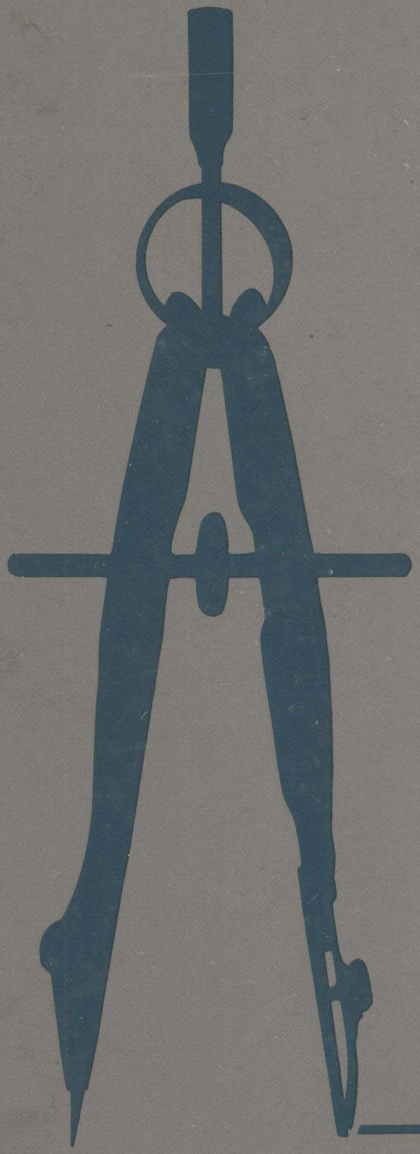
ELECTRICAL—ELECTRONIC DRAFTING AND DESIGN



