A Study of Domestic Electrical Fire Hazards

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Introduction

Many electrical fire hazards exist in a typical home. An electrical arc is a serious one among them and can occur without the occupant's knowledge. It creates a potential fire risk leading to property damage and loss of life.

An electrical arc can be generated by flash over or by tracking. Electrical arcing can be classified into two main types a) Series arcing b) parallel arcing.

Protection devices presently available in the market make use of characteristics of electrical arcs such as high/low frequency noise and distortion in the electrical waveforms to detect and operate against an arc.

As households have a wide variety of loads and network conditions, current AFCI technology faces the challenge of being able to operate reliably under all such circumstances.

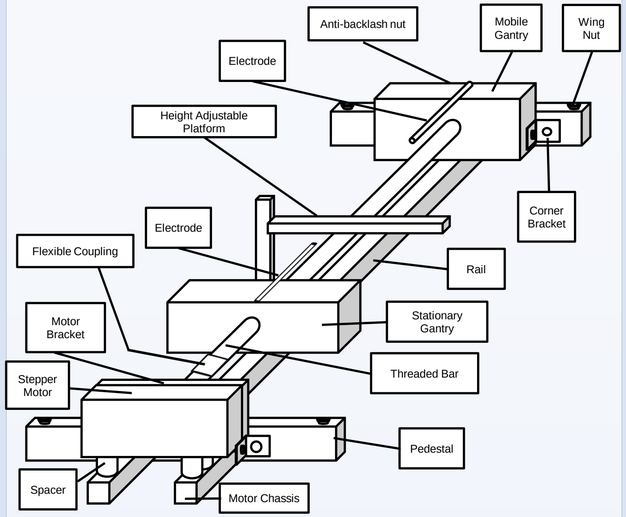
Objectives

The practical aim of this project is twofold:

1. To gather knowledge on the subject through literature review.

2. To build a rig and gain hands on information about electric arcing. The author planned to investigate the mechanism of electric arc related fires, observe arcing during break down of dielectric, observe arcing across carbonized surfaces and test the effects of electric arcing on common NZ house materials such as wallpaper, carpeting, plywood and timber.

Assembly of the rig



Experiments

Following experiments were carried out for this project:

1. Mechanism of an electric arc related fire
2. Electric arcing via breakdown of medium
3. Electric arcing via pyrolization of cable insulation

Experimental Findings

Experiment1: Near exponential rise in temperature was observed. Confirms theory that electric arcs produce heat which ignite nearby material

Experiments 2 & 3: Electric arcs gave instantaneous voltage and current leading to instantaneous power and conversion to heat.

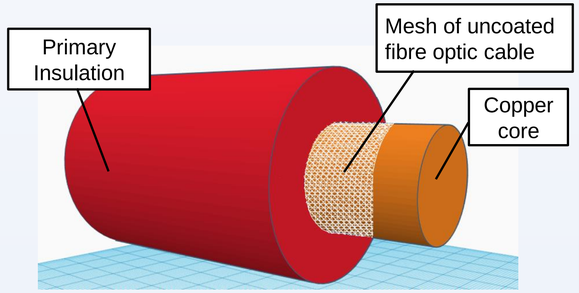
Further Research

Major drawbacks of present-day Arc Fault Detection Devices (AFDD) are nuisance tripping and non-detection of actual Arc Faults on random occasions.

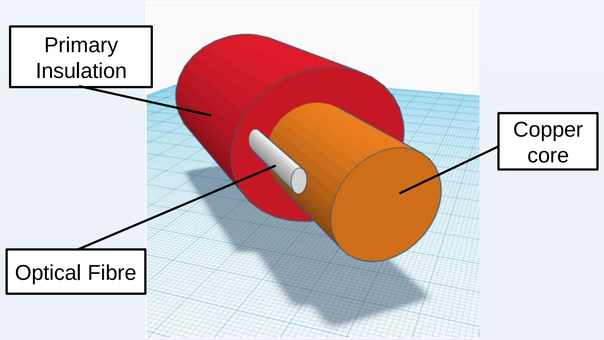
To overcome above drawbacks, the author proposes a cable, which when perfected, could be the solution.

The name coined for the proposed cable is Optically Screened Copper Cable with acronym OSCC.

Construction of the OSCC: Copper core screened by a mesh of slim uncoated optical fibre cables, which in turn is sheathed by the cable insulation material as shown below:

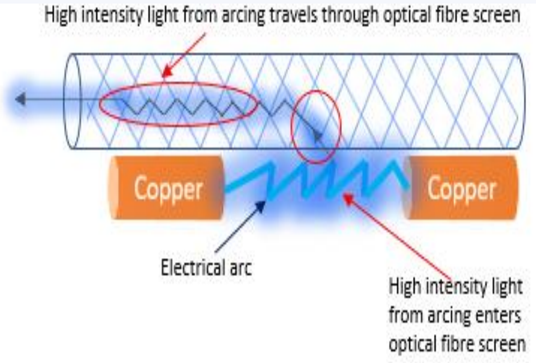


A simplified version of a OSCC would appear as shown in the figure below:



Mode of operation of OSCC

- Light beams from the arc enter the fibre optic cable.
- Part of it undergoes innumerable number total internal reflections, propagates along the fibre optic media and activates tripping mechanism of isolating circuit breaker.



Advantages of OSCC

- Vast improvement in detection
- Near instant response

Present disadvantages of OSCC

- Limitation on bending radius of optical fibre cable
- Degradation of light intensity at total internal reflections

If above disadvantages could be eliminated by further research, the OSCC would be an ideal solution.