Most Common Causes for Preventable Premature Commutator Failure

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Overheating Kills Commutators Prematurely

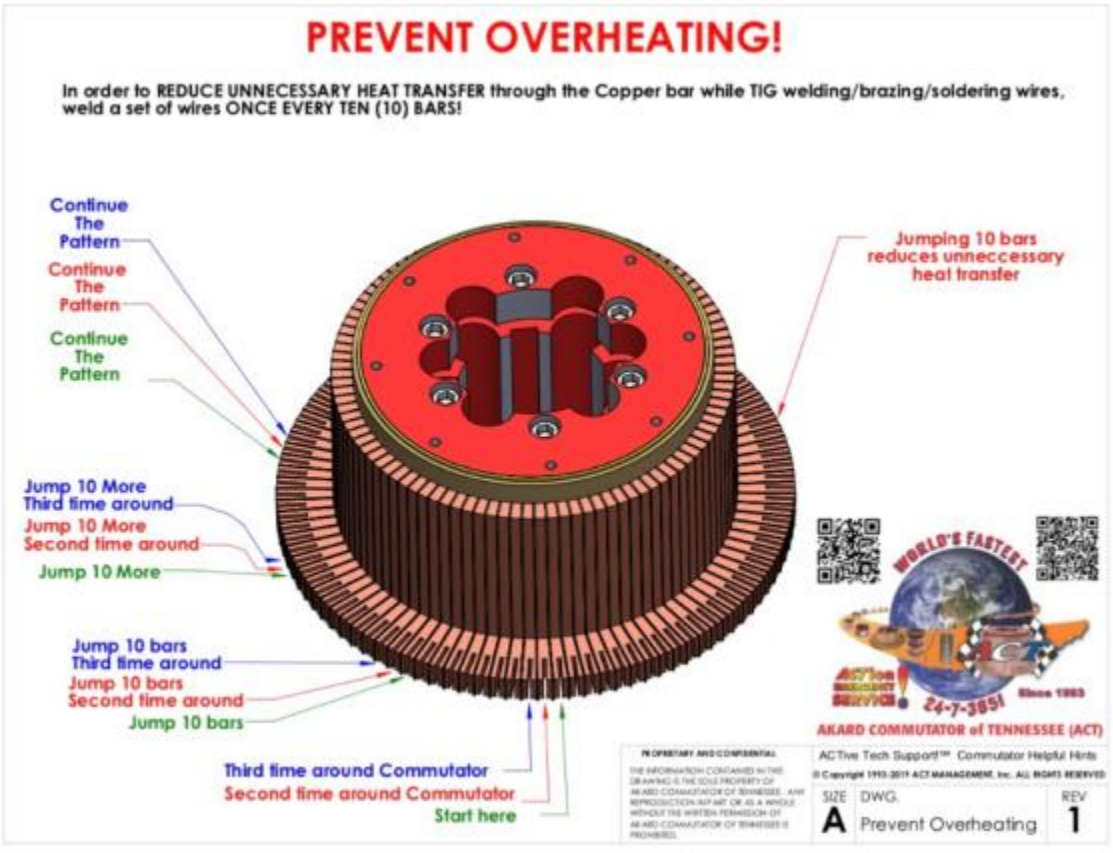
Premature commutator failure due to being severely overheated during the winding process is entirely too common yet completely avoidable given proper care taken during the winding process to prevent heat build-up.

One often overlooked way to prevent overheating is to utilize an oven with maximum temperature set at 190ºC/375ºF to preheat commutators for installation on the armature shaft. Using a torch to preheat any type of commutator is extremely risky due to the maximum temperature rating of most electrical insulation materials to ground (more details to follow) and the fact that there's no good way to evenly heat the steel part without risking severe damage internally from overheating.

Pictured above: A steel part from a commutator that failed prematurely having clear signs of severe overheating resulting from a torch being used to expedite the installation process onto the armature shaft as evidenced by the uneven heating originating in bore on riser end in addition to a brand new steel part prior to normal oven cycles and a brand new steel part after completing multiple cycles of normal heating to 190ºC/375ºF. Please note, the overheated commutator in these images has not been in a burn-off oven. Using an oven for preheating might take longer, but it's vastly superior than risking premature commutator failure as a result of overheating.