JOHN TRAISTER

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John E. Traister

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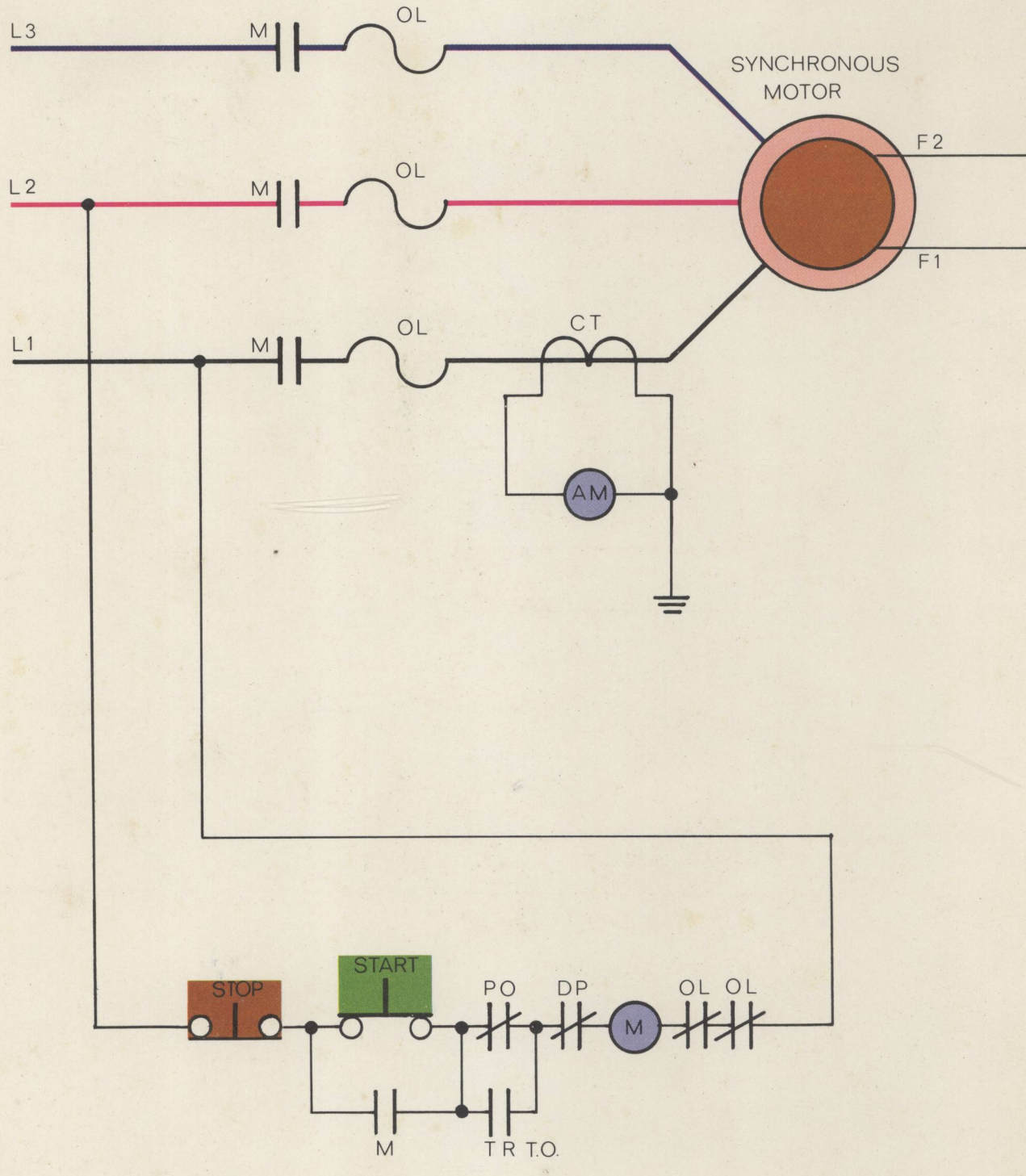
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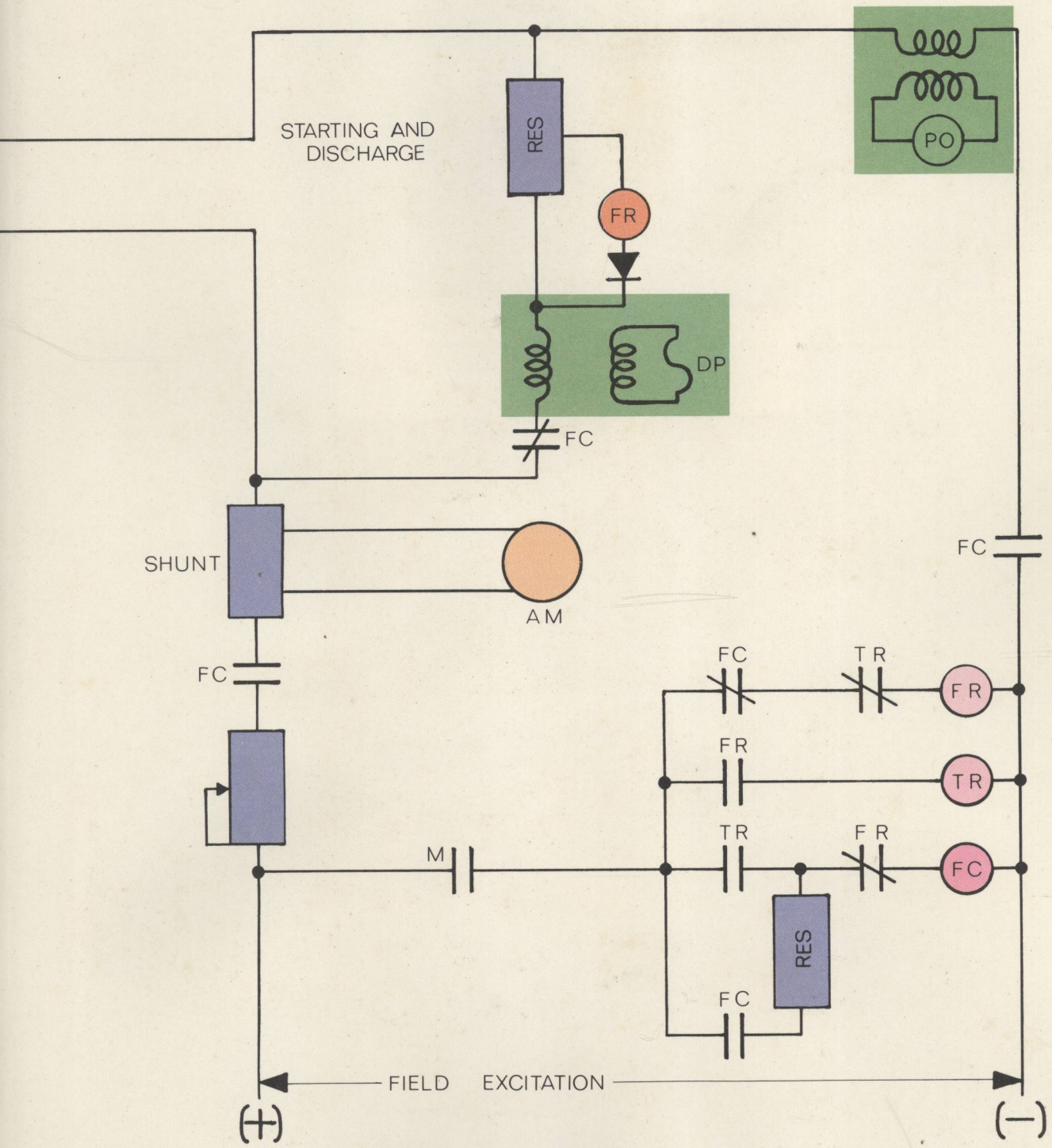

