Press release

June 30, 2021

Mobility and energy transition with the electron beam

The mobility and energy transition has picked up speed in recent years. Better batteries combined with modern drive technology and complex battery management offer increasingly longer vehicle ranges. Photovoltaic systems with battery charging technology and electronic energy meters in building technology are improving CO_2 neutrality. This has led to a growing demand for precision resistors, so-called shunts.

Specimen copy requested after print!

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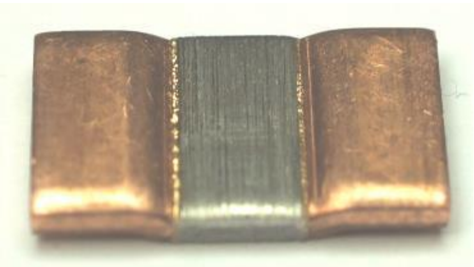
Shunts in battery management systems offer precise power metering to coordinate the energy flow from high-voltage batteries to optimize an electric vehicle's drive system.



Caption: Shunt, welded using an electron beam

Shunts have to process very large currents and adhere precisely to resistance values within narrow tolerances. Shunts are made from a particular alloy, which has both the required resistance and a low temperature dependence. For a defined electrical connection, copper strips are welded to the actual resistance material. These form the connections – and this is where the electron beam can really display its strengths!

The difference

between electrons and photons and the deep welding effect

In electron beam welding, electrons are focused on a very small area of a metallic workpiece at almost the speed of light. This process generates so much local heat energy that the material is melted and vaporizes. The resulting vapor channel allows the electron beam to penetrate deeper into the metal.

The deep welding effect was discovered in the 1950s by the physicist Dr. Karl-Heinz Steigerwald, the inventor of electron beam machining.

The electrons convert more than 90% of their energy in the material into thermal energy, in contrast to laser welding, where, depending on material and surface quality, a large proportion of the photons are reflected on the surface.

Performing electron beam welding in a vacuum prevents oxidation and other reactions with atmospheric gases, thus eliminating the need to use inert gas.

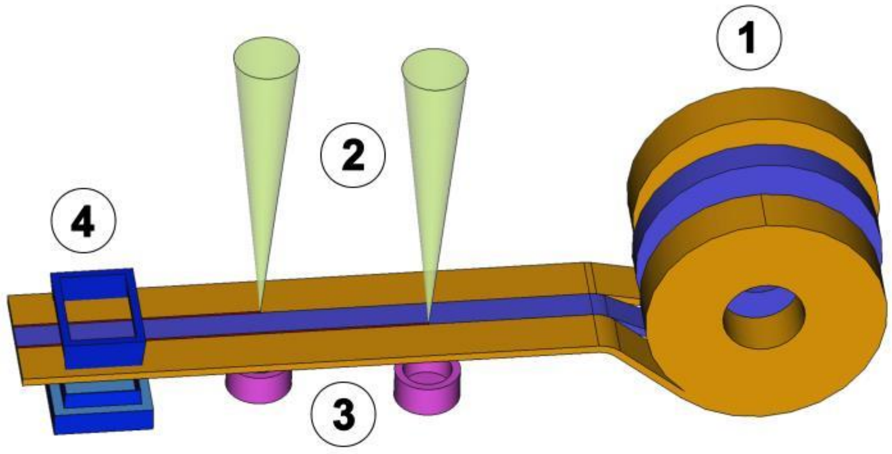
The electron beam makes it possible to obtain stronger welding of similar metals — and even two different metals — without the addition of a filler material.

The electron beam can be manipulated quickly using electromagnetic coils. This facilitates different working distances, deflection figures, welding at an angle or welding at several points at the same time using super-fast beam deflection.

Steigerwald Strahltechnik GmbH (SST) in Maisach near Munich developed the “super-fast beam deflection” method known as the “EBOJump method”, which it uses in its electron beam machines.

Shunt or trimetal strip production

Shunts are made of trimetal strips that have been welded using the electron beam. Two copper strips **(brown)** and the resistance strip **(blue)** are fed continuously by rollers **(1)** into the electron beam welding system and welded (2). For additional quality assurance, the electrons escaping on the underside of the strip are measured **(3)**. In a separate process **(4),** the shunts are then punched from the welded trimetal strips and deformed.



Caption: Principle of tri-strip welding

The specialist: 25 km of continuous production

The EBOCONT series electron beam welding systems from Steigerwald Strahltechnik are the obvious choice for welding strips. They enable continuous welding of the materials in a vacuum. The individual strips are unwound from coils and aligned. Next, they run through special vacuum lock systems developed by Steigerwald Strahltechnik. These make it easy to run the strips from atmosphere to vacuum and back to atmosphere. These locks ensure a stable vacuum in the welding chamber, thus guaranteeing a highly reproducible, continuous welding process. The finished welded metal strip is then rewound onto a coil after the welding process. In addition to different steel metals, the EBOCONT systems also perfectly weld together copper and copper alloys of the same or different thicknesses. At welding speeds of up to 20 meters per minute, approximately 25 km of continuous welding per day can be achieved.

Caption: Impressive: Up to 25 km of tri-strip production in a single day with an SST EBOCONT electron welding system

A closer look at the weld seam

The materials for shunts are primarily selected according to their electrical and thermal parameters, and only secondary based on the material's weldability.

SST EBOCONT systems offer an extremely wide range of welding parameters with highly flexible welding parameter development options to meet customer-specific requirements for weld geometry.

In addition to the electrical requirements, also the mechanical demands of the weld seam are particularly high. The focus here is on the high mechanical stress on the weld during the punching and bending process. If the weld seam breaks during the punching process, this can seriously damage the punching tool.

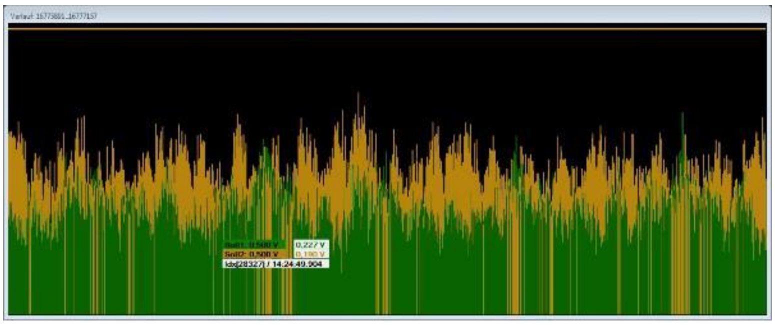
If the mechanical properties of the two seams are provided for the punching process, all-over connection of the strips can also be assumed, along with good electrical properties.

Caption: Cross section of a tri-metal strip. The weld seams between the copper strips and the resistance strip are clearly visible.

Specifications for the shape of the weld root must also be observed. The reasons for these requirements are, for example, pin contacts for 4-wire resistance measurement. If the components are to be provided with a housing, a correct fit for casting must be maintained, usually with very narrow tolerances.

Everything under control

Since the electron beam is a fully automated welding tool, all the parameters can be controlled electronically. All parameters can be recorded and the specified limits monitored. Other variables such as the through current, strip position, or the top bead and bottom bead can also be documented.



Caption: Recording the through current of a good weld seam

Outlook

Producing large quantities of high-precision shunts places high demands on the joining technology. The high welding speeds and use of copper alloys as well as compliance with narrow tolerances over many kilometers make electron beam welding with an SST EBOCONT the only economical welding process for shunt production.

For more information, visit: www.sst-ebeam.com

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