

CONTENTS

Preface 11

1. GENERAL CONSIDERATIONS, HISTORY 13
2. BASIC CRITERIA OF THE PERFORMANCE AND DESIGN OF MACHINE PARTS 20
 - 2.1. General Considerations, Strength 20
 - 2.2. Rigidity 25
 - 2.3. Wear Resistance 27
 - 2.4. Heat Resistance 29
 - 2.5. Vibration Stability 30
 - 2.6. Reliability 31
3. ENGINEERING MATERIALS 35
 - 3.1. General Considerations 35
 - 3.2. Cast Irons 37
 - 3.3. Structural Steels 41
 - 3.4. Nonferrous Alloys 47
 - 3.5. Plastics and Other Materials 51
 - 3.6. Ways to Economize Materials 56
4. PRODUCIBILITY OF MACHINE PARTS, FITS AND TOLERANCES, DESIGN PROCEDURES 58
5. JOINTS, RIVETED JOINTS 67
 - 5.1. Types of Joints 67
 - 5.2. Types and Applications of Riveted Joints 68
 - 5.3. Types of Rivets and Joint Design 69
 - 5.4. Riveted Joint Design 71
 - 5.5. Strength Riveted Joints 73
 - 5.6. Strength Fluid-Tight Riveted Joints 77
6. WELDED JOINTS 79
 - 6.1. General Considerations 79
 - 6.2. Arc-Welded Joints 82
 - 6.3. Resistance Welded Joints 91
 - 6.4. Welded Joint Design, Examples 94
 - 6.5. Soldered, Brazed and Adhesive-Bonded Joints 100

| | |
|-------------------------------------------------------------------------------------|----------------|
| 7. INTERFERENCE FIT JOINTS | 103 |
| 7.1. General Considerations | 103 |
| 7.2. Cylindrical Interference Fit Joints | |
| 7.3. Shrink-Ring and Shrink-Link Joints | |
| 8. SCREW JOINTS | 116 |
| 8.1. Basic Concepts and Definitions | 116 |
| 8.2. Screw Threads | 117 |
| 8.3. Screw Fastenings | 125 |
| 8.4. Setscrews and Special Bolts and Screw | |
| 8.5. Nuts and Threaded Inserts | 131 |
| 8.6. Tools for Tightening Screws and Nuts | 132 |
| 8.7. Preventing Unintentional Unscrewing | Screw Joints 1 |
| 8.8. Strength Classes and Materials of Threaded Parts | 137 |
| 8.9. Screwing-Up Torque, Efficiency and Self-Locking Condition | 39 |
| 8.10. Nut and Screw Interaction | 143 |
| 8.11. Screw and Thread Element Design for Steady | |
| 8.12. Screws Subject to Eccentric Loads | 148 |
| 8.13. Design of Screw Joints Subject to Loads in the Plane of the Joint | |
| 8.14. Design of Screw Joints Subject to Separating Forces and Moments | |
| 8.15. Screws Subject to Variable Loads | 160 |
| 8.16. Clamp or Screw and Friction Joints | 164 |
| 8.17. Taper-Ring Friction Joints | 166 |
| 9. COTTER, WEDGE AND PIN JOINTS | 170 |
| 9.1. Types of Cotter and Wedge Joints | 170 |
| 9.2. Forces in Cotter Joints, Conditions for Self-Locking and Strength Calculations | 172 |
| 9.3. Pin Joints | 173 |
| 10. KEY, SPLINE, SERRATION AND SHAPED JOINTS | 177 |
| 10.1. Key Joints | 177 |
| 10.2. Multiple Spline and Serration Joints | 186 |
| 10.3. Shaped (Keyless) Joints | 196 |
| 11. MECHANICAL POWER TRANSMISSION. FRICTION DRIVES | 198 |
| 11.1. General Considerations | 198 |
| 11.2. Calculating Contact Stresses | 199 |
| 11.3. Elements of Friction Drives | 201 |
| 11.4. Principal Types of Friction Drives | 206 |
| 11.5. Kinematic and Strength Calculations | 212 |
| 11.6. Friction Losses, Efficiency and Pressure Device Design | 214 |
| 12. BELT DRIVES | 218 |
| 12.1. Preliminary Discussion | |
| 12.2. Flat Belt Material | 21 |
| 12.3. Belt Joints | 224 |

