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DIFFERENTIAL TRANSFORMER CORES FOR GROUND FAULT CIRCUIT INTERRUPTING DEVICES

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ABSTRACT

Ground Fault Circuit Interrupting Devices (GFCI's) disconnect an electrical supply circuit in households when a fault current of a specified value flows from the circuit.

We can distinguish between two types: those which activate a relay, tripping the circuit breaker by drawing sufficient energy (100µW to 200µW) from the ground fault current (20 mA to 300mA) and those which sense the 5mA to 10mA fault current and then in combination with an integrated circuit trip a low carbon steel relay.

In this paper, the magnetic core requirements for sensing the fault current and tripping the breaker relay are discussed.

INTRODUCTION

Since the early use of electrical power, attempts were made to protect humans and animals from the potentially lethal shock hazard of this power. We know today that death caused by electrical shock from power supply lines of 110V to 380V, is caused by heart fibrillation when the heart is exposed to ac currents of 70mA or more for times exceeding 200mAs. Just how much electrical energy a person can safely tolerate, has been the subject of investigations by many authors.[1-4] For a review, the reader is referred to the publications listed in the reference. The following brief introduction might be useful to give a better understanding of the problem. The wet electrical circuit resistances of the human body at 50Hz were measured by Osypka, for instance, at 1,300Ω for the current path from hand to body to hand, 975Ω for the hand to body to both feet and 650Ω for both hands to both feet. At 110V this would result in currents of 85, 113 and 170mA, respectively. Exposure even for a few seconds could be lethal. It should be mentioned that in most practical cases, the body resistances are much higher.

The human body starts to sense currents as low as 1mA. At currents from 5 - 30mA, muscle cramps occur, preventing the victim from letting go of the current (Fig. 1). Once this happens, sweat formation occurs, decreasing the body resistance

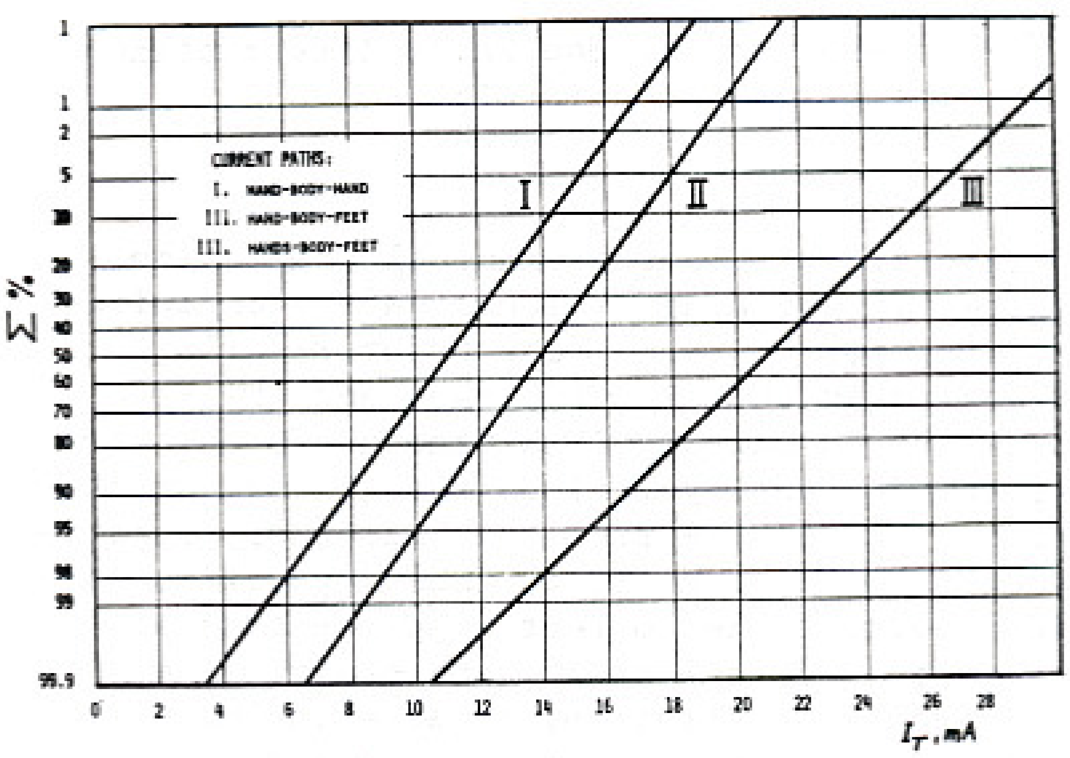

Fig. 1 - 'Let go' current distribution for humans (after Osypka).

