Issue 04 | February 2021

Hot Application
Wire Compacting for EV

THIS ISSUE
Wire Compacting for EV

THE CHALLENGE

Problem:

- Manufacturers are tasked with building increasingly powerful, efficient and reliable long-range electric vehicles and they rely on robust electrical connections to efficiently distribute power from the charging source throughout the vehicle. Stranded wires are utilized for their flexibility and durability, but they are heavy and make it difficult to make solid, robust interconnects.

Solution:

- Wire compacting forms stranded wires to a solid, cuboid shape that is robust, possesses less contact resistance and can reduce overall weight.

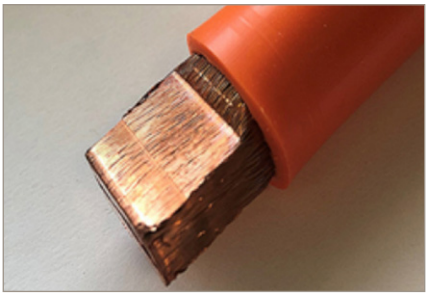
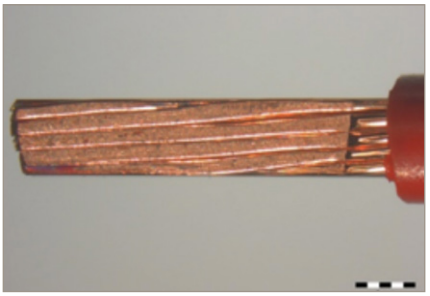
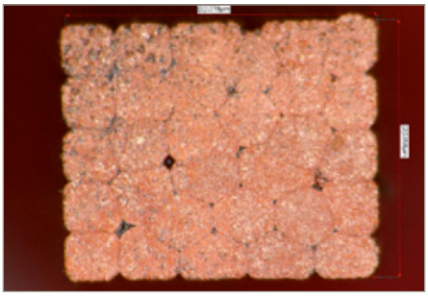
Electric Vehicle (EV) Cabling

Today's electric vehicles need to be powerful, fast and efficient – and they need to be able to go farther, faster, on a single charge. Every EV has several kilometers of cable throughout, and as the "central nervous system" of the vehicle, their connections must be fault free and robust enough to ensure, among other things, that the vehicle starts, headlights come on, tire pressure is sufficient and battery power level is displayed on the on-board computer throughout the servicable life of the car. Some of the issues engineers encounter in designing and assembling these essential cables include thermal management, contact resistance, connector dimensions, mechanical stress load, product lifespan and the need for cost reduction. Wire compacting can help design and manufacturing engineers achieve these goals.

