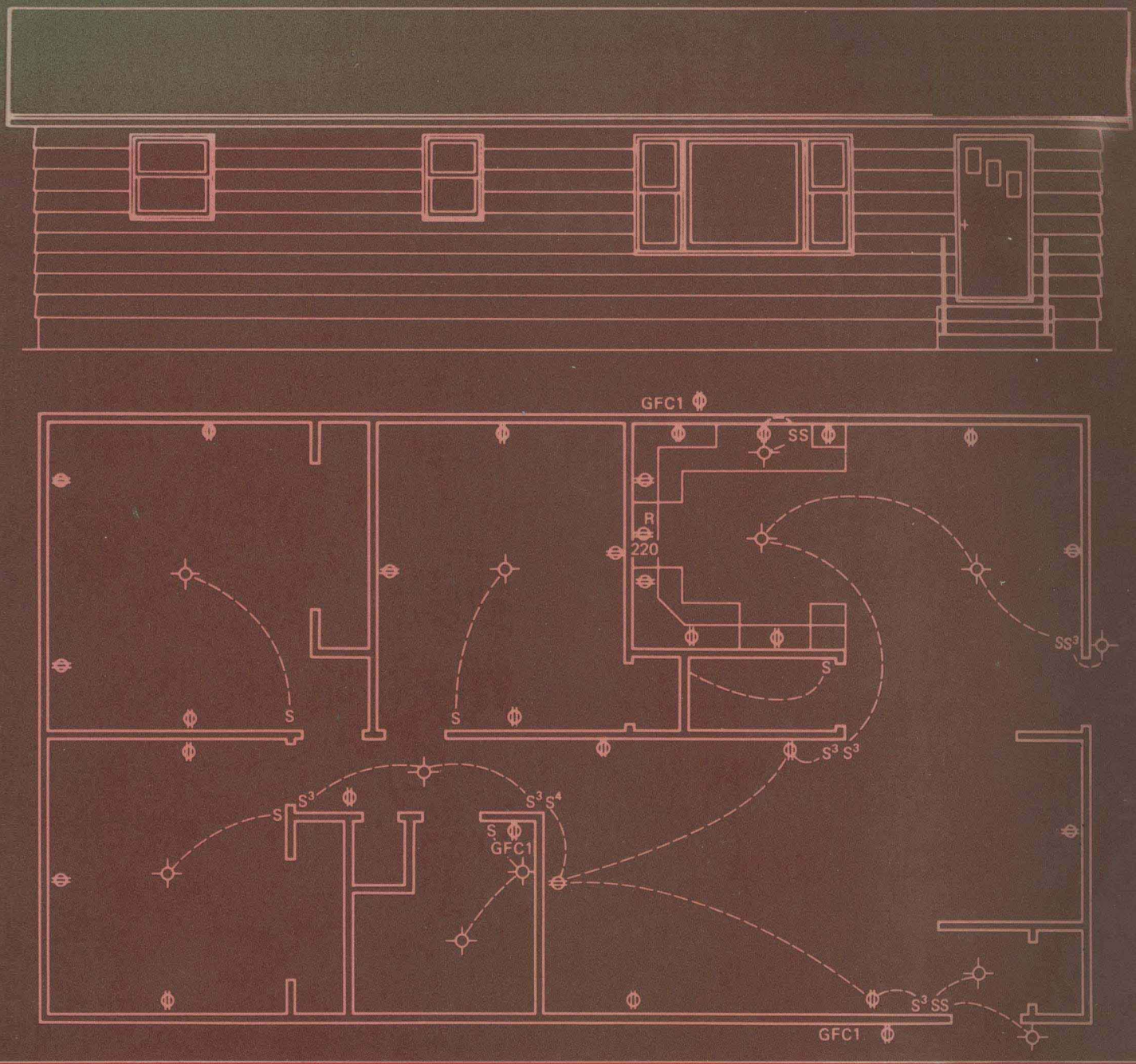
WILLIAM J. WHITNEY



RESIDENTIAL AND COMMERCIAL ELECTRICAL WIRING

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William J. Whitney

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RESIDENTIAL AND COMMERCIAL ELECTRICAL WIRING

To my wife Elizabeth
My active partner
for 40 years

PREFACE

The purpose of this book is to aid you in your study of residential and commercial wiring. The text presents in nontechnical terms the mathematical theory behind the electrical devices and equipment used in residential and commercial construction. I draw on my experience as a journeyman electrician, electrical contractor, apprentice, adult educator, and vocational technical institute instructor, to explain, as simply as possible, electrical wiring as it applies to single- and multiple-family dwellings, farm operations, store buildings, mobile and recreational vehicle parks, and commercial industry. My aim has been to downplay the use of complex technical terms and to emphasize the reasons for electrical installations and practices. Much of the text and many of the illustrations and examples have been reviewed by manufacturers and others to ensure that the content is up to date and corresponds with the 1981 National Electrical Code.