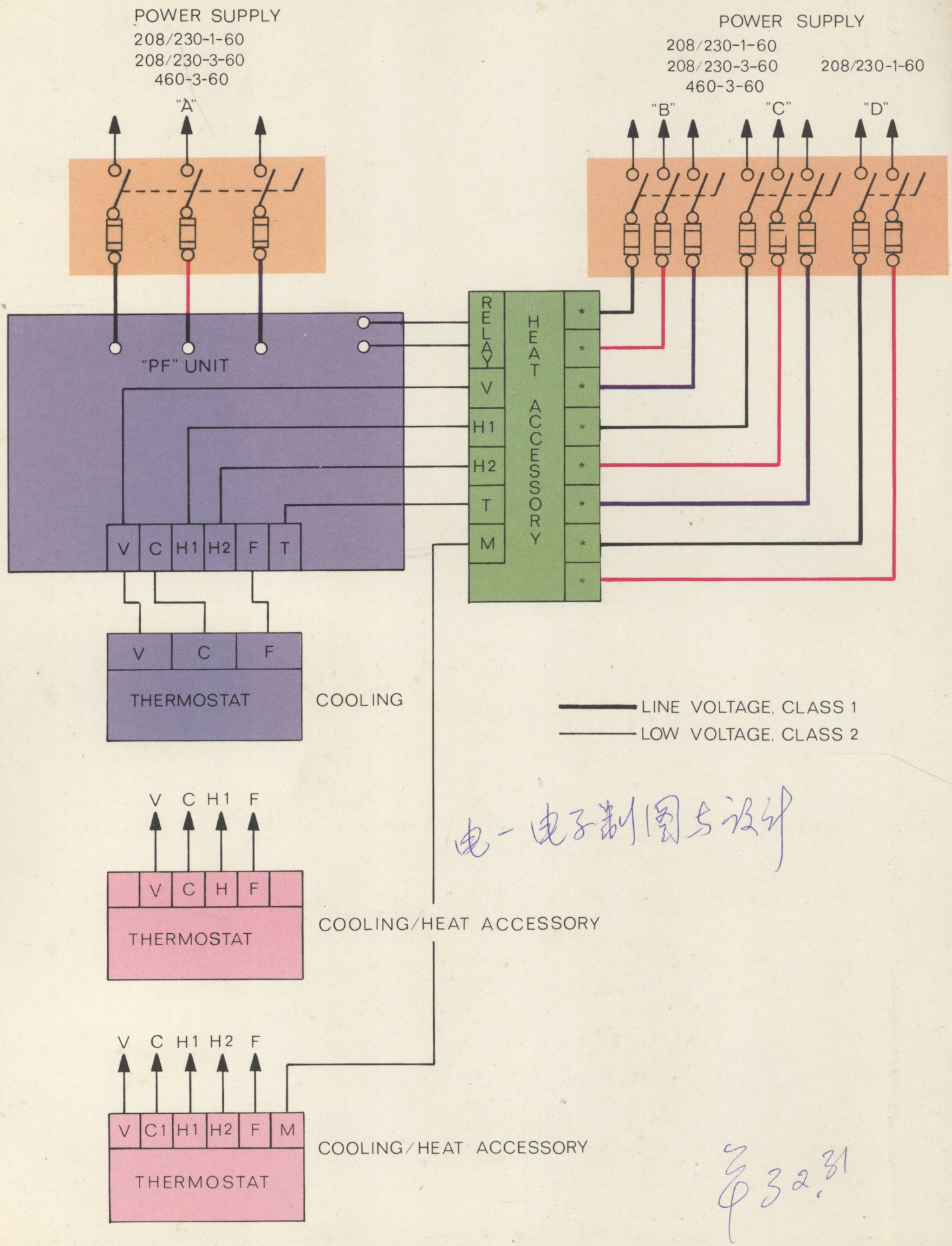

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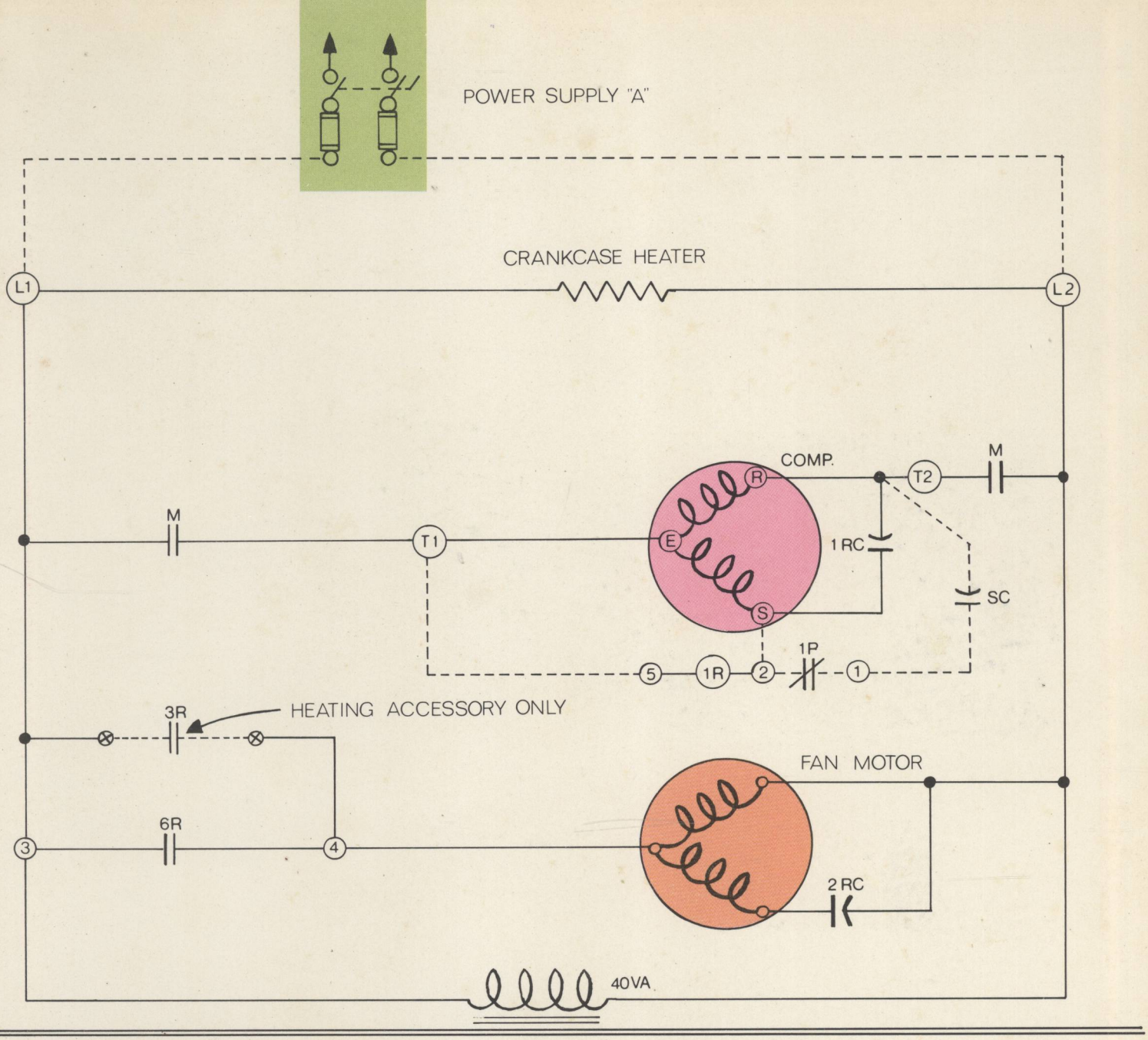

