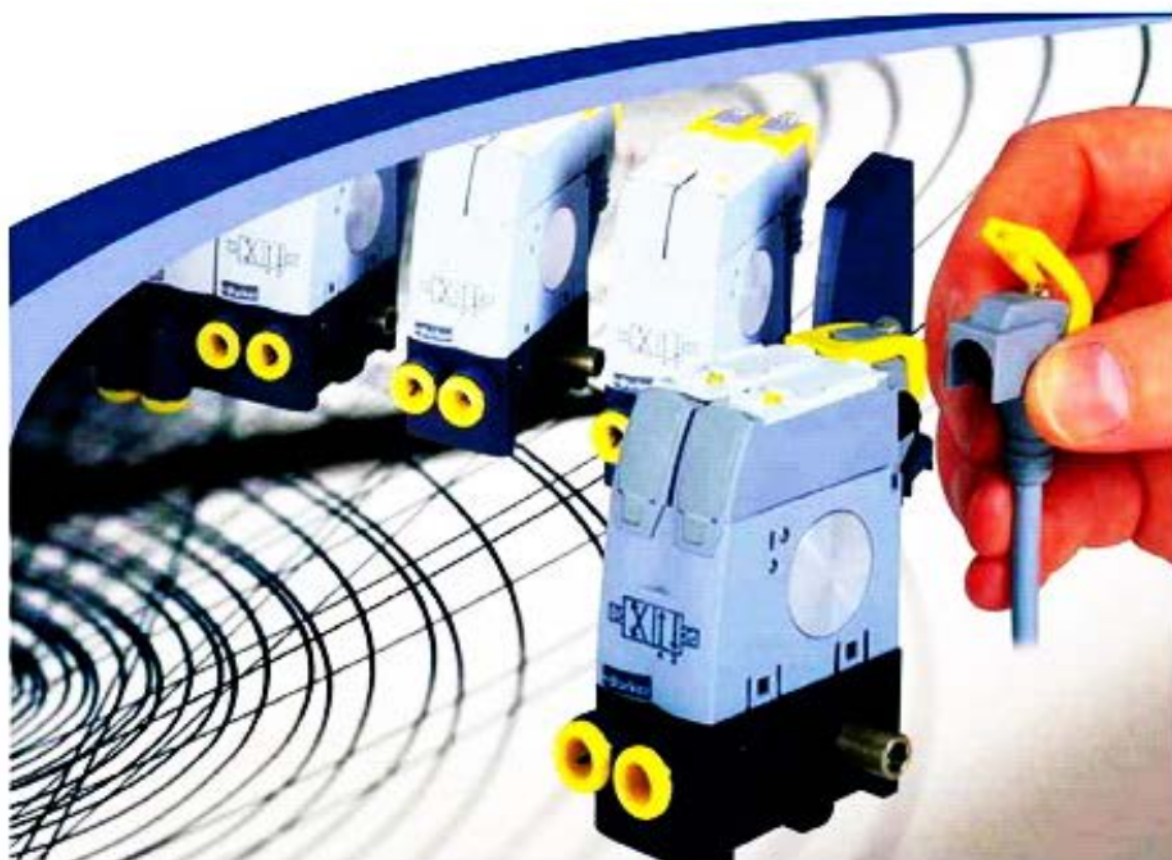


WILEY  
**PRECISE**  
TEXTBOOK

  
WILEY-  
INDIA  
EDITION

# Pneumatic Controls

JOJI P.



# **Pneumatic Controls**

**Joji P.**

Deputy Director of Training,  
Govt. of India, Ministry of Labour & Employment  
Directorate General of Employment & Training (DGE&T),  
Foremen Training Institute, Bangalore



Wiley India Pvt. Ltd.

## **Pneumatic Controls**

Copyright © 2008 by Wiley India Pvt. Ltd., 4435/7, Ansari Road, Daryaganj, New Delhi-110002.

All rights reserved. No part of this book may be reproduced in any form without the written permission of the publisher.

**Limits of Liability:** While the publisher and the author have used their best efforts in preparing this book, Wiley India Pvt. Ltd. and the author make no representation or warranties with respect to the accuracy or completeness of the contents of this book, and specifically disclaim any implied warranties of merchantability or fitness for any particular purpose. There are no warranties which extend beyond the descriptions contained in this paragraph. No warranty may be created or extended by sales representatives or written sales materials. The accuracy and completeness of the information provided herein and the opinions stated herein are not guaranteed or warranted to produce any particular results, and the advice and strategies contained herein may not be suitable for every individual. Neither Wiley India Pvt. Ltd. nor the author shall be liable for any loss of profit or any other commercial damages, including but not limited to special, incidental, consequential, or other damages.

**Disclaimer of Liability:** The contents of this book have been checked for accuracy. Since deviations cannot be precluded entirely, Wiley India Pvt. Ltd. or its authors cannot guarantee full agreement. As the book is intended for educational purpose, Wiley India Pvt. Ltd. or its authors shall not be responsible for any errors, omissions or damages arising out of the use of the information contained in the book. Only qualified personnel should be allowed to install and work on pneumatic and electrical equipment. Qualified persons are defined as persons who are authorized to commission, to ground and to tag circuits, equipment and systems in accordance with established safety practices and standards.