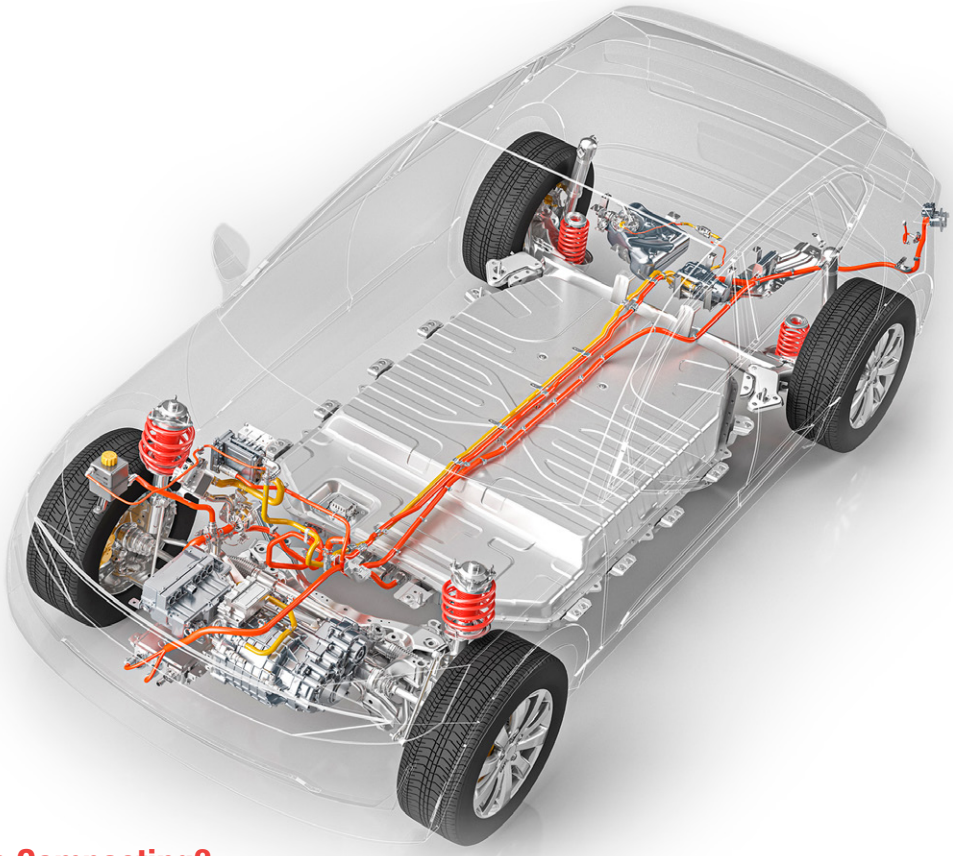
Wire Compacting

Wire compacting is a process in which stranded wire is compacted and welded into a desired shape in order to better facilitate attachment to other components, using resistance welding or other joining processes. In addition to automotive wire harness cabling, wire compacting is used in the production of:

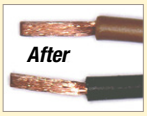
- Safety belt sensors
- Electrical distribution from batteries
- Temperature sensor connections
- Airbag initiators
- Y and T Connections