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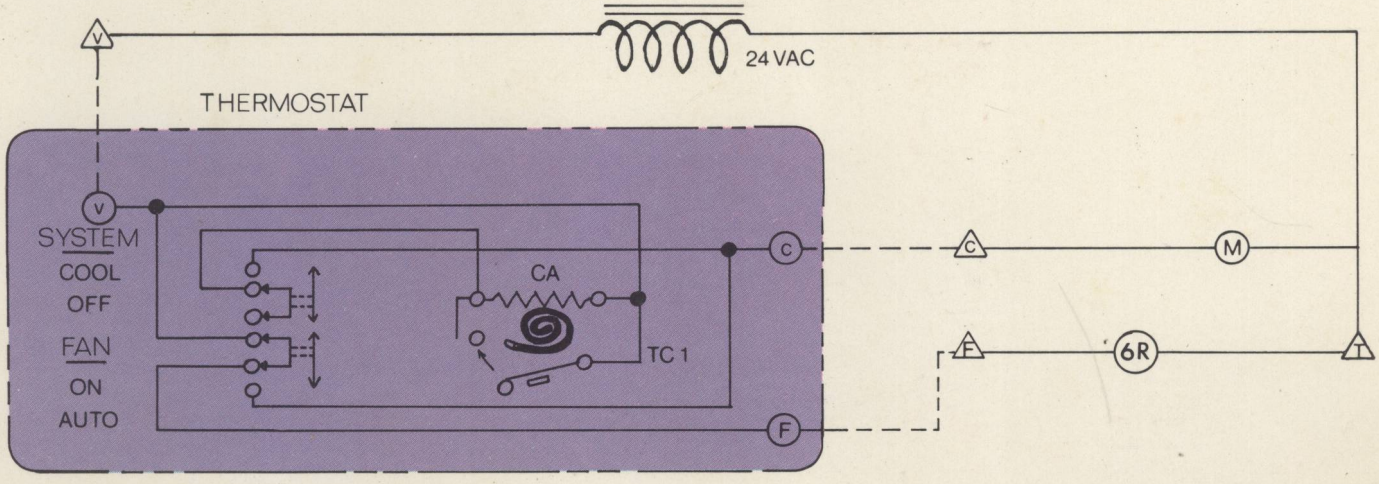

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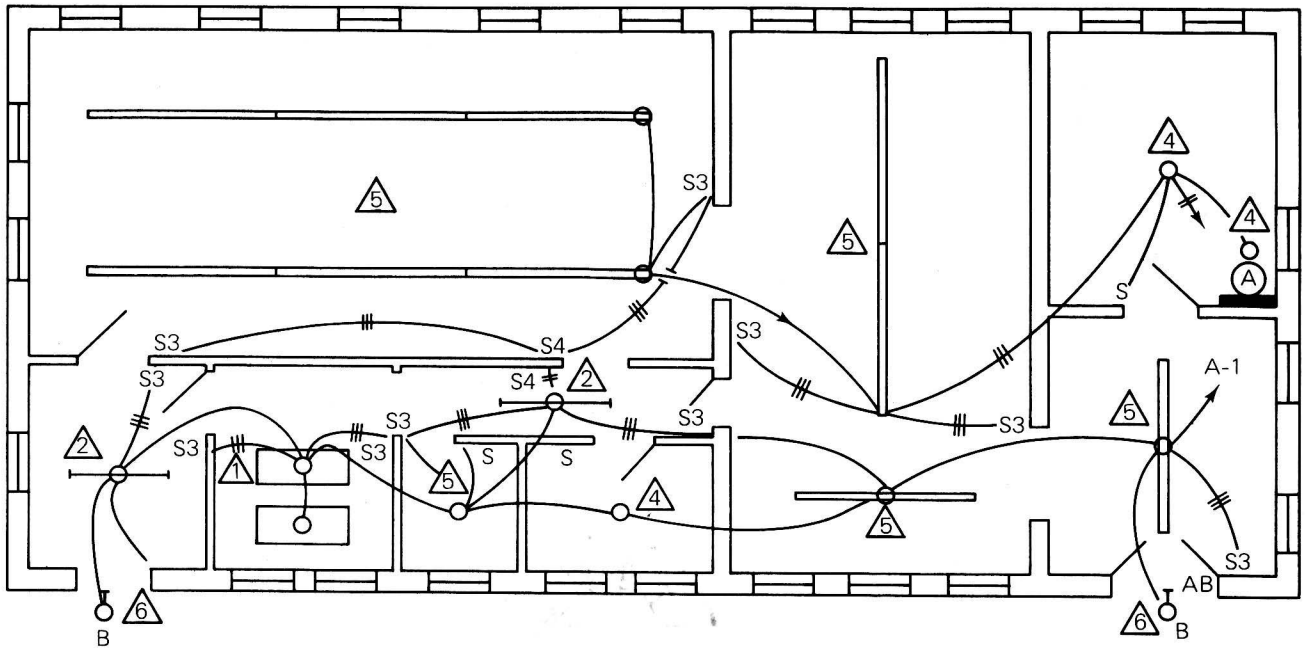

