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Accident Prevention By Isolation of Earth Leakage by Using Earth Leakage Circuit Breaker

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ABSTRACT: Power outage is a common problem when there are electrical faults occurred, which would lead to discontinuity of electrical supply to domestic building. For domestic consumers power continuity is very important since some of the appliances such as refrigerator, aquarium and alarm system require a continuous electrical supply. However, fault occurred in the system will trip the earth leakage circuit breaker (ELCB) and disrupt the supply to all the appliances. Power system grounding or earthing plays a important role while using this circuit breaker. The ELCB operates properly whenever the proper grounding is provided to the electrical system. This circuit breaker mainly focus on the line to ground fault detection. Fault may occur due to short circuit, ground fault, leakage current or overloading. These are the minor faults which causes the major damages to human body and the electrical system. Thus, the aim of this project is to overcome these problems. This system is able to detect and isolate the fault in order to ensure the power continuity and provides safety to the human beings.

KEYWORDS: Earth Leakage Circuit Breaker(ELCB), Minature Circuit Breaker(MCB), Residual Current Circuit Breaker(RCCB), Supervisory Control and Data Acquisition(SCADA).

I. INTRODUCTION

The ELCB is the Earth Leakage Circuit Breaker which is used to isolate the earth leakage. The ELCB works on the CURRENT BALANCE PRINCIPLE. There are two types of ELCB's are available. They are single phase 2-pole earth leakage circuit breaker and three phase 4-pole earth leakage circuit breaker. The Fault current overloads and short circuits can be detected by circuit breakers like MCB's MCCB's & Fuses etc. But, Circuit breakers don't detect leakage currents, which are dangerous for humans and livestock and if not detected can lead to fire hazards. We need a solution that detects such leakages currents and disconnects the circuits from the power supply. Here comes the solution in the form of RCCB (Residual Current Circuit Breaker) also known as ELCB (Earth Leakage Circuit Breaker) which provides protection against direct and indirect contact of personnel or livestock and against probable fires. The earth leakage is detected by the ELCB, as soon as the the circuit breaker trips and disconnect the power supply.

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II. FEATURES

Positive detection of earth leakage currents as low as 30mA in less than 40 milli seconds there by acting as a life saver. The moving contacts of the phases are put on a moving arm, actuated by a rugged toggle mechanism. Hence the closing and opening of all the phases occur simultaneously. This also ensures simultaneous opening of all the contact under automatic tripping conditions. ELCB's are provided with an ARC chamber consisting of arc-chute. They arc-chute quenches the arc faster, which further increases electrical contacts life. This can be implemented for Domestic and Industrial purposes.

SPECIFICATIONS

Rated Voltage(V)	Pole No	Rated current (A)	Leakage action current(mA)	Leakage dead current(mA)	Leakage action time(s)
220V	1P	1~10	30	15	<0.1
		15~32			
380V	2,3,4P	40~60	100	50	

TABLE.1

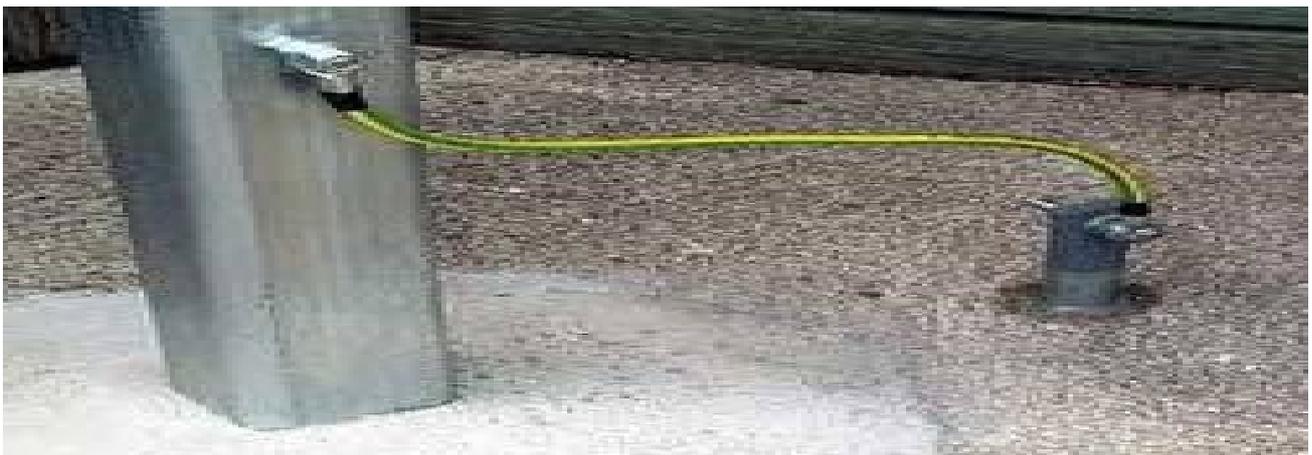
III. EARTHING

The Earthing or Grounding is the safety provided to each and every electrical system. Earthing is the major consideration in protecting the electrical system from internal causes and external causes. The internal causes like switching surges, overflow current and voltage, fault current, etc. and the external causes such as lightning.

