LASER INTERFEROMETER GRAVITATIONAL WAVE OBSERVATORY

LIGO Laboratory / LIGO Scientific Collaboration

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Review of basic shorting tests on Coil Formers **D020188-04** and **D020188-08**

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LIGO Science Collaboration

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1.0 Introduction

This document contains a very brief summary of some basic testing carried out on two contrasting Coil Former designs wound with Kapton coated wire.

These tests were carried out in order to prompt discussion on the finer details of the Coil Former design with respect to design robustness prior to the supply of 72 OSEM assemblies.

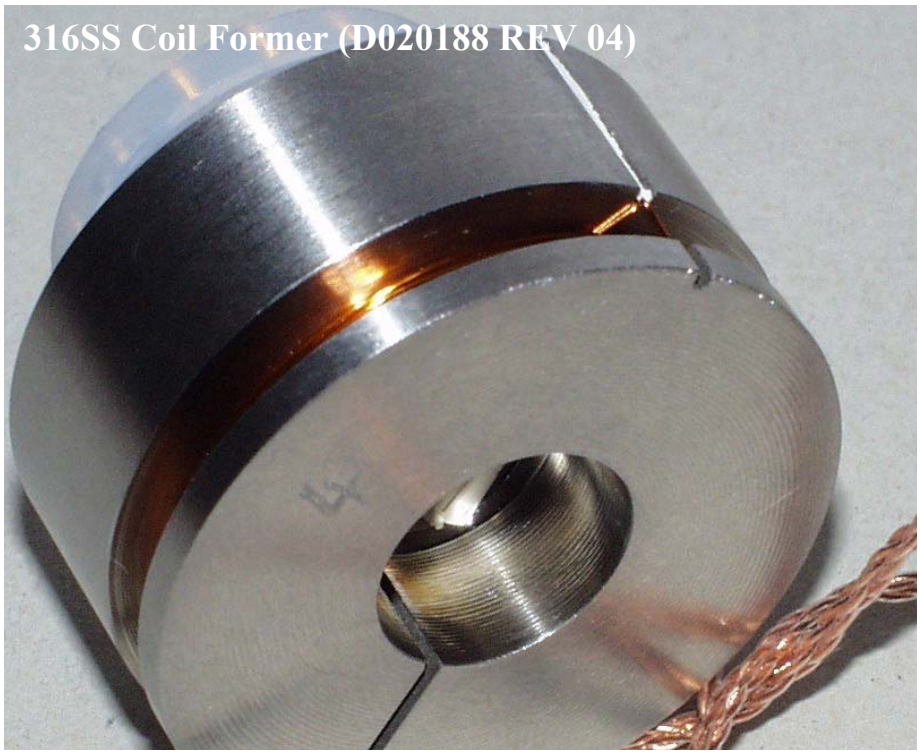
The breakdown of this number is as follows:

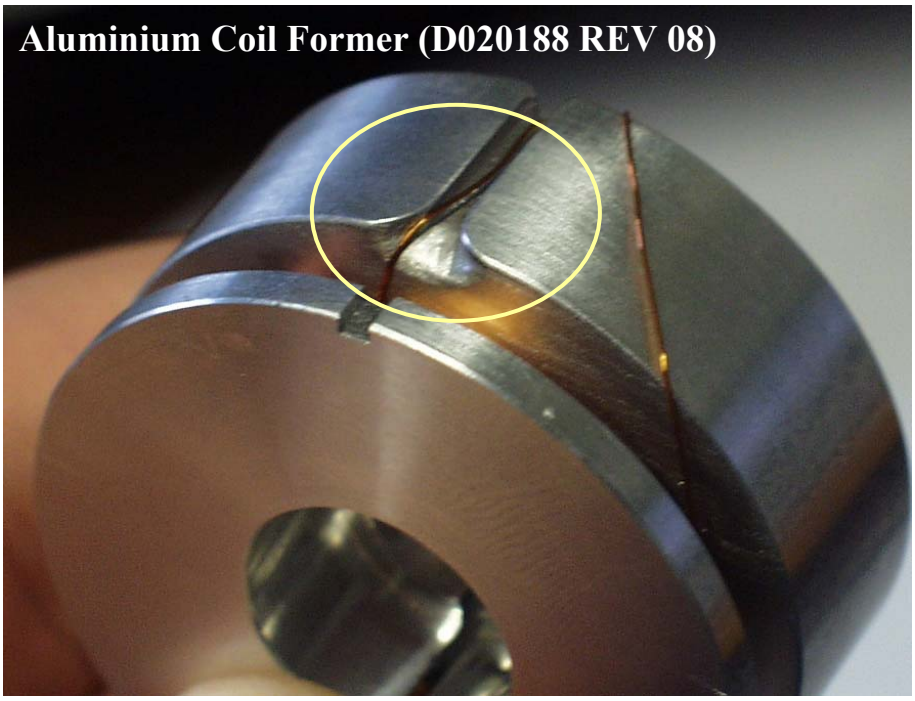
Requirements:		
MC1	**9**	(6+3 spare)
MC2	**9**	(6+3 spare)
Vac test & shelf spares	**9**	-
RM	**9**	(6+3 spare)
QUAD1	**18**	(12+6 spare)
QUAD2	**18**	(12+6 spare)
TOTAL assemblies	**72**	

