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Desert Cooler Safety Enhancement: Mitigating Leakage Current Risks

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***Abstract*— Desert coolers, popular for their cost-effective cooling mechanism in arid regions, have become integral to maintaining comfort in households. However, their operation poses potential electrical hazards due to leakage currents, presenting risks to users and properties. Crucially, the study yielded significant findings. These findings highlighted key areas for improving user safety and enhancing appliance security in desert coolers. The proposed safety measures, as a result, emerged as a practical roadmap for implementation, addressing challenges in adoption, considering cost-effectiveness, and emphasizing potential implications for industry stakeholders. This study undertook a comprehensive investigation into these risks to propose pragmatic safety measures, focusing on user protection and enhancing appliance safety. The outcomes of this study hold substantial promise in augmenting the safety standards of desert coolers. By implementing these proposed measures, users can expect increased safety, reduced risks from electrical hazards, and heightened awareness regarding safe practices when using these appliances.**

***Index Terms*— Desert coolers, Electrical hazards, Leakage currents, Safety measures, User behavior, Appliance safety**

I. INTRODUCTION

Electricity is an indispensable element of modern life, serving as the lifeblood powering our industrial, commercial, and domestic realms. However, its misuse or inadvertent leakage poses grave threats, including the peril of fire outbreaks and the risk of fatal electrocution. The pivotal role of secure and reliable electrical power in the advancement of a nation's industrial and economic sectors cannot be overstated, underscoring the critical need for robust safety measures within power supply systems. Invention has provided an in-depth analysis of home electrical fires, covering causes, statistics, prevention methods, and potential solutions. This resource may offer valuable insights into the dangers posed by electrical fires and effective strategies for prevention and safety [1,2]. Leveraging advanced technology, specifically employing high-precision current transformers and high-gain linear converters, this detector aims to surpass existing systems in reliability and precision. [3]. Earlier work focuses on machine learning applications for fault detection in air conditioning systems. The study may delve into using AI-based algorithms to detect and prevent faults in air conditioning units, potentially offering insights into leveraging advanced technologies for system reliability [1]. In paper discussion of the causes, effects, and possible solutions

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related to poor quality issues within power systems. It might explore various problems affecting power system quality and propose mitigation strategies for enhanced system performance and safety [4]. Research on an Arduino-based smart home wiring system may focus on developing a system that employs Arduino technology for home safety. This work discuss utilizing sensors, cameras, and Arduino controllers to create warning systems that alert homeowners about potential hazards like fires, gas leaks, or electrical faults, emphasizing preventive measures [5]. The primary aim of this study is to devise a highly accurate and efficient detection mechanism capable of identifying leakage currents exceeding 1 mA.

II. METHODOLOGY

A. Block Diagram

Figure 1 shows Circuit diagram of Circuit diagram of leakage current protection for Desert cooler.