This publication is designed to provide accurate and authoritative information with regard to the subject matter covered. It is sold on the understanding that the Publisher is not engaged in rendering professional services. If professional advice or other expert assistance is required, the services of a competent professional should be sought.

**Trademarks:** All brand names and product names used in this book are trademarks, registered trademarks, or trade names of their respective holders. Wiley India Pvt. Ltd. is not associated with any product or vendor mentioned in this book.

First Indian Edition: 2008

ISBN: 978-81-265-1542-4

ISBN: 978-81-265-8004-0 (ebk)



## Foreword

I am happy to write foreword for this book written by Joji P. I compliment the author for his dedicated and committed efforts to bring out this much-needed book. Pneumatics is basically an emerging technical area, especially in the world of industrial automation. The engineering design of a pneumatic system requires the knowledge of how to interconnect various components of the system, such as actuators, valves, sensors, etc., to satisfy various control requirements.

There are only a few books available for reference in this field. A student has to refer to many books to get the complete information on this subject. This book provides a comprehensive study of pneumatic and electro-pneumatic systems and presents all related information together. The fundamentals of pneumatic systems, typical pneumatic and electro-pneumatic circuits, and the maintenance aspects of pneumatic systems are all well covered. Interfacing of pneumatic system components with PLCs and their programming aspects are also well covered. This book also carries latest topics, such as fluidic muscle, vacuum equipment, valve terminals, etc., which have, perhaps, been presented for the first time compared to other contemporary books on this subject. So the students need only one book for their study of pneumatics.

Further, the author has tried to project a comprehensive account of the subject matter in a proper logical sequence and in an easy-to-understand language. The balanced treatment of theory, technology, and circuits makes this book rather unique and educational. I recommend Joji's timely book not only for undergraduate students but also for professionals and industrial technicians involved in pneumatics. I believe that this informative book will benefit many readers and be a fine reference.

**H A Keshava Murthy**  
Deputy Director General  
Govt. of India, Ministry of Labour & Employment  
Directorate General of Employment & Training (DGE&T)  
New Delhi

# Preface

*Pneumatic Controls* is an introductory textbook designed to provide basic technical information for dealing with pneumatic components, circuit diagrams, PLC programs and systems. Educating people to properly use pneumatic power is crucial for the economical use of energy. The three aspects having a vital bearing on the efficient use of pneumatic power are: proper designing of pneumatic circuits, selection of appropriate components for a pneumatic system, and top-class maintenance of a system. This textbook covers the operation and maintenance procedures of pneumatic devices thoroughly. It has been designed to make students, engineers, and technicians feel at ease while trying to understand the ‘why’ and ‘how’ of the operating principles of pneumatic and electro-pneumatic equipment and their control aspects including Programmable Logic Controller (PLC)-based controls.

The contents of this book evolved gradually over the last 10 years from the notes used by the author in training the participants attending programmes on ‘Pneumatic Controls’, ‘Electro-pneumatics’, and ‘Programmable Logic Controllers’ at the Foremen Training Institute, Bangalore. Besides, a number of books, manuals and catalogues were consulted, and information from the electronic media was used in the preparation of this book. The author has tried to acknowledge all these sources in the bibliography. As pneumatics is among the fastest growing engineering fields, the book’s text has been kept as current as possible. The illustrations and their explanatory text graciously supplied by many manufacturers are greatly acknowledged.

The author expresses his appreciation of H.A.K. for his, professional advice and constant encouragement that helped a lot in the book completion. The writing of this



book was inspired and assisted by numerous scholars working in the area especially S.D.L., B.V.S., D.V.K, K.R.G., G.N.E., G.C.R., C.R.S., B.N.S., and J. Mukhopadhyay. It is a pleasure to thank each one of them for their intellectual exchanges, valuable suggestions, critical reviews and technical assistance. Several organizations have also contributed significantly to this effort. The author also extends his thanks to his former students for their evaluation and suggestions during the early stages of the manuscript preparation. Most of the text material have been reviewed and tested in the classroom by both trainers and students. To everyone involved goes my deepest appreciation. Thanks to Paras Bansal, the editorial, and the production team at Wiley India for handling the production of the first edition of this book. The author also wishes to express his thanks to all friends who have helped in any manner in the preparation and writing of this book.

While working on this book, the author had spent long hours, numerous evenings and weekends in isolation during the last few years that had a bearing on his personal life. He appreciates the patience and understanding of his friends, students and his family members during these tense periods.

The author requests all prospective readers to offer their valuable suggestions for further improvements. Finally, the book has been completed and the author hopes you enjoy reading it. Have fun and good luck!

### ***Acknowledgements***

The author expresses grateful thanks to the following organizations in the alphabetical order for their support and kind permission to reproduce extracts from their training material and other publications.

- Festo Controls
- Norgren IMI
- Nucon
- SIEMENS
- SMC Pneumatics





# Contents

## Foreword

## Preface

### **1 Industrial Prime Movers**

#### Learning Objectives

- 1.1 Introduction
- 1.2 Power System Functions
- 1.3 Control System Functions
- 1.4 Mechanisation and Automation
- 1.5 Electrical Power System
- 1.6 Fluid Power System
- 1.7 Hydraulic Power System
- 1.8 Pneumatic Power System
- 1.9 Selection of Energy Media
- 1.10 Comparison of Different Energy Media
- 1.11 Overall Power System

#### Questions

### **2 Introduction to Pneumatics**

#### Learning Objectives