| | |
|-----------------------------------------------------------------------------------------------|------------|
| 12.4. V Belts | 226 |
| 12.5. Basic Characteristics of Belt Drives | 230 |
| 12.6. Belt Drive Design Criteria and Calculations. Behaviour of Belts on Pulleys | 232 |
| 12.7. Kinematics of Belt Drives | 233 |
| 12.8. Principal Geometric Relationships in Belt Drives | 234 |
| 12.9. Forces and Stresses in Belts | 235 |
| 12.10. Belt Drive Calculations Based on Pulling Capacity and Flat Belt Drive Design | 240 |
| 12.11. Service Life of Belts | 244 |
| 12.12. V-Belt Drive Design | 245 |
| 12.13. Forces Acting on the Shafts, and Losses in Belt Drives | 248 |
| 12.14. Design Procedure for Flat-Belt Drives | 249 |
| 12.15. Design Procedure for V-Belt Drives | 250 |
| 12.16. Multiple-V-Belt Drive Design | 250 |
| 12.17. Drives with Idler Pulleys or with Automatic Tension Control | 252 |
| 12.18. Variable-Speed Belt Drives | 253 |
| 12.19. Toothed-Belt Drives | 257 |
| 12.20. Belt Drive Pulleys | 260 |
| | |
| 13. TOOTHED GEARING | 266 |
| 13.1. General Considerations | 266 |
| 13.2. Brief Data on the Geometry and Kinematics of Involute Gearing | 267 |
| 13.3. Parameters and Design of Toothed Gearing | 272 |
| 13.4. Types of Tooth Failure. Gear Drive Design Criteria and Calculations | 277 |
| 13.5. Materials and Heat-Treatment | 280 |
| 13.6. Accuracy of Toothed Gearing | 284 |
| 13.7. Beam Strength Calculations for Spur Gears | 287 |
| 13.8. Contact Strength Calculations for Spur Gears | 292 |
| 13.9. Special Features of Helical and Herringbone Gearing Design | 296 |
| 13.10. Toothed Gearing with Basic Rack Displacement (Correction) | 300 |
| 13.11. Design Load | 307 |
| Load Concentration along the Face Width of the Gear | 307 |
| Dynamic (Impact) Loads | 312 |
| 13.12. Allowable Stresses | 317 |
| 13.13. Bevel Gearing Drives | 327 |
| Geometrical Calculations for Bevel Gearing | 328 |
| Bevel Gearing Strength Calculations | 333 |
| 13.14. Efficiency of Toothed Gearing | 336 |
| 13.15. Forces Acting on the Shafts and Axles of Toothed Gearing | 338 |
| 13.16. Novikov Cylindrical Gearing | 342 |
| 13.17. Reducing Gears | 350 |
| 13.18. Gearing Between Nonparallel, Nonintersecting Shafts—Crossed Helical and Hypoid Gearing | 355 |
| 13.19. Planetary Gearing | 359 |
| 13.20. Strain Wave Gearing | 367 |

| | | | |
|-------------------------------------------------------------------|------------|---------|---------|
| 14. WORM GEARING | 380 | | |
| 14.1. General Considerations | 380 | | |
| 14.2. Geometry of Worm Gearing | 381 | | |
| 14.3. Worm Gearing with Basic Rack Displacement (Correction) | | | 385 |
| 14.4. Causes of Worm Gearing Failure and Performance Criteria | | | 386 |
| 14.5. Materials | 387 | | |
| 14.6. Strength Calculations | 388 | | |
| 14.7. Design Load. Load Factor | 391 | | |
| 14.8. Allowable Stresses | 393 | | |
| 14.9. Forces Acting in Worm Gearing | 395 | | |
| 14.10. Worm Body Design and Worm Gearing Efficiency | 395 | | |
| 14.11. Heat Generated by Worm Gearing, and Cooling Facilities | | | 108 |
| 14.12. Worm Reducing Gear Design | 400 | | |
| 14.13. Lubrication | 403 | | |
| 14.14. Gearing with Concave-Sided Gearing | | Threads | Globoid |
| | 404 | | |
| | | | |
| 5. CHAIN DRIVES | 411 | | |
| 15.1. General Considerations | | | |
| 15.2. Power Transmission Chains | 411 | | |
| 15.3. Principal Parameters of Chain Drives | | | 419 |
| 15.4. Performance Criteria in Chain Drive Design. Chain M | | | |
| 15.5. Load-Carrying Capacity and Selection of Chain Drives | | | |
| Constant Forces in the Sides of the Chain and Loads on the Shafts | | | |
| 15.6. Variation in Speed Ratio and Impact (Dynamic) Loads | 427 | | |
| 15.7. Friction Losses. Designing Chain Drives | 430 | | |
| Sprockets | 432 | | |
| 15.8. Lubrication | 435 | | |
| 15.9. Chain-Type Variable-Speed Drives | 436 | | |
| | | | |
| 16. POWER SCREWS | | | |
| | | | |
| 17. SHAFTS AND AXLES | 450 | | |
| 17.1. General Considerations and Design Fundamentals | 450 | | |
| 17.2. Materials and Machining of Shafts and Axles | 457 | | |
| 17.3. Basic Design Layouts for Shafts and Axles. Design Criteria | | | 458 |
| 17.4. Strength Calculations | 460 | | |
| 17.5. Endurance Calculations | 463 | | |
| 17.6. Rigidity Calculations | 474 | | |
| 17.7. Vibration Behaviour Calculations for Shafts | 479 | | |
| 17.8. Special Shafts | 483 | | |
| 17.9. Flexible Shafts | 484 | | |
| | | | |
| 18. SLEEVE BEARINGS | | | |
| 18.1. General Consideration | 486 | | |
| 18.2. Bearing Materials | | | |
| 18.3. Lubricants | 500 | | |
| 18.4. Performance Criteria | | Design | 108 |

| | | |
|-----------------------------------------------------------------|-----|---------|
| 22. SPRINGS | 659 | |
| 22.1. Basic Concepts | 659 | |
| 22.2. Spring Materials | 661 | |
| 22.3. Design Calculations for Extension and Compression Springs | 664 | Helical |
| 22.4. Special-Shaped and Twisted-Wire Helical Springs | 670 | |
| 22.5. Spring Washers | 672 | |
| 22.6. Helical Torsion Springs | 674 | |
| 22.7. Flat Spiral Power Springs | 675 | |
| 23. MACHINE FRAMES AND HOUSINGS | 679 | |
| 23.1. Preliminary Discussion | 679 | |
| 23.2. Design of Castings | 682 | |
| 23.3. Calculations. Installing Beds on Foundations | 685 | |
| 24. LINEAR BEARINGS | 687 | |
| 24.1. Slideways | 687 | |
| 24.2. Linear Ball and Roller Bearing Slideways | 691 | |
| Index | 697 | |