2.0 Test Subjects

The following Coil Formers were used in the tests:

- **D020188-04**…an older design 316 Stainless Steel design with sharper edges
- **D020188-08**…the latest Aluminium former exhibiting larger fillets and also the introduction of the 'trumpet flute' impression (circled below) at a location where it had been evident that problems were occurring



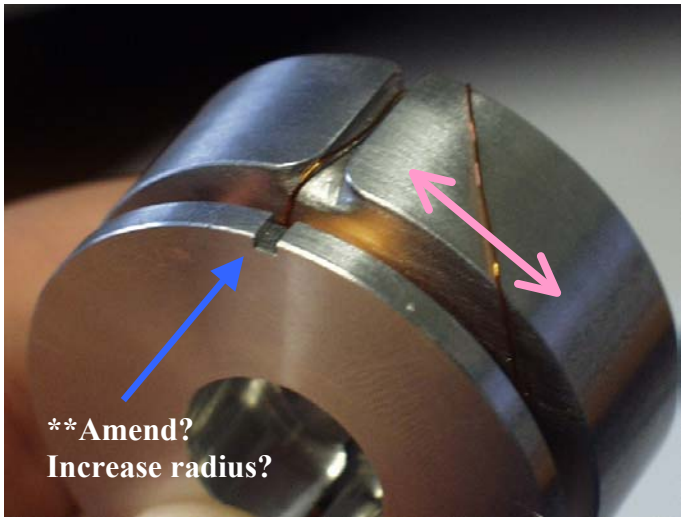


3.0 The Tests

In every case to follow, it took much less effort to create a short circuit in the case of the older design (in Stainless Steel). This is positive as it proves that previous refinements to the design have improved the robustness – which is particularly important during assembly. For this reason, the following only details the observations of tests carried out on the Aluminium former.

These tests involved extreme mishandling of both Coil Former and Kapton wire - beyond what could be considered as the reality case where far more care is taken in the handling of each component/assembly.
However, it is important that we consider such extremities so that we are sure our final design is the most reliable.

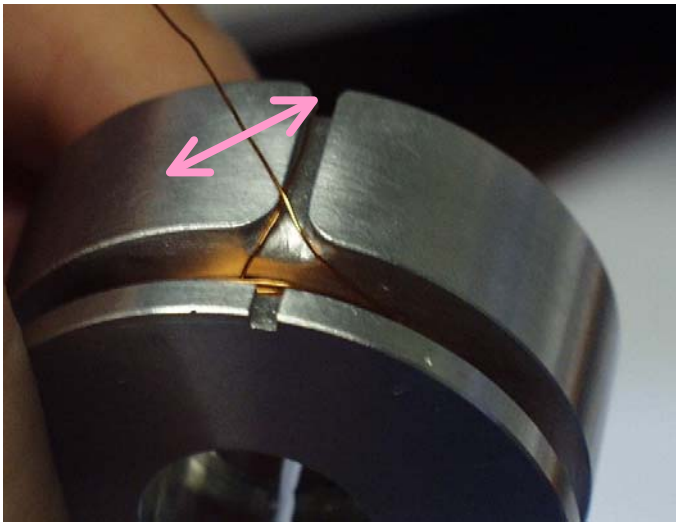
1) Test: Rubbing of Kapton wire over the edge of the main channel



Comments
This scenario is unlikely to cause a short during the winding given the winding set-up here at the Institute for Gravitational Research (Glasgow), as the wire is generally parallel to the walls of the channel during winding. However, if the winding responsibilities are transferred to the team at the California Institute for Technology (as is currently under discussion) it would be sensible to assess any new winding facility with respect to out Coil Former design so that any unforeseen problems can be highlighted.
I was eventually able to create a short, but this took a while. The fillets at the point of interest would appear to be adequate.