Because of our changing times, I place emphasis on intermediate metal conduit, PVC conduit, and other new materials and equipment now available to the electrical industry.

It is my hope that high school students, vocational students, Vocational Technical Institute students, apprentices, tradespeople, adult classes, and newcomers to the industry will find this book a useful tool for understanding residential and commercial wiring.

I think you will enjoy the book's format. It includes instructional objectives and several self-evaluation questions at the beginning of each chapter, text discussion with a summary, and problems at the end of each chapter. This book is designed to focus your attention on what's important, point you in the right direction, and make you sure you understand the material in each chapter.

As you read the book, you will notice that the National Electrical Code is included in the text material; however, it is suggested that a copy of the 1981 National Electrical Code be referred to while studying this material.

The material covered in this text has been classroom tested by second-year construction electrician students at the Albert Lea, Minnesota Area Vocational Technical Institute.

I gratefully acknowledge the support of the Wiley staff and the tireless work of Mrs. Irene Holz, who typed the manuscript and its many revisions.

William J. Whitney

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W.J.W.

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PART 1

INTRODUCTION

chapter 1

BASIC ELECTRICITY

Instructional Objectives

1. To learn how Ohm's law applies to a circuit.
2. To solve simple Ohm's law problems.
3. To understand the formula for making Ohm's law.
4. To name and define the units of current, electromotive force (emf), and resistance.
5. To distinguish between emf and potential difference (pd).

Self-Evaluation Questions

Test your prior knowledge of the information in this chapter by answering the following questions. As you read the chapter, watch for the answers. When you have completed the chapter return to this section and answer the questions again.

1. State Ohm's law when voltage and resistance are known.
2. State Ohm's law when voltage and current are known.
3. State Ohm's law when current and resistance are known.
4. What effect does resistance have on voltage delivered to the load?
5. What is meant by the term "drop of potential"?
6. Name the three primary circuit elements.

Electricity alone is a subject that would require several chapters to cover the basics. However, in this chapter we discuss basic electricity as it relates to electrical wiring for the construction industry.

1-1 OHM'S LAW

Experience with direct-current circuits shows that the current established in closed metallic paths is directly proportional to the emf of the source of

electricity in the circuit and inversely proportional to the resistance of the path. These facts were first exposed by Ohm, and the relation between the three factors involved is known as Ohm's law. Since its first phrasing in 1827, this law has had outstanding importance in electrical calculations.

Ohm's law states that the current in a metallic circuit is equal to the emf available in the circuit divided by the resistance of that circuit. In order to unite the formula for this law, let

I = current maintained in the circuit
E = emf of the source of electricity included in the circuit
R = total resistance of the circuit, including the internal resistance of the source

Then, by the foregoing statement of Ohm's law,

$$\text{Current} = \frac{\text{emf}}{\text{resistance}}$$

The value of any one of the three factors can be calculated when the value of the other two are known.

To find the current in a circuit when the emf and resistance are known, divide the emf by the resistance

$$I = \frac{E}{R}$$

Introducing the units in Ohm's law, ampere for current, volt for emf, and ohm for resistance, it follows that in a metallic circuit

$$\text{Amperes} = \frac{\text{volts}}{\text{ohms}}$$

EXAMPLE 1

A particular incandescent lamp is connected to an electric generator which develops an emf of 110 volts; under these conditions the lamp has a resistance of 275 ohms. What current will the lamp take?

The current is given by Ohm's law as

$$I = \frac{E}{R} = \frac{110}{275} = 0.40 \text{ ampere}$$

EXAMPLE 2

An electric heater has a resistance of 20 ohms and another has a resistance of 4[illegible] ohms. Two sources of emf are available, one of 240 volts and the other of 120 volts. Find how much current each heater will take when connected to the source.

The formula $I = E/R$ is used to complete the results desired; first take $R = 20$ ohms with $E = 240$ volts and then $E = 120$ volts.

(a) For the 20-ohm heater operating on 240 volts

$$I = \frac{240}{20} = 12 \text{ amperes}$$