Macmillan Engineering Evaluations-Student Editions

Electromechanical Prime Movers:

Electric Motor Development and Usage

Editor: P.C. Bell

Electromechanical Prime Movers: Electric Motor Development and Usage

Edited by Peter C Bell

Macmillan Engineering Evaluations Student Edition

Macmillan Education

Preface

This book, which is intended as supporting reading for students of electrical engineering, discusses the development of a.c. and d.c. motor types, both from the aspect of improving the electrical design and through the use of new materials and techniques of machine manufacture.

The reader will be made aware of the steady reduction in size of a.c. motors due to improved materials and design methods, together with the advantages brought by the use of computers to simplify and speed up design analysis.

Chapters are devoted to the special problems of the starting and speed control of electrical machines. Further, the more practical aspects of the use of electrical machines are covered by discussions of the protection of induction motors (against overheating in particular), and of their installation, commissioning and maintenance in use.

Each chapter has been written by an industrial specialist, and a companion volume presents a survey of the wide range of motor types now available.

Contents

ISBN 978-0-333-13796-3 ISBN 978-1-349-01594-8 (eBook)
DOI 10.1007/978-1-349-01594-8

Student Edition 1972

Reprint of the original edition 1972

Published by

THE MACMILLAN PRESS LTD
London and Basingstoke
Associated companies in New York Toronto
Dublin Melbourne Johannesburg and Madras

SBN 333 13796 5

Chapter 1

Development of d.c. Motors

R A Bruce *BSc(Eng)*
CAV Limited

If an armature, free to rotate and having conductors in which a current flows, is placed in a magnetic field, forces are produced which cause the armature to rotate. Two basic equations can be derived which define the nature of this phenomenon: they are called the induced voltage equation and the torque equation.

Torque production

Principles of operation and performance discussed in this chapter are concerned only with the generally familiar, heteropolar, direct-current motor in its widely accepted, contemporary modes of construction. Assume the use of copper for conductors, and low-carbon steels for the magnetic circuit. The need to keep air gaps in the magnetic circuit reasonably small, and the desirability of protecting the insulated copper conductors from magnetic and mechanical forces, decrees that these conductors are housed in slots on the armature periphery. The mechanism of torque production, and deriving the torque equation, are explained in terms that avoid making use of the classic law that the force on a conductor is given by the product of the conductor length, the current it carries, and the flux density of the field surrounding it. In a machine with armature conductors in slots the torque is due not to mechanical forces on the conductors themselves but to tangential magnetic pulls on the armature teeth. The current in the conductor gives rise to an armature flux which flows up one tooth, across the open top of the slot and down the adjacent tooth so that the density of the bunches of flux crossing the airgap varies across each tooth and, in addition, the flux lines are inclined to the radial direction. The effect is shown in Fig. 1, which indicates that tangential forces are produced which cause the armature to rotate in the direction indicated.

Induced voltage equation

The stationary field system sets up a stationary magnetic field around the armature, adjacent poles being of opposite polarity. The commutator, rotating under stationary brushes of fixed polarity, ensures that the current flowing in each