HANDBOOK OF PRECISION ENGINEERING

HANDBOOK OF PRECISION ENGINEERING

- Volume 1 Fundamentals
- Volume 2 Materials
- Volume 3 Fabrication of Non-metals
- Volume 4 Physical and Chemical Fabrication Techniques
- Volume 5 Joining Techniques
- Volume 6 Mechanical Design Applications
- Volume 7 Electrical Design Applications
- Volume 8 Surface Treatment
- Volume 9 Machining Processes
- Volume 10 Forming Processes
- Volume 11 Production Engineering
- Volume 12 Precision Measurement

Philips Technical Library

HANDBOOK OF PRECISION ENGINEERING

Edited by A. Davidson

Volume 1 Fundamentals

Macmillan Education

Original Dutch edition © N. V. Philips' Gloeilampenfabrieken, Eindhoven, 1966

English edition © N. V. Philips' Gloeilampenfabrieken, Eindhoven, 1970

Softcover reprint of the hardcover 1st edition 1970

All rights reserved. No part of this publication may be reproduced or transmitted, in any form or by any means, without permission.

SBN 333 012062

ISBN 978-1-349-00087-6

ISBN 978-1-349-00085-2 (eBook)

DOI 10.1007/978-1-349-00085-2

First published in English by

MACMILLAN AND CO LTD

London and Basingstoke

Associated companies in New York, Toronto, Melbourne

Dublin, Johannesburg and Madras

PHILIPS

Trademarks of N. V. Philips' Gloeilampenfabrieken

Foreword

During the last twenty or thirty years, precision engineering, although not strictly a separate branch of engineering, like shipbuilding and the aircraft industry, has emerged as a specialized technology, involving methods and ideas foreign to conventional mechanical engineering.

Precision-engineered parts (or fine mechanisms, as they are often termed) are very often of limited size, and vary in quantity from one-off to very long runs. But they don't have to be small, of course. For example, the driving mechanism of an observatory telescope, which is fairly large, has to be designed and constructed with extreme precision, whilst an ordinary watch, which is quite small by comparison, is relatively crude as far as tolerances are concerned.

Examples of fine mechanisms are to be found in telecommunications equipment; optical apparatus such as microscopes and comparators, as well as cameras and projectors; office machines like typewriters, accounting and calculating machines; various toys of a technical nature, mentioned because of their often ingenious design and the consummate tool-making that goes into them; electric shavers; and various electronic equipment used in the home.

There is a need, in industry and in training schools, for a Handbook such as this, covering, in a convenient form, the different subjects that are related to the design of fine mechanisms. Much of the material dealt with is not new in itself, of course, but, because it is presented specifically in the context of precision engineering, it should be invaluable to designers, manufacturers and users of precision-engineered parts.

The authors, each of whom is a specialist in his own field, do not claim to have covered the individual subjects fully in the chapters assigned to them. They have presented the main features as clearly as possible, and provided international references from which the reader can obtain more details as required.

The Handbook is divided into eleven parts, of which Volume 1 deals with the general principles to be observed when designing a product, and Volume 2 with the materials available. Theoretical and practical data useful to designers and draughtsmen is given.

Volumes 3–6 discuss production techniques, and production staff will find them to contain comprehensive information on production methods and plant. Volumes 7–11 deal with the practical design of precision-engineered products, and the equipment and components required for this purpose. Designers, manufacturers and users can all profit from them.

The editor would like to take this opportunity of thanking the authors and all who have helped to produce the Handbook.

