DESIGN AND CONSTRUCTION OF A 30-AMPERE 220-VOLT SINGLE-PHASE VARIABLE INDUCTOR WITH MINIMUM LOSSES

by

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Thesis Title DESIGN AND CONSTRUCTION OF A 20-AMPERE 220-VOLT SINGLE-PHASE VARIABLE INDUCTOR WITH MINIMUM LOSSES

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ABSTRACT

A method of designing a 20-ampere 220-volt single-phase variable iron-core inductor with the losses being kept minimum is presented in this thesis. The effects of changes in the winding, in linear dimensions and of an air-gap length were studied carefully. The insertion of an air-gap in the magnetic circuit of an iron-core reactor altered the characteristics of the reactor in several ways. Only the reactive magnetizing current was affected by changes of the gap length of which its insertion resulted in a decrease in the inductance.

A variable iron-core inductor of which its inductance being changed by varying the length of the air gap had been constructed and tested. The results of the tests are considered satisfactory.

Experiments with reactor of the type considered in this problem having a coil placed over the air gap showed that the amount of magnetic flux in the iron was larger than that should be obtained by the use of the fringing correction. The calculations of flux for long gaps and of leakage flux must be approached from the point of view of the field rather than the circuit.

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INTRODUCTION

The total losses in an iron-core reactor comprise of the effective resistance loss I^2R, and the hysteresis and eddy-current losses in the core. The alternating-current effective resistance R exceeds the direct-current resistance of the winding because of skin effect of the wire and some other causes. When the impedance of a reactor is measured, the real component of the impedance,-- called the apparent resistance,-- is found to be greater than the effective resistance of the winding. By definition, the apparent resistance equals the total power dissipated in the reactor divided by the square of the coil current, and hence must be greater than the effective resistance of the winding whenever core losses are present. The distinction between the effective resistance R and the apparent resistance R_a should be carefully noted. The effective resistance accounts for the loss in the winding only, whereas the apparent resistance accounts for the total loss in the reactor.

As the frequency is increased, the advan-tages of the iron-core become less marked. The increase in core loss with frequency may cause the apparent resistance to become excessive.

In many applications of inductance coils, the ratio of inductive reactance ωL to apparent resistanc R_a should be as large as possible. In spite of the increase in apparent resistance due to core loss and the decrease in apparent inductance due to the

screening effect of eddy-currents, the ratio $\omega L/R_a$ can be made larger with an iron core than with an air core.

Insertion of an air gap in the magnetic circuit of an iron-core reactor results in a decrease in the inductance. If the frequency and rms value of the flux are maintained constant by adjustment of the applied voltage as the air gap is changed, the core loss and the induced voltage are constant. Only the reactive magnetizing current is affected by changingin the gap length. The changing of the length of the air gap in the magnetic circuit of the variable inductor is considered to be better than the other ways.