Advice & Counsel

Frank Altmayer, MSF, AESF Fellow
Scientific Control Labs, Inc.
3158 Kolin Ave.
Chicago, IL 60623-4889
E-mail: faltmayer@sclweb.com

Galvanic and Other Corrosion Mechanisms

Dear Advice & Counsel,

We manufacture a "grounding strap" as shown in the photo. The strap consists of copper braid with a crimped connector end made of tin plated steel. The opposite end of the strap is where the copper braid is soldered and a stainless steel clip is bolted on. The copper braid is protected from impact, when the strap is installed underneath a car, by a loose fitting plastic sleeve. Figure 1 illustrates this product.

We have experienced a significant number of corrosion failures as illustrated in fig. 2. The copper braiding is attacked and the stainless steel clip corrodes. Your insight is being solicited.

Signed,
I. M. Strapped

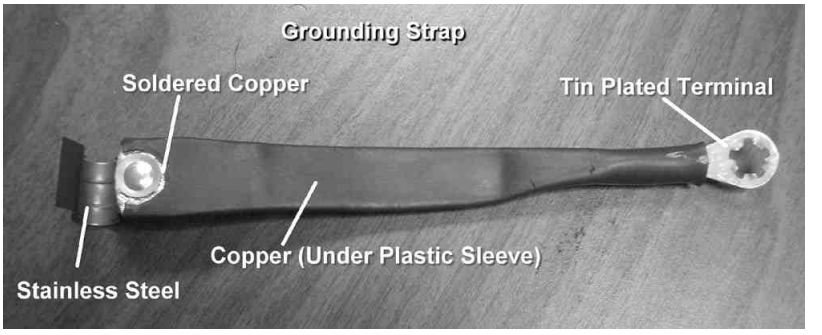

Fig. 1—Grounding strap.

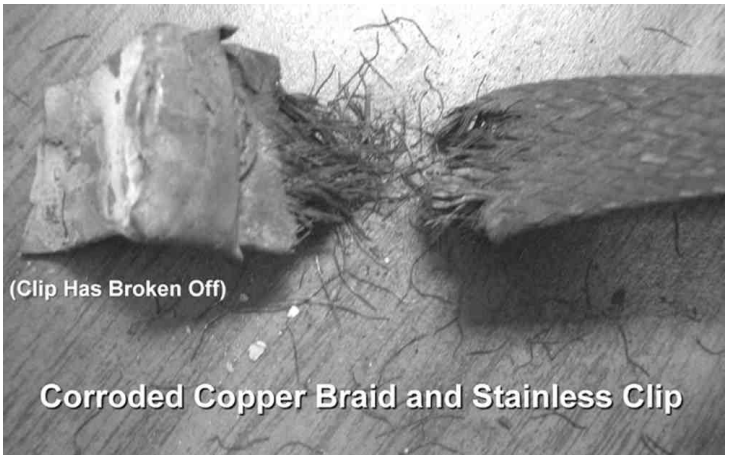

Fig. 2—Corroded braid.

Dear Ms. Strapped,

There are three major concerns I have about this component:

1. Dissimilar metals (galvanic corrosion)

Corrosion can be produced when two different metals are in contact with a liquid that conducts current. This liquid may be water, or in your case is most likely water containing road salt, which is highly conductive. The two different metals that become the terminals of a battery need to be different in electrochemical activity. In other words, there are metals that are Acompatible@, and don't make a galvanic corrosion cell when exposed to water, and there are metals that are incompatible. When an incompatible set of metals are in contact with water, one of these (the one that is more electrochemically active) will corrode. A classic example is copper and zinc, which will make a battery that generates about 1 volt when these two metals are exposed to water at the same time. The zinc is more electrochemically active than the copper, so the zinc corrodes.

In your case, you have a copper braid that is connected to a tin plated terminal at one end. To see if copper and tin produce a battery in salt-water, we consulted a galvanic series in seawater. This can readily be obtained via the internet. Shown in fig. 3 is a galvanic series in sea water from www.corrosionsource.com. Since the tin and copper are located very close to each other, they are considered to be a compatible couple and we would not expect galvanic corrosion to occur between the copper braid and the tin plated terminal. However, from the same chart, we can see that copper and stainless steel can produce a galvanic cell where the stainless steel is the corroding terminal. This is most likely what is causing the premature corrosion failure.