Contents

Foreword

Introduction	A. Davidson	I

1 General Basic Standards	A. T. Hens	3

Standardization – Quantities and SI units – Preferred series – Engineering drawing office practice – Tolerances and fits – Surface roughness – Tolerances of form and position – Screw threads – Gears – Ball bearings

2 Design Theory	F. C. W. Slooff	76

Introduction and explanatory notes – Strength of materials – Some aspects of statics – Some aspects of dynamics – Gearwheels – Friction drives – Transmission by shaft couplings – Differential drives

3 Kinematics	F. C. W. Slooff	205

Explanatory note – Introduction – Pole and velocity – Relative poles – Fixed polode and moving polode – Direct-contact mechanisms – Inversion of motion – Tangents to paths of points – Elliptical motion – Inversion of elliptical motion, cardioid (heart-shaped) motion – Centres of curvature of the paths of points – Circle of inflection and circle of cusps – Consequent positions – The relationship between consequent points and the triangle of poles – Four consequent points of the moving system, centre-point curve – Centre-point curve as applied to the case of the sewing machine – The centre-point curve in relation to tangents to paths – Approximate straight-line mechanisms with four-bar linkages – Straight-line mechanism governed by angular displacement – Straight-line mechanism with given fixed pivots of the four-bar linkage – Dwell – Three possible paths in the case of the four-bar linkage: Roberts' proposition (1) – Neutralization of dead centres – Velocities and accelerations associated with the four-bar linkage – Inertia associated with motion in a plane

4 Electrical Theory	J. P. Roorda	225

Explanatory note – Introduction – Static Electricity – Electrical field strength or intensity and induction – Dielectric constant – Electric flux –

Capacitance of a flat capacitor – Electricity in motion, power and energy – Resistances in series and in parallel – Kirchoff's Laws – Magnetism – Hysteresis – Permanent magnets – Calculation of self-inductance – Forces acting on current-carrying conductors in a magnetic field – Induced E.M.F. – Transformers – Sources of energy – Alternating current and voltage – R.M.S. value – Phase difference – Complex method of calculation – Impedance and admittance – Vector diagram – Power in an impedance – Tuned circuits

5 Electrical Contacts **H. van de Braak 288**

Introduction – Analysis of contact applications – Analysis of contact circuits – Reliability of contacts – Contact resistance – Measurement of contact resistance – Practical procedure for obtaining information concerning the quality of a contact material or contact assembly – Sparking contacts – Corrosion of the contact surfaces – Contacts which spark on opening – Hints on the dimensioning of RC spark-quenching networks – Shape and construction of switch contacts – Resistance to effects of the atmosphere – Sliding contacts and collectors – Principal contact materials

6 Geometrical Optics **P. E. Kassner 312**

Introduction – Optical nomenclature and symbols – Use of the optical symbols – Light as a physical phenomenon – Light and matter, the refraction of light – Passage of a light ray through a prism – Passage of a light ray through a lens, in the region of the optical axis (paraxial ray) – Position of the principal points in various lenses – Concentric lenses – Fresnel lenses (Stepped lenses) – The image-forming quantities – Examples of image constructions – Determination of image size, image angle and depth of image – Reflection of light – Fibre optics – Reflection at concave and convex surfaces – Reduction of reflection and selective mirrors – Aberrations – Resolving power

7 Development of a New Product **R. N. van Hees 355**

Why new products have to be designed – Planning as part of design – Specification – Methodical designing – Effect of the design on the method of production – Some aspects of organization

8 Cost Price Calculation **M. J. M. Postma 371**

Introduction – Purpose of cost price calculation – Costs – Cost price calculation – Cost price calculation as an aid to the designer – Some examples – Profitability

9 Electrical Safety Regulations **B. E. Kabel** **384**

Introduction – Safety regulations – Electrical hazards – Safety specifications

10 Quality Control **J. Vel** **391**

Introduction – Planning and quality – Design and Quality – Production and quality – Determination of the instantaneous quality – Functional quality – Distribution, sales and quality – Complaints concerning quality

11 Statistical Control of Dimensions **F. G. Willemze** **398**

Introduction – Frequency distribution and spread – Production control – Spread among assembled products – Accuracy of measurement

12 Industrial Rights **Ian F. Finlay** **409**

Patents – Licensing – Trade marks – Registered design

Index **419**