ARC FAULT CIRCUIT INTERRUPTERS

Michaela SLAVKOVA* and Raina TZENEVA **

*Technical University of Sofia, Department of Electrical Apparatus, 1156 Sofia, Bulgaria, E-mail: michaela_ds@tu-sofia.bg

**Technical University of Sofia, Department of Electrical Apparatus, 1156 Sofia, Bulgaria, E-mail: tzeneva@tu-sofia.bg

Abstract. Arc Fault Circuit Interrupters are significant devices in area of electrical fire safety. They are designed to prevent fires by detecting an unintended electrical arc and disconnecting the power supply voltage before the arc starts a fire. These devices are selective so that normal arcs do not cause them to trip. The aim of this paper is to present these new devices, the standard requirements that they have to meet, principle of their operation, types and the area of their application and installation.

Keywords: arcing, arc fault circuit interrupter, arc fault, fire safety, .

INTRODUCTION

There are many devices that can be used in homes to reduce the effects associated with electrical and other types of residential fires. Smoke alarms, heat detectors, fire extinguishers, escape ladders and another facilities are all examples of emergency equipment used in homes to take action when a fire occurs. The arc fault circuit interrupters (AFCIs) are the next generation in circuit breaker technology and provide a higher level of protection by switching off the electrical circuit before actual fire results [1], [2].

According to the statistical data, annually, over 40 000 fires are attributed to home electrical wiring in the USA. These fires result in accidents and incidents each year. Arcing faults are one of the major causes of these fires [1], [3].

An arc fault is an unintended arc created by current flowing through an unplanned path. When unwanted arcing occurs, it generates high temperatures that can ignite nearby combustibles such as wood, paper, and carpets. Arcing faults often occur in damaged or deteriorated wires and cords. Some causes of damaged and deteriorated wiring include puncturing of wire insulation from picture hanging or cable staples, poorly installed outlets or switches, cords caught in doors or under furniture, natural aging of insulation, and cord exposure to heat vents and sunlight [2], [4].

PRINCIPLE OF OPERATION

The AFCI continuously monitors the current flow through it. Once an unwanted arcing condition is detected, the AFCI trips the internal contacts, de-energizing the circuit and reducing the potential for a fire to occur. An AFCI should not trip during normal arcing conditions, which can occur when a switch is opened or a plug is pulled from a receptacle [4], [5].

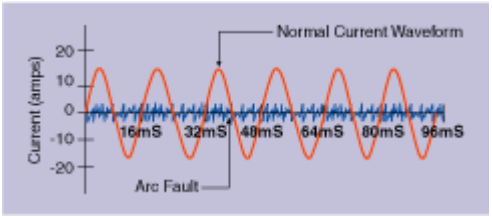

Figure 1. The pattern in blue is a signature of an arc fault and AFCI will trip. [5]

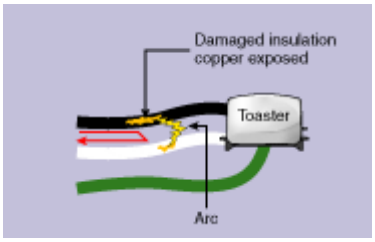

Figure 2. Typical arc fault. [5]

In Fig.2 the arc is outside the cable and continues indefinitely. The current has to jump an air gap to get from one conductor to the other. In this case of arcing the resultant current is relatively small and in most of the cases too small to trip a conventional breaker. When protected by a conventional breaker, the resultant heat may start a fire. AFCI must trip because there are exposed conductors relatively close to each other, an arc forms between the two and this arcing is recognized by the AFCI as an arc fault.

LiveWire's unique core technology is Spread Spectrum Time Domain Reflectometry, or SSTDR. LiveWire has achieved a significant breakthrough in being able to monitor changes in wiring systems, in real time. Changes that occur for as brief a time period as one millisecond can be detected, characterized, and located (distance to fault) within an accuracy of ±2% over a distance of a few inches to hundreds of meters [6], [7], [8].