One fix for this situation would be to tin plate the entire strap, eliminating any galvanic cell formation. An alternative over-plate would be electroless nickel (high phosphorous preferred), which can

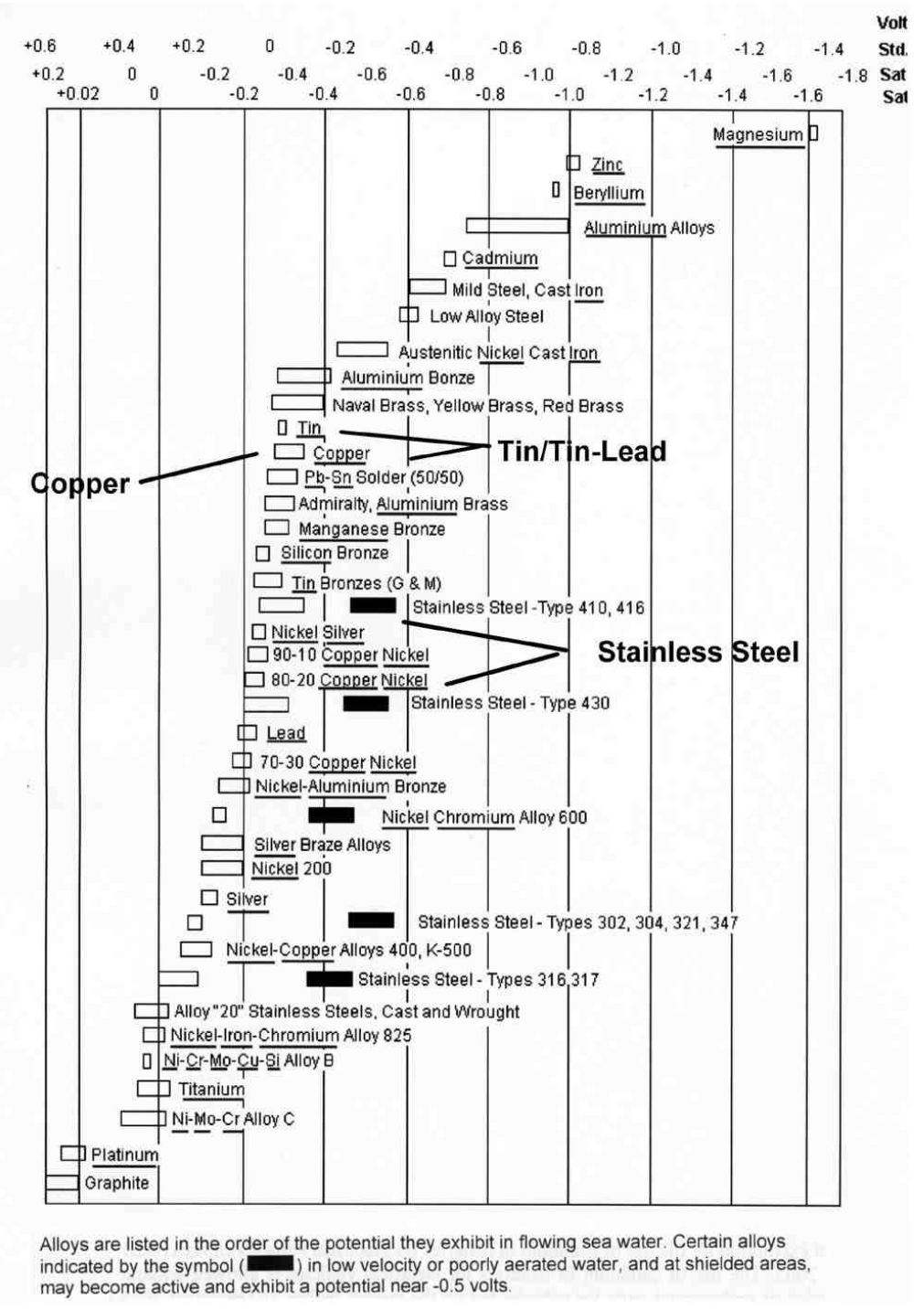

Fig. 3—Source: www.corrosionsource.com.

better cover a complex component, such as copper braining.

2. Oxygen concentration cell corrosion

The plastic sleeve is loosely attached over the copper braid. The gap between the plastic and the braid will act as a capillary, holding saltwater against the copper braid. When this happens there is a difference in oxygen between the surface of the strap not covered by plastic and that which is covered. Whenever a metal sees differences in oxygen, the surface that is deficient in oxygen tends to corrode. This is called oxygen concentration cell corrosion. In your case the copper braiding corroded since the copper covered with plastic was oxygen deficient. The plastic sleeve should either be eliminated, or should be bonded to the braiding to prevent liquid from contacting the clean copper.

3. Chemical attack

Copper is chemically attacked by sodium chloride over time. In the absence of the plastic sleeve, this may occur too slow to be a concern. However, in the presence of the plastic sleeve, which produces another corrosion mechanism, the whole corrosion process is accelerated.

This can readily be confirmed by a salt exposure test. To protect the copper against chemical attack by road-salt, it needs to have a protective over-plate such as the tin or electroless nickel discussed above. ***P&SF***