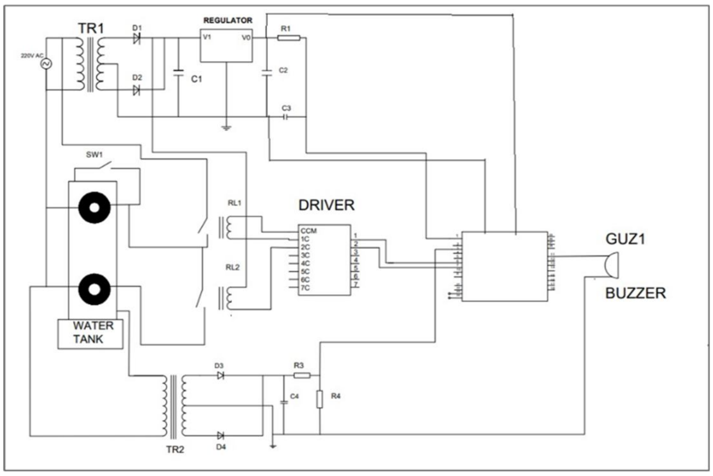

Figure1. Circuit diagram of leakage current protection for Desert cooler

The system is an intricate safety setup devised to promptly identify and address potential electrical leaks within a cooler's infrastructure. Operating at its core is a step-down transformer that reduces the incoming 230V AC supply to a manageable 12V AC. This voltage is then transformed into pulsating DC through a diode rectifier and smoothed out using Capacitor C1 to approximate pure DC. A voltage regulator IC (7805) further refines the output to a stable 5V DC supply, which is stored in Capacitor C2 and distributed to power the microcontroller. This microcontroller serves as the system's brain, receiving an analog signal originating from Transformer 2, connected to the cooler body. This signal acts as an indicator of any voltage abnormalities, which, if detected, prompt the microcontroller to act. To aid its operation, a reset mechanism utilizing a 0.1nF capacitor and a 10Kohm resistor is integrated into the microcontroller's pin 1.Upon detecting irregular voltage levels that suggest a potential electrical leak, the microcontroller swiftly triggers Relay 1 and Relay 2. Relay 1 controls the cooler fan, while Relay 2 governs the water pump. Both relays serve to immediately cut off the power supply to these components, thereby mitigating any risk associated with the detected electrical leakage. Upon detecting irregular voltage levels that suggest a potential electrical leak, the microcontroller swiftly triggers Relay 1 and Relay 2. Relay 1 controls the cooler fan, while Relay 2 governs the water pump. Both relays serve to immediately cut off the power supply to these components, thereby mitigating any risk associated with the detected electrical leakage. For managing relay operations, a driver IC is employed, converting the 5V signal from the microcontroller to the necessary 12V required to effectively activate the relays. Furthermore, the system includes a buzzer that acts as an audible alert, notifying operating personnel in the event of an electrical leakage detection. The system periodically checks the voltage in the cooler body every 10 seconds as a preventive measure. Should the microcontroller identify high voltage anomalies, indicative of a potential leak, it triggers the alarm and initiates the disconnection of electricity to the cooler via the relays. The system then maintains this cutoff for a safety duration of 10 minutes before restoring power and conducting another check. This cyclic process persists until the electrical leakage risk is rectified, ensuring a comprehensive and continual monitoring system for heightened safety protocols.

B. Working

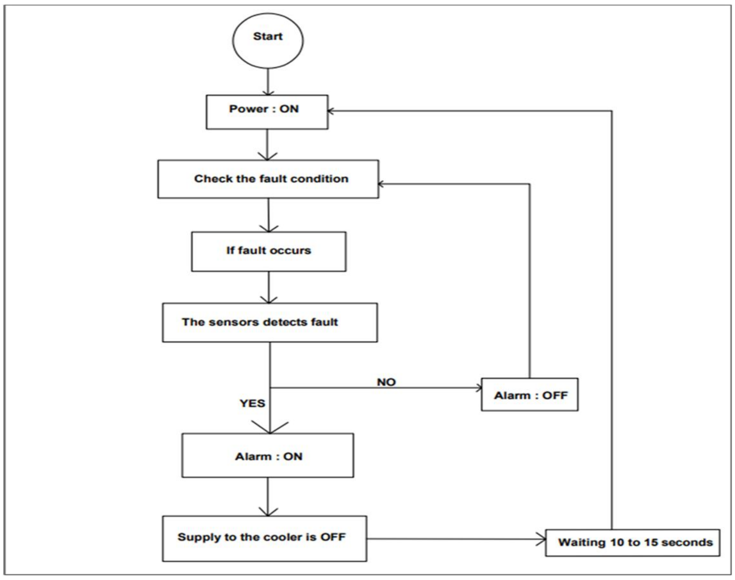

Figure 2. Flow chart of leakage current protection for Desert cooler

The project "Desert Cooler Safety Enhancement: Mitigating Leakage Current Risks" utilizes a PIC16F886 microcontroller as the core element to enhance safety measures in desert coolers. The system operates with a 5V regulator and incorporates various capacitors (475uF, 1000uF, 100uF, 0.01uF) to stabilize and manage electrical signals within the circuit. Employing a potential transformer (PT) with a 220/5 Volt configuration, it monitors the voltage in the cooler body. Relays, specifically Single Pole Double Throw (SPDT) type, controlled by the microcontroller, ensure immediate power disconnection to critical components (such as the fan and water pump) upon detecting potential electrical leaks. The specific relay driver used for this operation is not specified. A 5V buzzer is integrated to provide an audible warning signal in case of detected electrical irregularities. The system likely incorporates a 220/12 Volt transformer to step down the voltage for safe operation within the cooler circuit. Additionally, a 1 Kohm resistor might be employed in the system for certain signal conditioning or control purposes.

