

# Contents

## Preface vii

## 1 Introduction to Motor Controls 1

- Manual Starters, 2
- Magnetic Controllers, 3
- Overload Protection, 6
- Protective Enclosures, 13
- National Electric Code*<sup>®</sup> Requirements, 14
- Two-Wire Control, 15
- Three-Wire Control, 15
- Control Relays, 19
- Other Controlling Equipment, 20
- Electronic Controls, 22
- Energy Management Systems, 22
- Programmable Controllers, 23
- Summary, 24

## 2 Blueprint Reading 25

- Pictorial Drawings, 25
- Orthographic-Projection Drawings, 28
- Electrical Diagrams, 29
- Electrical/Electronic Graphic Symbols, 29

Schematic Wiring Diagrams, 77  
Electrical Wiring Diagrams, 80  
Conclusion, 80

### **3 Electricity Basics 81**

Common Power Supplies, 82  
Transformers, 83  
Control Circuit Transformers, 85  
Motor Starters, 85  
Contactors, 89  
Protector Relay (Lockout) Control Circuits, 90  
Time-Delay Relays, 90  
Disconnect Switches, 93  
Solenoid Valves, 94  
Electrical Line Current Capacity, 96  
Control Relays, 97

### **4 Electric Motors 98**

Single-Phase Motors, 101  
Polyphase Motors, 105  
Synchronous Motors, 108  
Direct-Current Motors, 109  
Motor Enclosures, 111  
Motor Type, 112  
Selection of Electric Motors, 112

### **5 Manual Full-Voltage Motor Starters 114**

Reversing Manual Starters, 117  
Drum Switches, 121  
Special NEC Requirements, 121  
Summary, 122  
Maintenance of Manual Starters, 123

### **6 AC Magnetic Starters 124**

Magnetic Sticking, 126  
Maintenance of Magnetic Starters, 126  
Thermal-Overload Relays, 127  
Magnetism, 127

### **7 AC Magnetic Reversing Controllers and Combination Starters 130**

AC Combination Starters, 135

- 8 AC Reduced-Voltage Motor Starters 137**  
Part-Winding Starters, 142  
Wye-Delta Magnetic Starters, 144  
Magnetic Primary Resistor Starters, 144  
Maintenance of Reduced-Voltage Starters, 147
- 9 Miscellaneous Motor Controls 150**  
Pneumatic and Motor-Driven Timing Relays, 150  
Control Transformers, 151  
Fuse Block Kits for Secondary Circuit Protection, 153  
Limit Switches, 153  
Solenoids, 154  
Foot Switches, 155  
Pressure Float Switches, 155  
Solid-State Logic, 156
- 10 Multispeed AC Motor Starters 158**  
Torque Characteristics, 159
- 11 Synchronous Motor Controls 166**  
Starting Synchronous Motors, 167  
Motor Braking, 168  
Synchronous Converters, 168  
Semiautomatic Synchronizing, 169  
Automatic Field Excitation of Synchronous Motors, 170
- 12 Starting and Speed-Regulating Rheostats and Controllers 171**  
Maintenance Requirements, 171  
General Maintenance, 172  
New Installations, 172  
Faceplate Types, 172  
Drum Controllers, 173  
Drum Contactor Controllers, 175  
Resistors for AC Motors, 176  
Starting and Speed-Regulating Rheostats for DC Motors, 179  
Cleaning, 179  
Reversing Contacts, 179  
Spring Tension, 180  
Resistor Replacement, 180  
Magnet Coil, 180  
Checking Loose Connections, 180  
Installation, 181

- 13 Direct-Current Controllers 182**  
Variable-Voltage Control, 188  
Overload Relays, 191
- 14 Connection Diagrams for  
Pushbutton Circuits 193**  
Jogging Circuit, 193  
Float Switch Circuit, 196  
Solid-State Control Circuits, 198
- 15 Maintenance of Motor Starters 211**
- 16 Water-Soaked Motor Controls 225**  
General Recommendations, 225  
Specific Recommendations, 226  
Contact Tips, 227
- 17 Methods of Deceleration 230**  
Plugging, 230  
Jogging, 231  
Electric Brakes, 232  
Characteristics of Motor Brake Parts, 238
- Appendix A: Glossary 243**
- Appendix B: Trade Sources 255**
- Index 273**