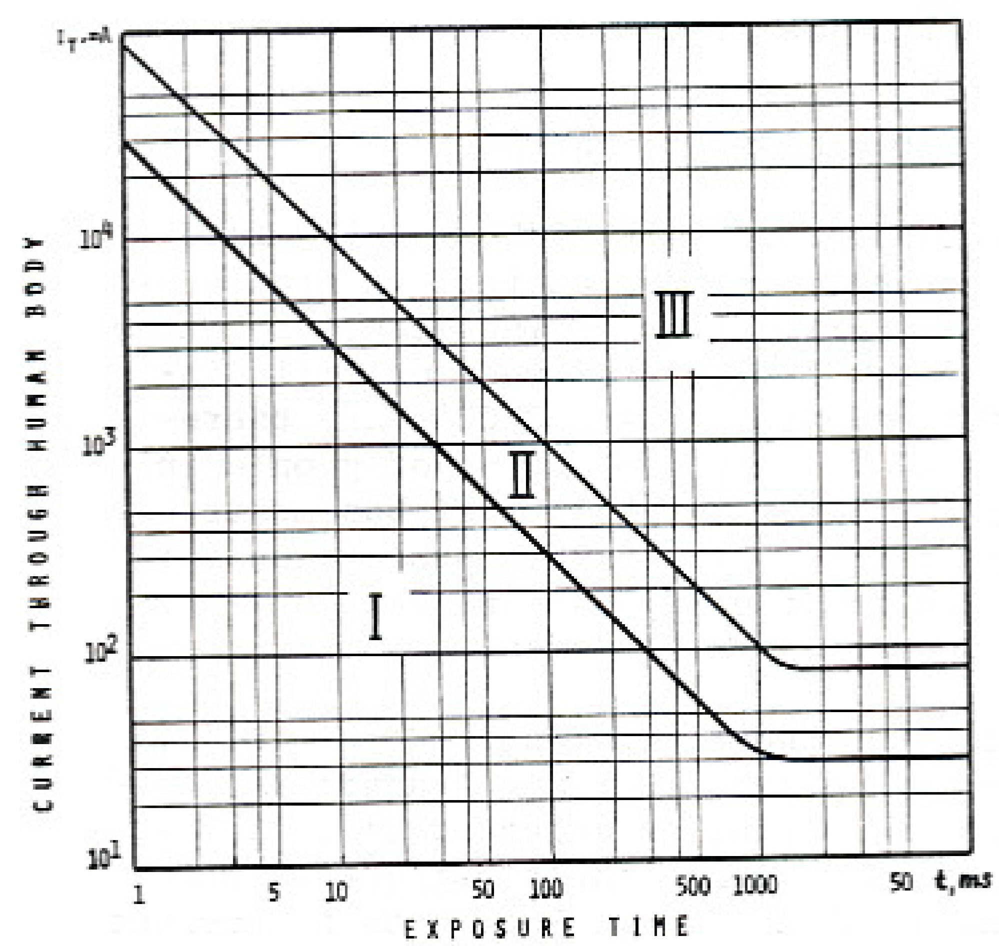

Fig. 2 - Hazard current iT vs exposure time (after Osypka). Region I, no damage to human organs. Region II, minor damage. Region III, heart fibrillation, death, burns, may occur.

and thus increasing the current flow until, for instance, a safety device will interrupt the current. Investigations by the authors listed[1-4] show that no permanent damage occurs at currents below 30mA, as shown in Region 1 of Fig. 2. Current exposures falling into Region 2 can cause light burns with muscle damage, while exposures falling into Region 3, can cause heart fibrillation.