APPLICATION OF TUNNEL DIODES
TO POWER SYSTEM PROTECTION

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INTRODUCTION

Static relays so far reported for application to power system protection employed thermionic valves, rectifier bridges, transductors, transistors, hall crystals and recently zener diodes. These devices with the exception of hall crystals and transductors (excluding the unpublished work on high speed Ramey type of magnetic amplifier) are basically used as switching elements to develop either an amplitude or a phase comparator; the comparator being the basic building block for all protective relays. They all have found wide applications in high speed relaying. The advantages claimed by the pioneers in favour of the static relays over the conventional electro-mechanical relays are now well established and in fact there is no doubt about the tremendous potentiality of realizing new types of high speed protective relays using semi-conductors.

With the development and availability of a comparatively new semiconductor device called the "Tunnel Diode or the Esaki Diode" and its well established application as a switching element in the bistable mode of operation, it was felt that it could well be investigated to develop basic comparators giving, with respect to the controlling signal derived from the measuring circuit, almost instantaneous saturated output (100 per cent output) suitable for operating the slave relay directly. An attempt to obtain this sort of instantaneous saturated output characteristic was reported using highly fedback Ramey type Magnetic Amplifiers, but proved unsatisfactory for the time delay involved in it.

The tunnel diode having a unique and inherent negative resistance characteristic is essentially a small and very fast two terminal semiconductor device, lending itself to high speed switching applications. When critically biased as a switching element in its bistable mode, it can theoretically give infinite power amplification. This could lead to higher sensitivity of the comparator.

The limit to sensitivity at low operating levels for most of the semiconductor devices is due to the fact that a minimum threshold voltage is required before they start conducting. In case of tunnel diodes the switching action is confined to a voltage less than the so called threshold voltage. Thus, amplification coupled with speed and ability to operate at low operating levels were believed to lend the comparator the desired sensitivity and speed.

The greatest disadvantage of the tunnel diode is the low output voltage available. The available voltage swing for germanium units is less than 0.5 volts, gallium arsenide units providing less than 1.0 volts. Peak currents, however, range from 10 microampere to more than 200 amperes. Hence the problem of increasing the power output can be solved to some extent by choosing high current tunnel diodes.

The work that is submitted contains the application of this new device to develop the amplitude and the phase comparator operated from either voltage or current and the application of these comparators to distance protection. Besides this, a critical level detector is built up and found useful in designing a high speed over-current relay with adjustable reset ratio and is considered almost free from transients in the operating current.

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