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The Earth Leakage Circuit Breaker mainly detects the leakage current and the earth leakage. Earthing plays a major role in the working of the ELCB. For the proper function of the ELCB the proper earthing is to be provided for the electrical system. The improper earthing or the absence of earthing may leads to the improper or malfunction of the Earth Leakage Circuit Breaker. The line to ground fault is detected by the ELCB, such that it mainly requires the grounding. Thus the surges cause internally and externally in the electrical system causes overflow in that system. Such that providing the proper grounding these surges are allowed to pass through the ground, which does not cause any effects on the electrical system and the human beings.

IV. OPERATING TIME

The operating time of the Earth Leakage Circuit Breaker is defined as the ratio of HUMAN BODY RESISTANCE to the VOLTAGE TO GROUND.

The safest limit of Current which Human Body can withstand is 30ma sec. Suppose Human Body Resistance is 500Ω and Voltage to ground is 230 Volt. The Body current will be $500/230=460\text{mA}$.

Hence ELCB must be operated in $30 \text{ ma Sec} / 460 \text{ mA} = 0.65 \text{ msec}$

Human body resistance

Operating time = -----

Voltage to ground

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V. HUMAN TOLERANCE VALUE FOR ELECTRICAL CURRENTS

500 mA		Immediate cardiac arrest resulting in death
70-100mA		Cardiac fibrillation; the heart begins to vibrate and no longer beats at a steady rate. This situation is dangerous since it is irreversible
20-30 mA		Muscle contraction can cause respiratory paralysis
10 mA		Muscle contraction : the person remains 'stuck' to the conductor
1-10 mA		Prickling sensations

TABLE.2

A. PRICKLING SENSATIONS

For 1-10mA of current flow in the human body causes the prickling effect but this does not cause the severe effects on the human body. Human body just absorbs the vibrations only.

B. MUSCLE CONTRACTION

For 10mA of current flow in the human body causes the Muscle Contraction. The muscles of the human body gets contracted and the person gets stuck to the conductor. It may also affects the respiratory system of the human body.

C. RESPIRATORY PARALYSIS

For 20-30mA of current flow in the human body causes the respiratory paralysis because of the muscle contraction. The entire respiratory system may gets collapsed and even it leads to dead of the human body.

D. CARDIAC FIBRILLATION

For 10-100mA of current flow in the human body causes the cardiac fibrillation. Here the heart begins to vibrate and no longer beats at the steady rate. This situation is dangerous since it is irreversible. This is the one of the sever cause which the entire biological system of the human body gets affected and cause death.

E. CARDIAC ARREST

For 500mA of current flow in the human body it suddenly experiences the cardiac arrest and causes death in few seconds. This is the very severe effect which the human body faces for such amount of current flow through it. There is less possibility of saving the life of the human beings.

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VI. BLOCK DIAGRAM

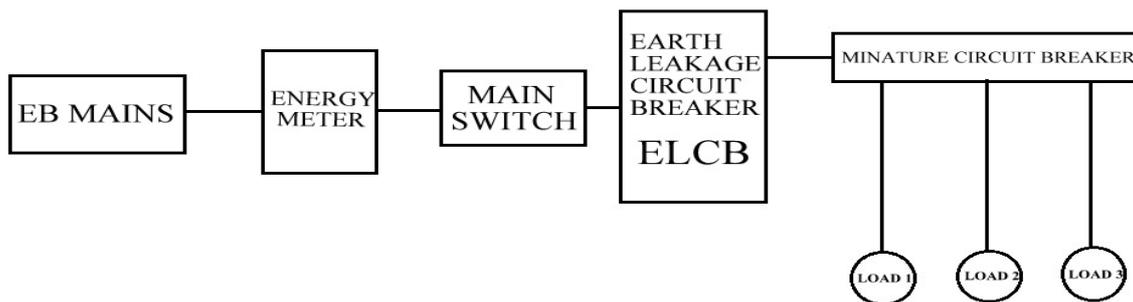


Fig.1

From fig.1, the EB mains the positive and the negative terminals of the power supply is given to the energy meter. Then a main switch is connected in order to control the operation. Thus from the main switch the power supply is given to the Earth Leakage Circuit Breaker. From ELCB the one or more number of MCB'S are connected for separate units which contains various loads.