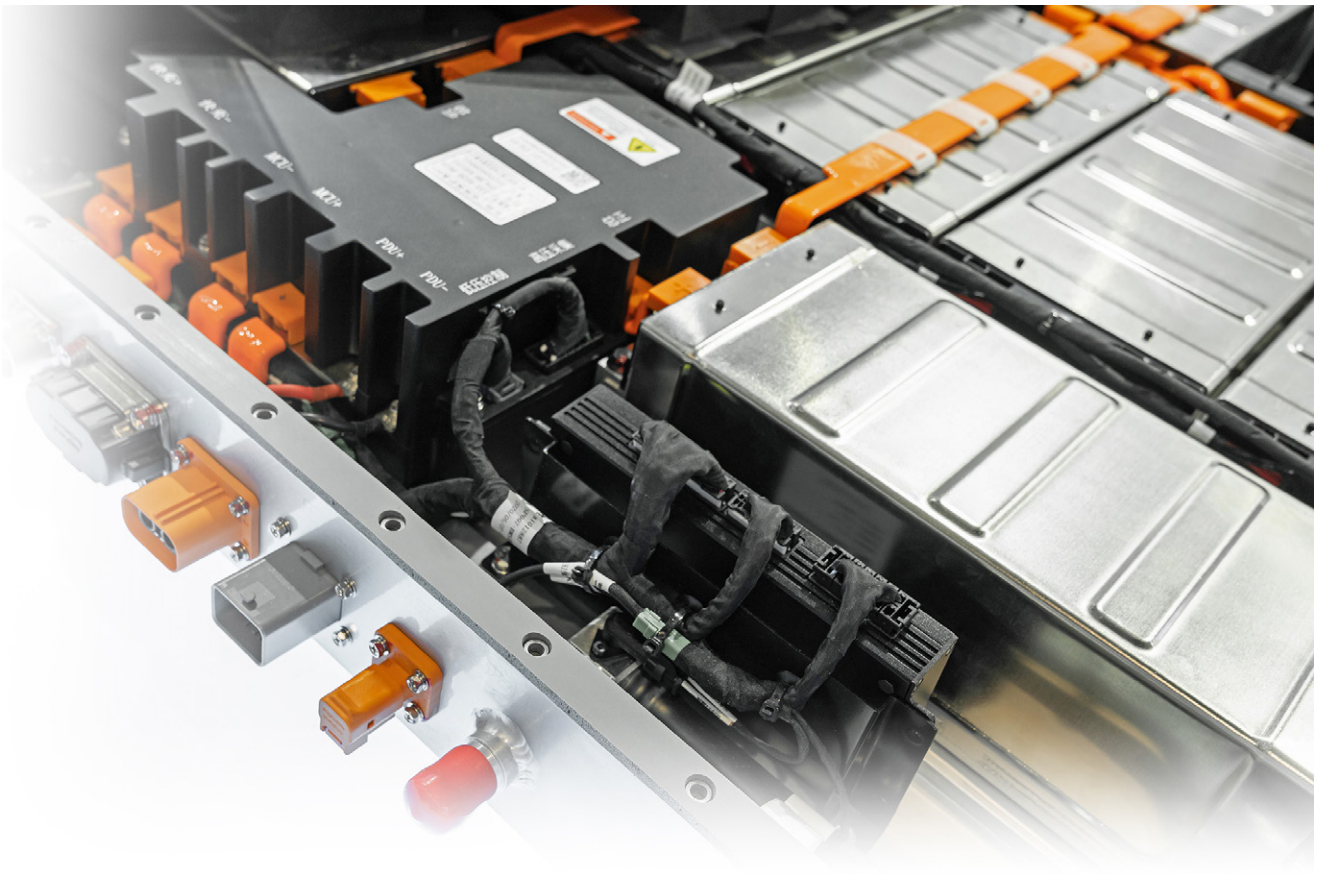





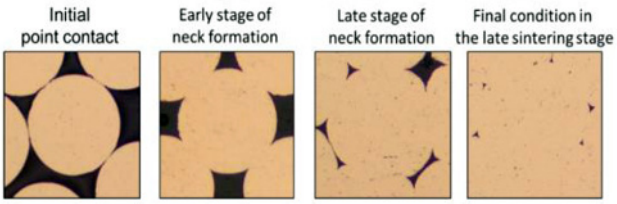
Resistance wire compacting (welding or brazing) is suitable for both stranded and solid wire applications. A weld head fitted with tungsten electrodes is utilized to deliver current and apply vertical force to "compact" the wires, while ceramic tooling inserts apply a sideward force to assist in controlling the final shape.



Why Wire Compacting?

CHALLENGE	HOW COMPACTING HELPS
Contact resistance. As contact resistance increases, current flow is reduced, generating heat at the interface. Exposure to heat weakens cables over time. Longevity of the electrical system, therefore, is directly proportional to its cumulative heat exposure.	Wire compacting produces a connector that possesses reduced contact resistance, which, in turn, helps to reduce the overall temperature of the electrical system.
Connection footprint. Stranded wire cables often have frayed ends, all of which need to be gathered together before making a connection to a terminal. Manufacturers often employ wire end sleeves to achieve smaller dimensions and facilitate installation. This process is slow and labor intensive. 	Wire compacting results in cables free of projecting wires. It does away with the need for wire end sleeves and achieves smaller dimensions for later installation. This is an enormous advantage particularly as engineers are routinely asked to reduce the size and weight of components. Furthermore, compacted cables can be welded to terminals whose geometry and package dimensions do not make them suitable for direct non-compacted wire connection. 
Reduced product lifespan. The cycle of localized heating and cooling of the weld joint causes minute expansion and contraction of the material which, as the material relaxes during cooling, often does not return to its original crimped dimensions, thus reducing the lifespan of the part.	The reduced contact resistance of the compacted joint results in lower temperatures, less thermal cycling and, ultimately, improved product lifespan.
Cost reduction - The EV market is becoming extremely competitive and every manufacturer seeks to make more and better product at a lower cost per unit.	Wire compacting reduces the need for complicated assemblies that require unnecessary processing steps like organizing frayed wires or adding wire end sleeves. It also reduces cycle time and increases throughput, saving money.
Mechanical stress load. Stresses due to vibrations and G-forces can cause degradation or failure in conductivity.	Wire compacting results in more robust connections reducing the potential for problems due to mechanical stress load.





Is Compacting a Good Fit For Your Application?

Compacting is an ideal solution for copper wire, with or without tin or silver coating. Depending on the parameters chosen, the degree of compacting (compacting strength) can vary from light adhesion of the individual wires to a solid copper end. AMADA WELD TECH has successfully compacted wires up to 90 mm^2. Twisted pairs and multiple sheathed cables are all good candidates for this process. Fully automated systems can be built for cutting and compacting braided wires off the roll so that their ends can be subsequently connected with terminals.

Material Challenges:

Aluminum - the thin oxide layer that naturally occurs on the aluminum when exposed to oxygen inhibits strong welds. The use of copper sleeves makes it somewhat possible.

