look uniform, have a small dent from the welding tip, and should have very little expulsion when the weld is formed. The other two inspections are called destructive inspection techniques for evaluating spot welds; they are the "peel" test or "chisel" test. It is obvious that the destructive testing should be done on scrap steel before the process of welding on the vehicle is begun.



The peel test consists of peeling apart a spot weld. The button should be measured and the average diameter should be calculated. (see Table 1)



The chisel test consists of forcing a tapered chisel into the gap on each side of the weld being tested until the weld or base metal fails. The edges of the chisel must not touch the weld being tested. This type of test is to be used when the peel test is not feasible. The button size is determined in the same manner described for the peel test.

GALVANIZING

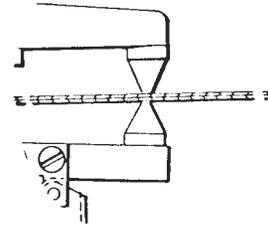
Galvanizing is a coating of zinc metal that is applied to the steel when it is manufactured, either in a hot dipped fashion or by electroplating. Zinc is a bluish, white metal, its melting temperature is 950 degrees F. and boils or vaporizes at 1350 F. Zinc, when used as a galvanizing coating, protects steel from rust. Also, zinc can be found in a body shop as die-cast or pot metal.

In pinch welding the galvanized coating should be left between the layers of steel because of the rust prevention it provides. In Two-Gun overlap welding the zinc is often removed with the cleaning process in preparation for the weld. The reason we remove the zinc in Two-Gun welding is because we lack significant pressure in the weld zone, and because we are only welding from one side.

Galvanizing can "foul" the welding tips, a condition called brassing. Brassing can cause the electrode to have trouble connecting with the material to be welded. If the electrode forms a gold or brass color on the face of the electrode, then the face of the welding tip should be cleaned. Care must

be taken to insure that the diameter of the face of the electrode is maintained at the correct size when cleaning welding tips. Galvanized steel requires about 25% more horse power than non-galvanized steel. Weld time and/or weld power need to be increased to spot weld galvanized steel. Welding of steel is done at 2550 degree F. When MIG welding galvanized steel, the weld puddle is 2550 degrees F. It should be obvious, even to the casual observer, that if you put 2550 degree liquid steel over a galvanized coating that boils at 1350 degrees F. that a great deal of spatter will occur.

Spot welding galvanized steel causes very little spatter. This is especially true when the welding controller has preheating like the DiGi S.W.A.T. Welder.



Rust Prevention: When using the TITE-SPOT Pliers, the black "E" coating should be left on the inside of the new part. Also, weld-thru or other rust inhibiting primer may be put on the old part. And for a tight, dry seal, a light coat of wax based rust proofing may be put between these layers of steel. These materials will be burned out of the way at 400 to 500 degrees F. as the steel is being heated to welding temperature. After the weld is formed and the weld zone is cooling, the wax based rust proofing will be pulled back around the weld nugget by capillary action.

In Two-Gun welding, three clean sides is the overall general rule. No weld-thru primer should be used between the parts. Black "E" coat may be left on the inside of the new overlapping part if a low power preheat cycle precedes the weld power. Because of the quantity of welds and the size of the heat effect zone in Two Gun welding, good rust prevention must be applied after the welding is done.

WARNING: Gases that are formed during the welding process can be harmful and welding should be done in a well ventilated area. This is particularly true when welding galvanized steel. Because TITE-SPOT uses compressed air to cool both the TITE-SPOT Pliers and the Cool Cords, a well ventilated environment occurs automatically.

HISTORY: Spot welding was invented and patented in 1885 by an American named Elihu Tompson. The discovery was made while giving a lecture and demonstration on the exciting new field of electricity in 1884. In response to a question from the audience, Tompson created an experiment and produced the first spot weld. To put the date into perspective, the incandescent light bulb was patented in 1880 by Thomas Edison. The two men, Edison and Tompson, merged their companies, i.e. Edison Electric and Tompson Electric into one company in 1895. They called it General Electric, a company you may have heard of today. Tompson was a prolific inventor with over 700 patents to his credit, Edison never made 700 patents. As a footnote, arc welding was invented in 1885 by a Russian and was based on the carbon arc method.

WELDING JOKE

What two things cannot be welded with a spot welder?
ANSWER: A Broken Heart and The Crack of Dawn.