A. ENERGY METER

Energy meter is an equipment which is used to calculate the amount of the consumption. The conventional mechanical energy meter is based on the basic principle of "Magnetic induction". It has a ferriwheel which is a rotating wheel and other toothed wheels. Thus the flow of current made the ferriwheel to rotate and thus the ferriwheel made the all other wheels to rotate. Thus the measurements are measured in the display section.

B. MAIN SWITCH

Here the 2-pole isolator switch is used for the operation. This is the main control which allows the current to enter into the earth leakage circuit breaker. If the main switch is turned off the power supply to the entire system gets interrupted.

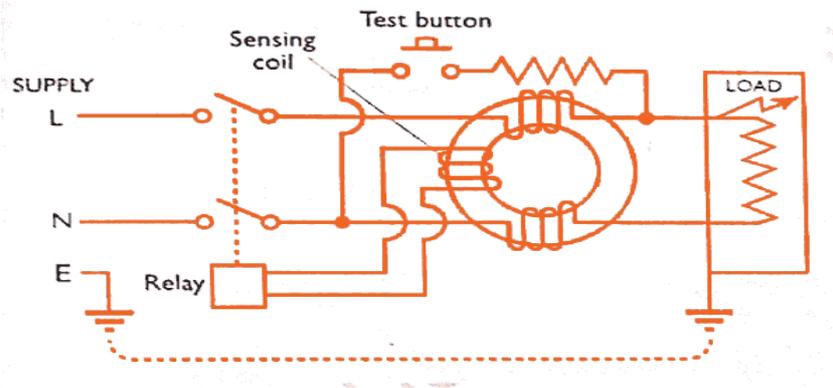
C. MCB

MCB is the Minature Circuit Breaker which acts as the protective device in the implementation of electrical system. Here in this project separate MCB's are provided for the different loads. The ELCB trips whenever the fault occurs in the electrical system. Such that by turning on the MCB's separately the unit in which the fault occurs can be easily identified

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D.ELCB

ELCB works on the current balance principle. It consist of sensing coil and a relay. The relay is connected to the sending coil and thus it trips the incoming positive and negative terminal. A test button is provided in order to ensure the proper function of the circuit breaker. The elcb should be checked periodically. If the test button is pressed once it touches the positive terminal and ground terminal of the earth leakage circuit breaker and thus suddenly it gets tripped, such that if it does not gets tripped while pressing the test button it is noted that the elcb is not working properly. The elcb has to be replaced for the better protection.

VII. CIRCUIT DIAGRAM

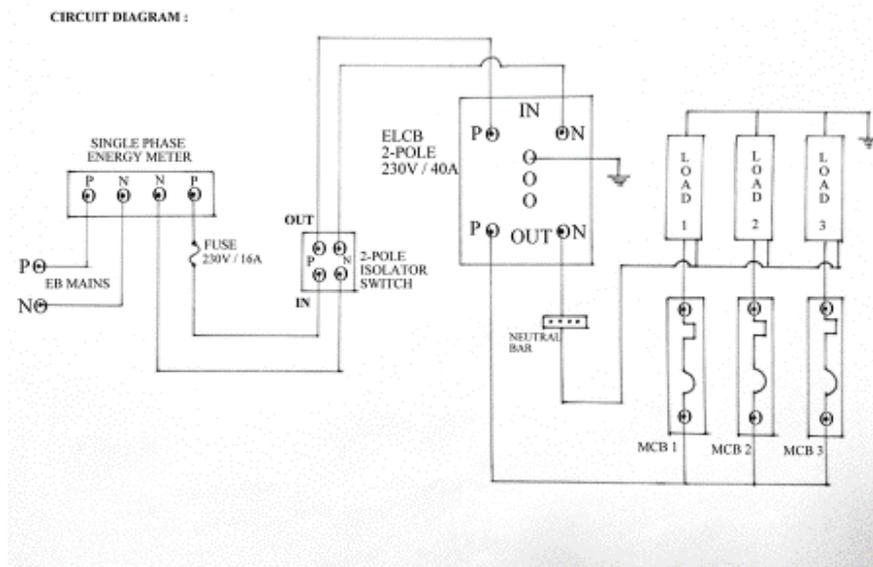


Fig.2

The connections are given as per the circuit diagram shown in the fig.2. As already discussed the EB mains are given to the energy meter. The fuse is provided at the positive terminal of the energy meter. From the main switch the positive and negative terminals of the power supply is given to the ELCB. A Neutral bar is provided in which all the neutral terminals of the electrical equipments are interconnected. A Earth bar is also connected in order to provide earthing to the each and every equipment in the electrical system and to ensure the proper function of the Earth Leakage Circuit Breaker. Thus the safety is provided to the electrical system using the Earth Leakage Circuit Breaker.