Suggestions
If anyone has any concerns about this scenario then we can of course increase the radius of the fillets on edges adjacent to the channel. This may be a sensible particularly on all edges that result from the slot (created to reduce eddy current effects).

2) *Test:* Rubbing of wire inside the “trumpet flute”



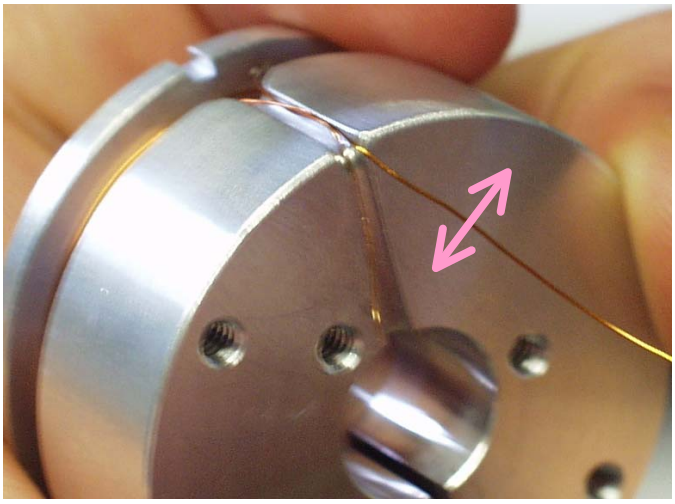
Comments

Again, this a few minutes ‘rough’ treatment to breach the Kapton coating, but the repetitive wear eventually takes effect. The introduction of this feature has made a huge difference though.

Suggestions

Given the importance of this feature, we should consider specifying a better surface finish in this area – and indeed on other regions of the former where repetitive wear is a possibility, whether it be during winding or otherwise.

3) *Test*: Wire coming over top and down the back path



Comments

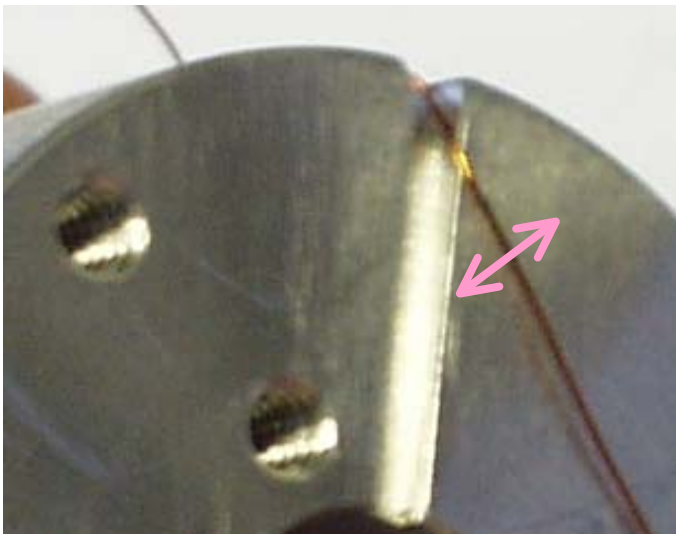
Repetitive wear again eventually caused a short.

Suggestions

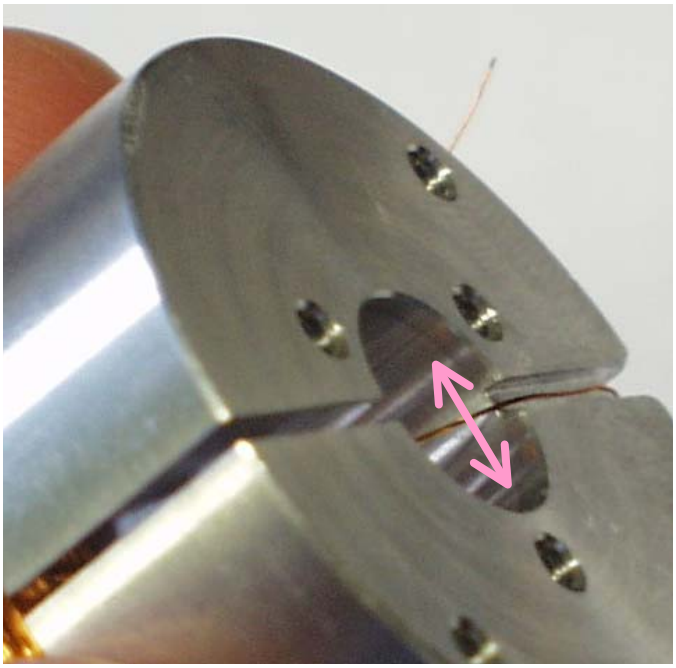
Review engineering drawing – again in relation to fillet radius and surface finish.