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PREFACE

This book is designed as a practical guide to the drafting of electrical and electronic systems. It contains much of the knowlege and experience gained over a period of many years by the author and by draftsmen, technicians, consulting engineers, and many manufacturers in the fields. It is tailored to the specific needs of the person responsible for transmitting technical information though the preparation and interpretation of electrical and electronic drawings; therefore, the first consideration has been the requirements of the draftsmen employed by consulting engineers, contractors, and manufacturers.

If any one word best describes this work, it is hoped to be the word *practical*. It is arranged in a logical order of learning difficulty; it is designed so that each student can work on his own job and may proceed with a minimum of assistance according to his or her own ability; it provides a well-rounded course in basic drafting with emphasis on the electrical and electronics fields and is ready for use without further preparation on the part of the instructor; it is usable at many educational levels; it bridges the gap between theory and problems encountered in actual employment at consulting engineering firms, electrical contracting firms, and manufacturers.

In summary, this book is a quick reference for those actively engaged in the drafting of electrical and electronic systems, a learning method for those studying electrical drafting and design, and a refresher for those with wide experience in the field.

A deep and grateful bow must be made in the direction of the draftspersons, designers, and engineers who helped supply material for this book. I am especially indebted to the many manufacturers who supplied several of the illustrations and reference data.

If this book can take a few of the stumbling blocks out of the student's path and light the way somewhat, the purpose of the book will have been fulfilled.

JOHN E. TRAISTER

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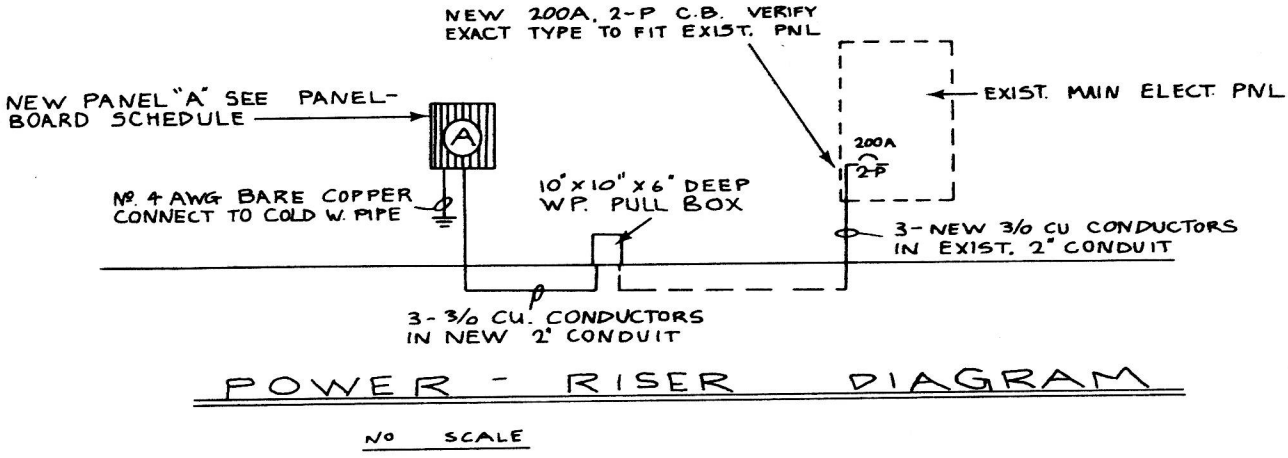
Chapter 1



INTRODUCTION TO ELECTRICAL AND ELECTRONIC DRAFTING

The primary objective of this chapter is to give the reader an overall picture of the electrical and electronic industry and the draftsperson's relationship to it. Familiarity with these relationships is considered necessary to give draftspersons a proper background for approaching their work more intelligently.

This chapter will also introduce fundamental drafting procedure, types of electrical and electronic drawings, a survey of electrical and electronic drafting, and other basic essentials necessary to the electrical and electronic drafting profession.

