RICHTER-TYPE MAGNETIC AFTER-EFFECT
IN MANGANESE FERRITE

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A study was made of magnetic after-effect of the Richter type in samples of non-stoichiometric manganese ferrites differing by their excess of manganese and having a different content of oxygen.

INTRODUCTION

Magnetic after-effect of the Richter type is a relaxation phenomenon characterized essentially by one relaxation time \( \tau \) the temperature dependence of which is given by the exponential relation

\[
\tau = \tau_0 e^{\frac{\epsilon}{kT}},
\]

where \( \epsilon \) stands for the activation energy of the relaxation phenomenon, \( k \) is the Boltzmann constant and \( T \) the absolute temperature. It is manifest e. g. by a decrease in the static value of the initial permeability with time or — in dynamic measurements — by a maximum of the loss angle for a frequency equal to the inverse value of the corresponding relaxation time.

Magnetic relaxation of this type was first observed in \( \alpha \)-iron [1] and it was found that it is always accompanied by an analogical elastic after-effect [2]. A joint explanation of both phenomena was given by Snoek [3] on the basis of the diffusion of atoms of impurities of carbon and nitrogen dissolved in iron. According to these conceptions, magnetostrictional tension in the neighbourhood of a Bloch wall causes the diffusion of the atoms of impurities which leads to the gradual "adjusting" of the Bloch wall, i. e. to the production of a local potential minimum in the wall which prevents it moving freely.

In ferrites magnetic after-effect of the Richter type was found by Wijn [4] for manganese-zinc and nickel-zinc ferrite and recently by v. Kienlin [5] on samples of nickel-zinc ferrite. In both cases the samples contained bivalent ions of iron the presence of which conditioned the existence of the relaxation phenomenon. With regard to the low values found for the activation energies these after-effects were explained on the basis of the diffusion of the electrons between the ions Fe\(^{2+}\) and Fe\(^{3+}\), which leads to the rearranging of these ions in octahedral positions of the spinel lattice with respect to the acting magnetostrictional forces.

The present paper gives some results from studying relaxation-effects in samples of non-stoichiometric manganese ferrites differing in their content of manganese and oxygen. The aim is to compare these results with those in the papers cited and point to some facts probably bearing witness to a somewhat different mechanism of the diffusion relaxation phenomenon in these materials.

RESULTS OF MEASUREMENT AND THEIR ANALYSIS

The various samples were prepared from an initial mixture of 1 mol Fe\(_2\)O\(_3\) + + (1 + \(x\)) mol MnCO\(_3\) (\(x\) in limits 0 to 0.67) by sintering at 1200 °C. Air of normal or lowered pressure (0.1 mm Hg) was used as the atmosphere during final firing while the lowering in pressure was carried out after attaining a
temperature of about 1000 °C. In this way various degrees of oxidation were attained in the samples; the oxygen content was then determined quantitatively by chemical analysis.

![Graph 1: Temperature dependence of tan δ with sample No. 8.](image1)

![Graph 2: Temperature dependence of real part of permeability with sample No. 8.](image2)

Measurement was carried out on a resonance bridge described in paper [6] for a value of the magnetizing field 10 mOe. The complex permeability and loss angle were measured for 50, 100 and 200 kc/s as a function of the temperature. The curves of tan δ as a function of T exhibit a characteristic maximum which