PREMATURE ELECTRICAL FAILURES IN AUTOMOTIVE STARTER SOLENOIDS DUE TO TERMINAL CONTAMINATION & CONTACT EROSION

Improvements in design & evaluation by experiments

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DIFFERENT CAUSES OF CORROSION , EROSION & TERMINAL CONTAMINATION

- ELECTROLYRTIC CORROSION
- ELECTROSTATIC CORROSION
- BIMETTALIC / GALVANIC CORROSION
- FRETTING CORROSION
- OXIDATION OF CONTACTS DUE TO WATER ENTRY
- SULPATION OF CONTACTS
- CONTACT CONTAMINATION DUE TO AMONIA, OIL,ETC
- EROSION OF CONTACTS DUE TO ARCING

CASE STUDY FOR ELECTROSTATIC & GALVANIC CORROSION

[Non conductive Copper Chloride & Copper Hydroxide deposits on battery terminal
in case of electrostatic & both terminals in case of galvanic corrosion]

Attempted Solution & Accepted Criteria for Evaluation
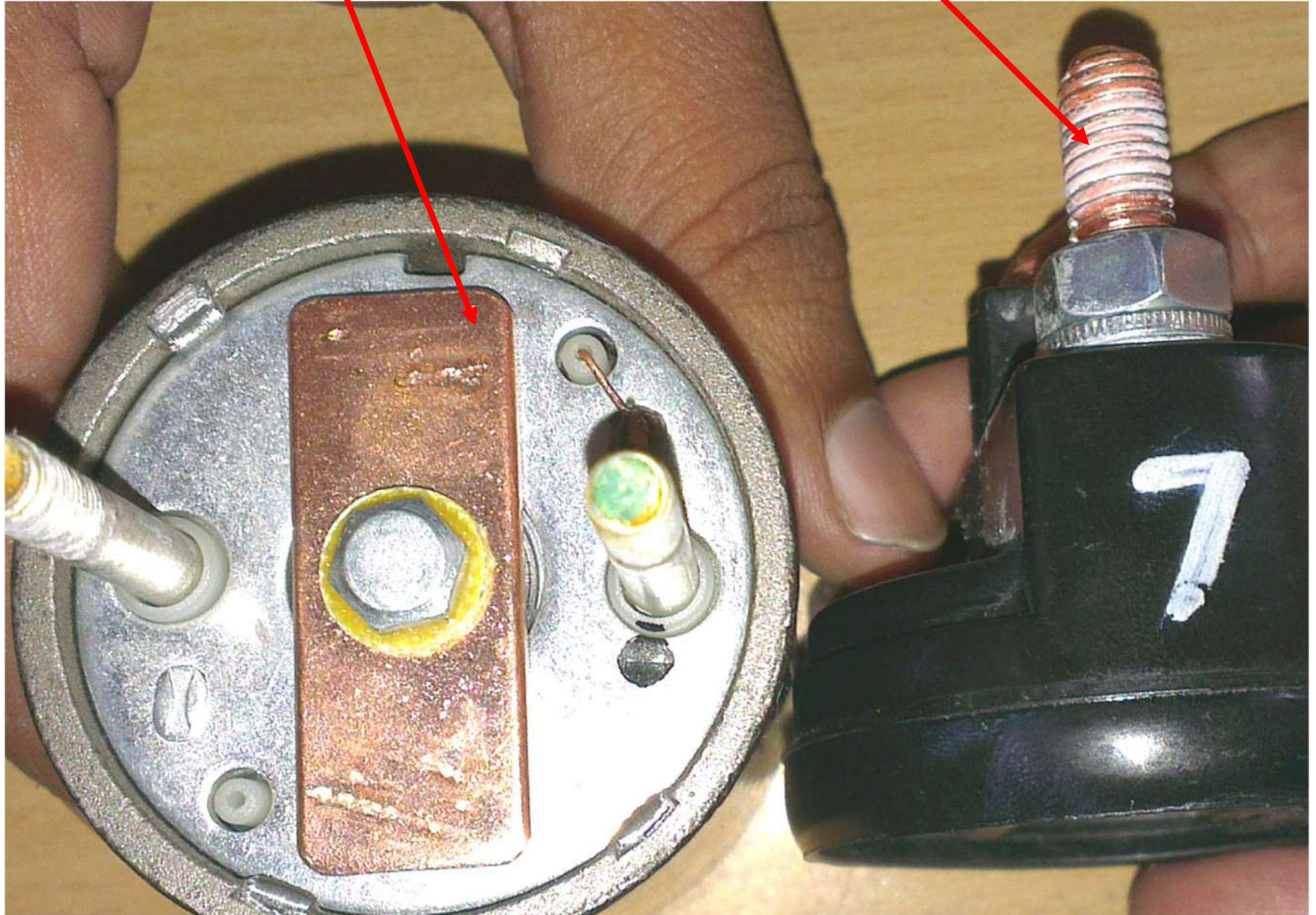
Solution Proposed for Improvement

- Copper plating on copper terminals & contact plate to be eliminated & cleaning process to be improved with better controls to eliminate acid & alkali residues in the finished components to prevent reaction with copper

- Water based anti oxidant/lacquer to be replaced by alcohol based lacquer

- All steel hardware like nuts, plate & spring washers to be Zinc-Nickel plated and trivalent passivized with a proper top coat to reduce galvanic corrosion.

Test procedure & accepted criteria for evaluation

- Two sets of solenoids both with existing as well as modified terminals & hardware are to be put through several cycles of salt spray test without motor for 8 hrs & left idle with 12V battery connected to terminals for 8 to 16 hrs.

- Solenoids are to be tested for 20 cycles on the test rig monitoring the contact drop at 100A or above before & after the salt spray cycle till failures occur.

- Acceptance of improvement should be based on simulation of failures in field and comparison of contact resistance after the build up of contamination on contacts noticed after opening the switches.

Oxidized Contact plate & excess white rust observed in E7

[Solenoid prepared with water based lacquer & zinc passivized hardware]

Contaminated contact plate & copper like coloring on plunger indicating erosion of copper terminals & contact plate

Clean Contact plate & less white rust observed in M3 in spite of arcing
[Solenoid prepared with alcohol based lacquer & zinc nickel passivized hardware]

Cleaner contacts, plate & no coloring on plunger in case of M3

Strategy for further improvement & Evaluation

Solution Proposed for further Improvement

- Copper plating on copper terminals & contact plate to be replaced by Zinc or Zinc Nickel / Zinc Tin alloy & cleaning process to be improved with better controls to eliminate acid & alkali residues in the finished components to protect copper

- Water based anti oxidant/lacquer to be replaced by alcohol based lacquer

- All steel hardware like nuts, plate & spring washers to be Zinc/ Zinc-Nickel or Zinc Tin alloy plated and trivalent passivized with a proper top coat to reduce galvanic corrosion.

Test procedure & accepted criteria for evaluation

100 cycles of On/Off to be added to the test procedure while doing salt spray to accelerate the reaction. The salt spray life of bare terminals of various types as suggested above with hardware are to be studied & compared.

Acceptance of improvement should be based on simulation of failures in field and comparison of contact resistance after the build up of contamination on contacts noticed after opening the switches.