Both of the following tests had the same end result as tests 1 - 3, but shorting took less effort.

4) *Test:* the edges of the back path



5) *Test*: On edges adjacent to centre bore

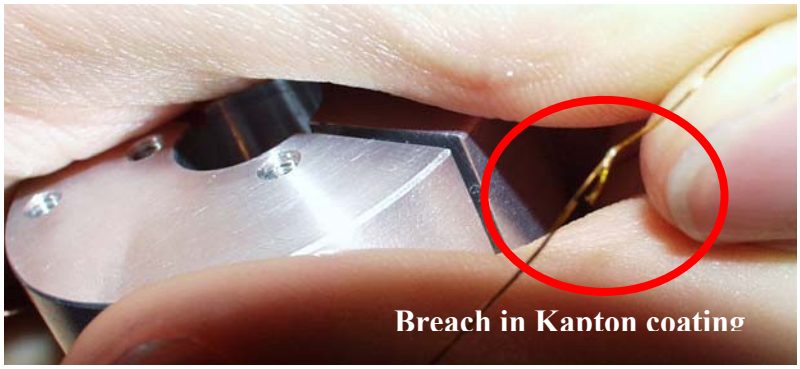


Suggestions
Increase fillet radius and make sure that this information is clearly communicated on the manufacturing drawing.

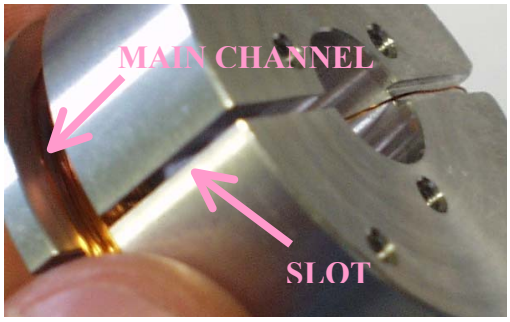
4.0 Conclusions

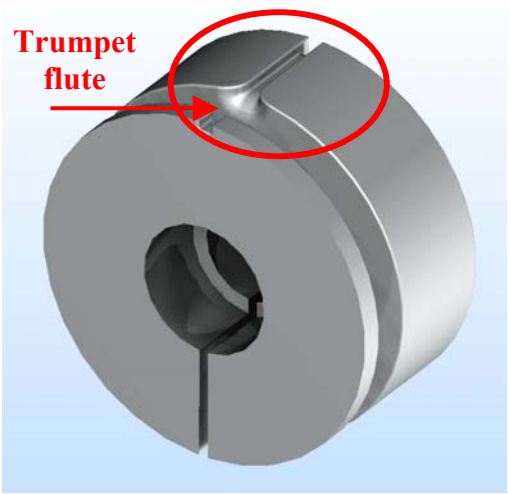
- Review and fine-tuning of our existing manufacturing drawings, particularly as regards surface finish and fillet radii, should ensure that the robustness of the current design is at an optimal level.

- It is also important that we have a full understanding of how the coils are to be wound, and also any subsequent assembly steps that may *over-stress* the Kapton coated wire.



- We are also looking into the feasibility of using Kapton film in certain locations to provide further protection against the occurrence of shorting.





This is particularly relevant in locations where the wire comes into contact with the slot.
It is difficult to create fillets on edges created by the slot inside the main wire channel.
One option may be to wind some Kapton film inside the main channel prior to the winding of the copper wire as this may provide the required protection from any hard edges.
We are also considering using Kapton Film for a similar purpose, an extra layer of protection as the wire passes out the main channel, over the “trumpet flute” and down through the back pathway.

Ideas such as this are currently under discussion.