CHAPTER I

INTRODUCTION

The term "eddy current" is applied to those electric currents which circulate within a mass of conducting material when the latter is situated in a varying magnetic field. The conducting material may be considered as consisting of a large number of closed conducting paths, each of which behaves like the short - circuited winding of a transformer of which the varying magnetic field is the work flux. Eddy e. m. f. 's are induced in these elemental paths, by the varying magnetic field, giving rise to the eddy currents.

Eddy currents result in a loss of power, with consequent heating of the material, and the magnitude of this power loss is often a matter of considerable importance in electrical engineering. The eddy currents, since they flow in closed paths in the material usually iron, have an axial magnetic field of their own which is in opposition to the inducing field, and so reduces its strength. The reduction is greatest in the centre of the core, since the eddy currents in all the elemental paths, from the centre of the material to the outside surface, are effective in producing the opposing magnetic field there. This result in a flux distribution which is not uniform, the flux density in the outer portions of the conductor being greater than that at its centre, which is screened by the eddy currents. There is thus a reduction of the effective cross-section of the core.

The effect of eddy currents upon the flux distribution is chiefly of importance in transformer, and other apparatus where the iron used would otherwise be worked of uniform flux density. Not only the distribution of flux in such cores affected by eddy currents, but also its magnetude, for a given value of magnetizing current, is obvionsly reduced thereby, and the phase of the resultant flux is not the same as that of the magnetizing current.

When two a-c fluxes in quadrature, pass through a disk, driving forces and torques are produced. Theory is developed herein, and formulas and procedure are presented whereby the force or torque can be solved for, even when the fluxes are irregular as well as the area and the distribution. As an example, the driving torque of the moving disk is solved for. A chart for greatly facilitating the work is described.

When a constant flux (or fluxes) passes through a rotating disk, a retarding or braking torque is produced. With the aid of what may be a new concept, theory, formulas, and procedures are presented whereby the torque may be found, even though the flux (or fluxes) has an irregular area. To illustrate, the braking torque of the disk is computed. The method can deal also with fluxes of nonuniform density. A chart is described which will greatly reduce the work. When a disk with constant flux through it is moved translationally, braking forces occur.

For both driving and braking torque reciprocity laws are proved, when needed, these laws greatly reduce the time required for a solution. It is often true that apparently complex devices can be analysed with relative simplicity, where as an apparently simple device may require complex analysis. Eddy current devices, structurally, are the simplest of the electric mechanisms. Yet, because the eddy currents are not confined to easily identifiable paths, analysis has yielded scanty return, and engineering design limped along as best it could.

An electromagnet or permanent magnet puts a flux, uniformly distributed and of density B, through a circular rotating disk within the area of the disk. The area has any size and shape. There may be more than one area, each with its own density.

The description of eddy currents caused by rotation, and the finding of resulting forces and torques heretofore have not been attacked successfully for such general cases. Solutions can be achieved by means of what is believed to be a new concept, by the use of some of the a-c developments and of some developments yet to be mentioned.