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VIII. SCADA OVERVIEW OF THE SYSTEM

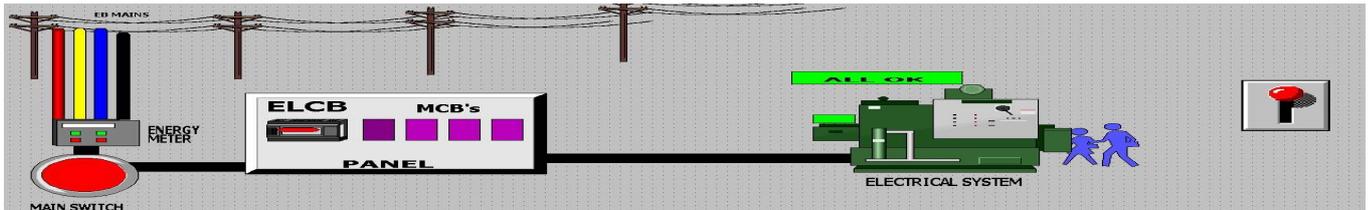


Fig.3.1

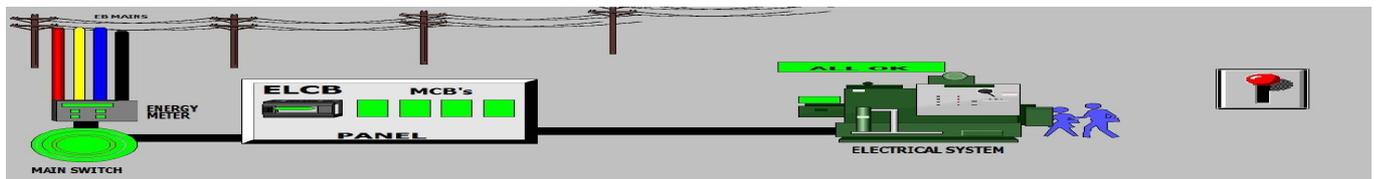


Fig.3.2

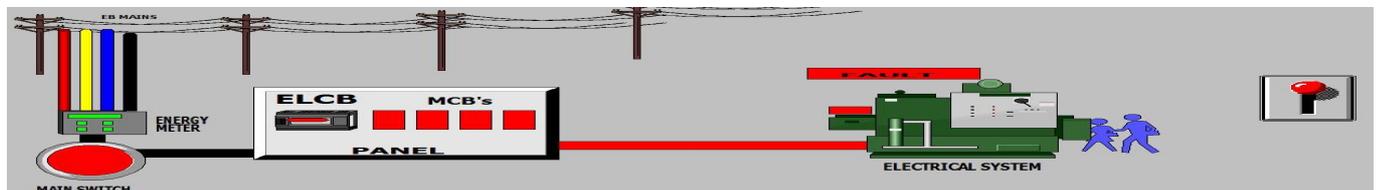


Fig.3.3

SCADA – Supervisory Control and Data Acquisition.

The SCADA overview of this project was shown in the above figures. The scada software used here is the WONDERWARE INTOUCH WINDOWMAKER SCADA.

The fig.3.1 shows the normal view of the project in which the arrangements are done in order to view the process of protection provided by the ELCB. In fig.3.2 the simulation of that system is shown. Here the process is switched on and thus the power supply is given to the system as described in the circuit diagram. All the process are ok and this will be displayed in the display provided in the layout. In fig.3.3 the fault occurred in the electrical system is shown. Here the fault (line to ground fault) occurs in the electrical system thus it suddenly gives the fault signal to the elcb and it gets tripped. Thus the protection is provided to the electrical system. After clearing the fault in the electrical system the ELCB is checked by pressing the TB (Test Button) present in the ELCB to ensure the proper function of the circuit breaker.

IX. CONCLUSION

The Electrical Protection System can be considered as a new invention in protection of electrical system. It is an additional feature to the electrical protection system to enhance the performance of domestic as well as Industrial protection system. From the findings and functionality of the prototype, this protective circuit will solve earth leakage leakage current problem in domestic as well as industrial electrical system.