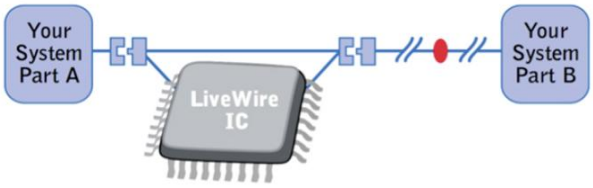

Figure 3. Live wire IC.

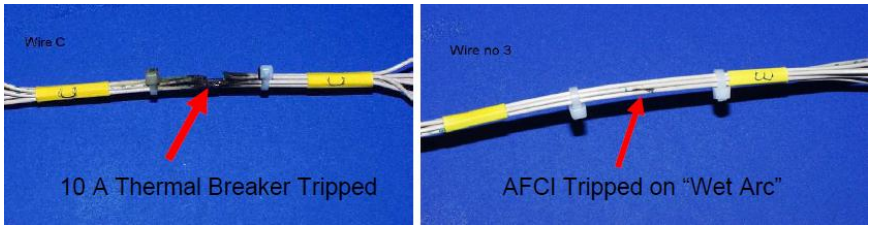

Figure 4. Live wire IC.

In Fig.5 are given the laboratory experimental test results that were performed at International Aero Inc with Square D Company to determine the differences between aircraft breakers and an Square D AFCI breakers adapted for aerospace [9]. They have shown that AFCI breakers containing Square D proprietary arc-fault technology can detect faults and trip faster than aircraft circuit breakers and are significantly faster at detecting arcing faults in aircraft wiring. [9].

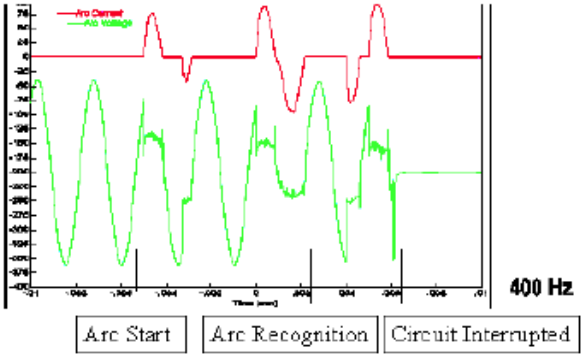

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Figure 5. Tests are based on the FAA Wet Arc Testing protocols developed to determine susceptibility of aircraft wire to arcing. (International Aero Inc) [9]

The 1999 edition of the National Electrical Code (NEC), requires AFCIs for receptacle outlets in bedrooms, effective January 1, 2002. The 2005 NEC 210.12 states that effective January 1, 2008 all arc fault circuit breakers must have both parallel and series arc detection. This is called combination AFCI. There are two types of arcing – series and parallel [1], [2], [4], [10].

a) **b)**

Figure 6. Types of arcing. a) parallel arc; b) series arc;

Series arcing: Arcing occurs when a single conductor is severed; for example, if one conductor on an appliance cord is cut completely and current continues to flow through a small air gap between the two compromised points of that conductor [10].

Parallel arcing: Arcing happens when current travels from one circuit conductor to second conductor through air; for example if both conductors on an appliance cord are compromised at the same point and current travel between the conductors through a slight air gap [10].

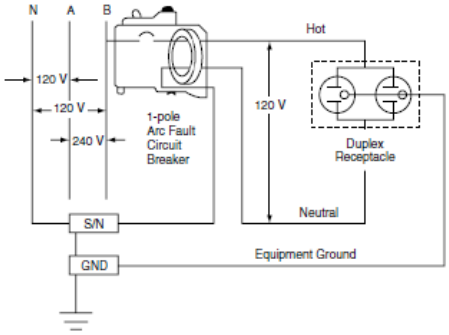

Figure 7. Connection diagram of the AFCIs to the mains.

AFCIs should be tested after installation to make sure they are working properly and protecting the circuit. Subsequently, AFCIs should be tested once a month to make sure they are working properly and providing protection from fires initiated by arcing faults.

CONCLUSIONS

The arc fault circuit interrupters will expand the protection and safety that a circuit breaker provides within the home and, more specifically, will help reduce the risk of electrical fires.

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