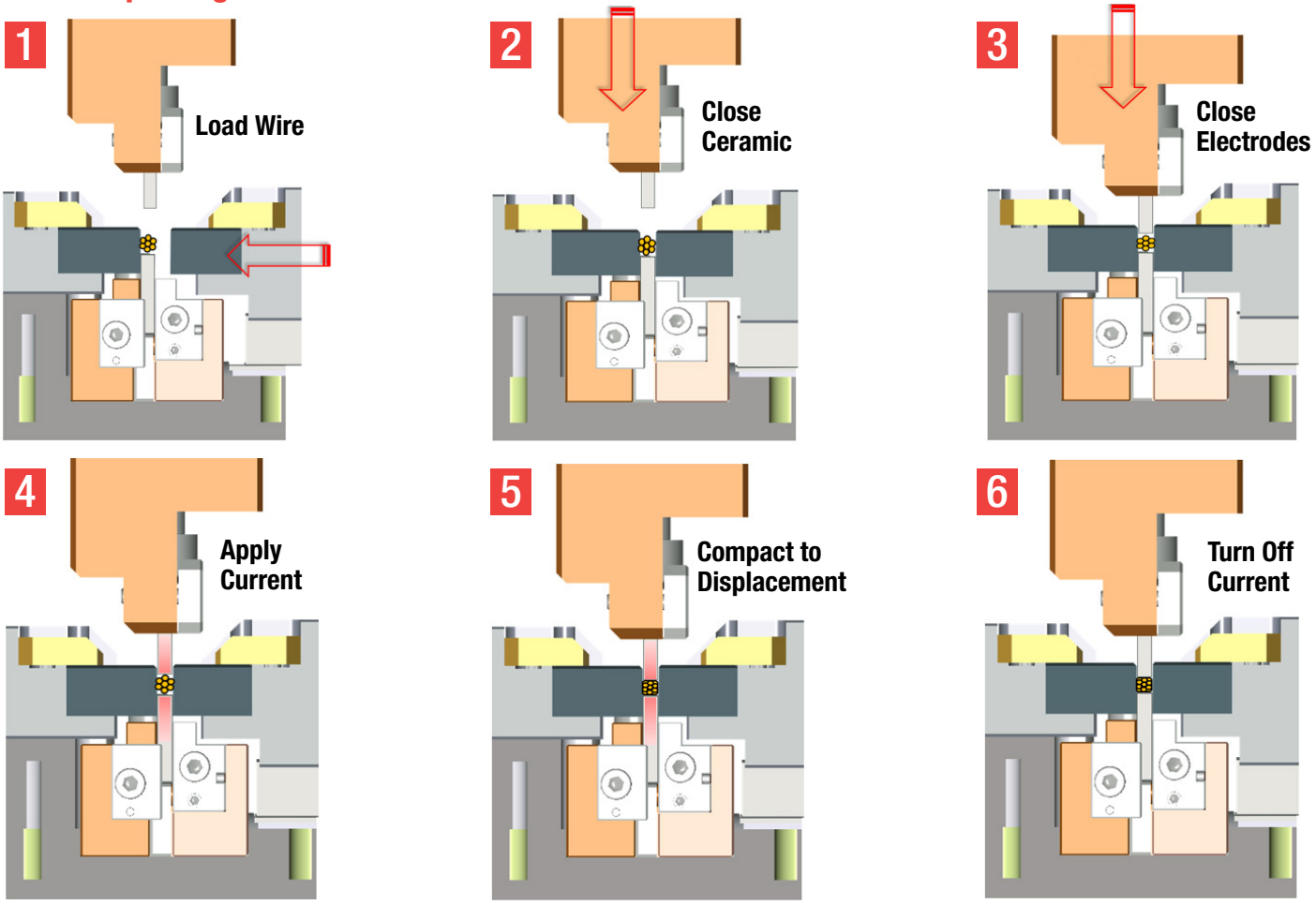
Copper wires with nickel plating coating or a nickel barrier layer - due to the different melting points of the base material and coating, it is not possible to get stable process results.

Other considerations:

Steel, nickel, nichrome (NiCr), Nisil (NiSil), NiCroSil - all of these materials will negatively impact electrode life.

Enameled wires with end sleeve - the enamel tends to vaporize during welding, and contaminating the compacting unit.

The Compacting Process



Typical Wire Compacting Images