The leading cause of overheating is failing to take adequate precaution during the soldering, brazing, or TIG welding process to keep components as cool as possible.

The Electrical Apparatus Service Association (EASA) recommends skipping at least ten bars after TIG welding coils into slots of solid riser commutators rather than permitting heat to build up by welding (or even brazing or soldering) connections on bars that are side-by-side or closer together than every tenth bar.



There are obvious reasons like burning the segment mica between the bars and melting the copper risers themselves, but there are also concerns that might not be so readily recognized.

The very best copper available for use in commutators begins to anneal tempered hardness above 300ºC/572ºF, so any significant exposure of the brush riding surface to elevated temperatures can shorten the brush surface life as a result of increased wear rate associated with softened copper commutator segments. Although this sort of premature failure is uncommon, it does happen (especially on smaller commutators where not enough time elapsed by skipping ten bars to allow previously welded, brazed, or soldered connections to cool before repeating the process on adjacent bars).

Copper expands and contracts rapidly with temperature change. The mica segments between the copper bars move with the copper when it expands while heating as a result of the significant compression necessary to manufacture and retain stability, but the mica segments themselves do not expand nearly as much. Whenever excessive heat build up causes the copper bars to expand enough to swell the brush riding surface it's very likely the mica segments that are forced to move outward at the same time will become fractured at the apex of the internal commutator dovetail. If this occurs, the mica segments might remain "high" when the copper cools back down and returns to its original position (even if the bars were not overheated enough to anneal as in previous example).

burned mica segment

Even when mica segments might return to original position along with the copper bars when the overheated commutator cools down, mica segments that were cracked at or near the apex of the internal dovetail are extremely likely to lift once placed in service as a result of their mechanical strength integrity being compromised from the swelling of the copper segments forcing them to fracture. This sort of unrecognized internal damage is the root cause of the vast majority of "lifting mica" type premature commutator failures and it can be easily prevent by taking

additional precaution skip ten bars to prevent overheating when TIG welding, brazing, or soldering connections during the winding process.

Excessive overheating during TIG welding, brazing, or soldering process can also result in damage to external glass banding as well as internal insulation materials that might not have nearly as high maximum temperature rating as the mica segments between the bars. Molding mica used for v-rings and other ground insulation is only rated at only 155ºC/311ºF. Regardless of segment Mica's temperature ratings, molding mica materials used for v-rings and other ground insulation cannot withstand extreme overheating resulting from heat build up during the TIG welding, brazing, or soldering process if special care is not taken to skip ten bars so that previously TIG welded, brazed, or soldered connections can adequately cool prior to TIG welding, brazing, or soldering an adjacent connection.

A tell tale sign of extreme overheating is discoloration of the copper segments moving away from the risers along the brush riding surfaces during the TIG welding, brazing, or soldering process. We've seen bars that were so extremely overheated the Dolph's ER-41 anti-tracking paint on the outboard (opposite of riser) ends of the copper bars became blackened externally and the entire bars were purple/black (resembling having been in a burnout oven) once disassembled. This often results in bar-to-bar electrical shorting as a result of the internal ground insulation being burned significantly as well as mica segments being fractured at the apex of the internal dovetail angle.

Taking a little extra precaution to prevent heat build up and extreme overheating during the TIG welding, brazing, or soldering process by skipping ten bars can mean the difference in years of commutator life expectancy. Please take note.

Resin Kills Commutators Prematurely

Premature commutator failure due to being VPI/dipped during winding process. EASA has had Seminars and been publicizing that v-ring type commutators should never be submerged in resin (dipped) for many years, but some folks still might not realize that commutator copper should also never come into contact with any resin at any time while vacuum is being applied during VPI process. Quite a few folks have been lowering the wound armature into the resin to a point just touching the commutators' risers, thinking that since the entire commutator was not submerged everything would be alright. This practice, in and of itself, is not likely to cause problems with the commutator if no vacuum is applied to the unit while the resin remains uncured. However, whenever vacuum is applied, it is extremely important to be certain that the copper bars of the commutator are not touching the resin as the vacuum will pull some of the resin inside the commutator. This will result in greatly increased likelihood of premature failure of the commutator, even though it was never "submerged" in resin.

A little extra care to prevent exposure to resin can mean the difference in years of commutator life expectancy. Please take note.

AKARD COMMUTATOR of TENNESSEE provides a video for further reference.