The project's implementation involves a printed circuit board (PCB) with a copper-clad base, indicating the use of standard PCB manufacturing techniques to assemble and connect the various components

III. Results And Discussion

A. Ratings of a System

Table 1 gives ratings of major components applied for the system.it consists of following major components.

PIC16F886 Microcontroller; The PIC microcontroller, specifically the 28-pin variant, stands as a pivotal component in modern embedded systems due to its versatility and computational capabilities. This 28-pin microcontroller, part of Microchip's PIC family, integrates a powerful yet compact architecture, housing essential functionalities within its constrained footprint. With a blend of robust processing capabilities and diverse peripheral features, this microcontroller serves as the core processing unit in a wide array of applications, spanning from consumer electronics to industrial automation.

SPDT Relay: A Single-Pole Double-Throw (SPDT) relay is an electromechanical switch that consists of a common terminal (COM), a normally open (NO) terminal, and a normally closed (NC) terminal. When the relay is not energized, the common terminal is connected to the normally closed terminal. Upon applying power (typically 12 volts in this case) to the relay coil, the relay switches, and the common terminal gets connected to the normally open terminal while disconnecting from the normally closed terminal.

Buzzer: It is used as warning alaram for leakage current in the desert cooler so that human being coming in contact with cooler will remain alert.

Crystal Oscillators: A crystal oscillator is an electronic oscillator circuit that uses the mechanical resonance of a vibrating crystal of piezoelectric material to create an electrical signal with a very precise frequency. The crystal used in these oscillators vibrates at a specific frequency when an electric field is applied to it and generates a stable frequency output.

TABLE I. LIST OF COMPONENTS FOR DESERT COOLER SAFETY ENHANCEMENT

Components	Specification	Quantity
Micro-Controller	PIC16F886	01
Regulator	5 Volt	01
Crystal Oscillator	-	01
Relay	SPDT	02
Relay Driver		01
Buzzer	5 Volt	01
PT	220/5 Volt	01
Capacitor	475uf, 1000uf,100uf, 0.01uf	06
Diode	-	04
PCB	Copper Glad	01
Transformer	220/12 Volt	01
Resistor	1 Kohm	04

B. Hardware

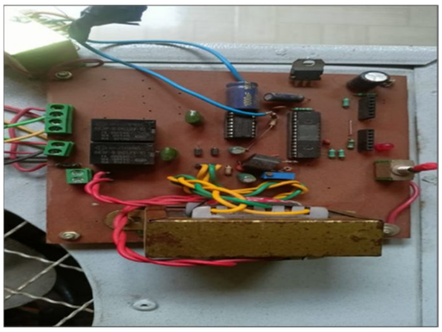

Figure 3. Hardware Module assembly for Desert cooler

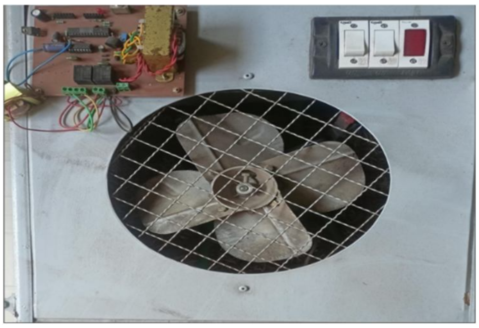

Figure 4. Complete Hardware Module of Desert cooler with protection circuit

Figure 3.shows hardware module assembly for protection from leakage current.
Figure 4.Shows protection hardware module assembly installed on desert cooler.

IV. CONCLUSION

In this paper, a robust system has been successfully installed and developed to safeguard individuals from potential fatalities and protect valuable resources against the hazards arising from unforeseen electrical leakages into desert cooler bodies. The primary objective was to create a comprehensive solution that not only identifies the presence of danger but also responds intelligently to mitigate the risk. The system, meticulously designed and implemented, demonstrated its efficacy through practical testing on the cooler. By intentionally applying an electrical voltage to the cooler body, the system promptly and effectively alerted users to the impending danger through sound notifications. Furthermore, it showcased its smart decision-making capabilities by swiftly cutting off the electrical current to the cooler, thus preventing any escalation of risk until the danger subsided. The results obtained from the practical testing were not only satisfactory but also aligned seamlessly with the initial expectations, underscoring the success of the system in providing a proactive and reliable safety mechanism. This project marks a significant stride towards enhancing electrical safety measures, offering a tangible and efficient solution to potential hazards in the context of desert coolers, and potentially paving the way for broader applications in electrical safety systems.

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