1.1 Fundamentals of Electrical and Electronic Drafting

During the early days of the electrical construction industry, the electrical installations were usually laid out by the electrician on the job—often only as the work progressed. As these systems became more extensive and complex, contractors began hiring mechanical draftsmen to prepare working drawings to supplement the sketchy layouts on the architect's drawings. These electrical working drawings provided a basis for preparing the cost estimates and for giving instructions to the electricians installing the systems. In fact, these are still the primary purposes of most electrical drawings today.

As the electrical systems in buildings continued to become a more important part of the general construction and the systems became still more extensive and complex, persons with the proper knowledge and training began to devote their time exclusively to designing and laying out electrical systems as consulting engineers, selling their services to architects. These firms probably accounted for the hiring of more electrical draftsmen than any other industry at the time.

Engineers, technicians, designers, and draftspersons are still constantly working on drawings and construction documents for electrical systems in new buildings as well as plans for the renovation of existing buildings. Much of the design for such systems is accomplished by the use of mathematics, good judgment, and drafting. Mathematical equations are used in calculating the amount of illumination for a given area, circuit and feeder wire sizes, the service-entrance size, and the like. Good judgment is gained from experience and is used to determine such items as the type of lighting fixtures to be used in a given area, etc. Drafting is the means of using lines, symbols, dimensions, and notations to convey the engineer's calculations and design to the workmen on the job. Therefore, drafting is really a language—a means of communication—and any potential draftsman must master this language so that his drawings will show a complete description of the finished product and so that the workmen can understand what is expected of them.

Unlike freehand artists, who require a certain amount of natural talent, draftsmen are made—by acquiring a good knowledge of the profession and then applying this knowledge to practical applications. However, there are a few personal characteristics that, by the very nature of the work, a person should have to be a successful draftsman regardless of his previous training or background. These characteristics include:

1. A reasonable amount of mathematical ability
2. Patience
3. An orderly mind
4. Imagination and ability to visualize
5. Ability to concentrate
6. Neatness

Any potential draftsman who lacks the preceding background should take steps to improve himself.

1.2 Types of Electrical and Electronic Drawings

Those involved in electrical and electronic drafting will encounter many types of drawings during the preparation of even a single project. A brief sampling of the various types that are likely to be encountered in this field of the drafting profession is in order. A more detailed study—including step-by-step procedures for drawing them—will be covered in the chapters to follow.

Pictorial drawings are those drawings in which the objects are drawn in one view only; that is, three-dimensional effects are simulated on the flat plane of drawing paper by drawing several faces of an object in a single view. This type of drawing is very useful to describe objects and convey information to those who are not trained in blueprint reading or else to supplement the conventional orthographic (multiview) drawings in the more complex systems.

Examples of the use of pictorial drawings would be the instructions for the many do-it-yourself kits now on the market for beginners; drawings used in training manuals in various industries and the armed forces; catalog illustrations, and those drawings used by assembly-line workers for assembling electronic equipment.

The types of pictorial drawings most often found in the electrical and electronic fields include:

1. Isometric drawing
2. Oblique drawing
3. Perspective drawing

All of these types are more difficult to draw than conventional multiview drawings. Further disadvantages of pictorial drawings are that intricate parts cannot be pictured clearly and that they are difficult to dimension. Still, as mentioned previously, they are being used more and more, and every electrical and electronic draftsman must be able to draw such views professionally.

A view projected onto a vertical plane in which all of the edges are foreshortened equally is called an *isometric projection*. Figure 1-1 shows an isometric drawing of a cube. In this view, the edges are 120 degrees apart and are called the isometric axes, while the three surfaces shown are called the isometric planes. The lines parallel to the isometric axes are called the isometric lines.

This type of pictorial drawing is usually preferred over the other two types mentioned for certain electrical details and wiring diagrams on working drawings, because it is possible to draw isometric lines to scale in the same manner as floor plans or multiview plans are drawn in orthographic views. Isometric drawings may be made with the 30–60-degree triangle.

The *oblique drawing* is similar to the isometric drawing in that one face of the object is drawn in its true shape and the other visible faces are shown by parallel lines drawn at the same angle (usually 45–30 degrees) with the horizontal. However, unlike an isometric drawing, the lines drawn at a 30-degree angle are shortened to preserve the appearance of the object and are therefore not drawn to scale. The drawing in Fig. 1-2 is an oblique drawing of a cube.

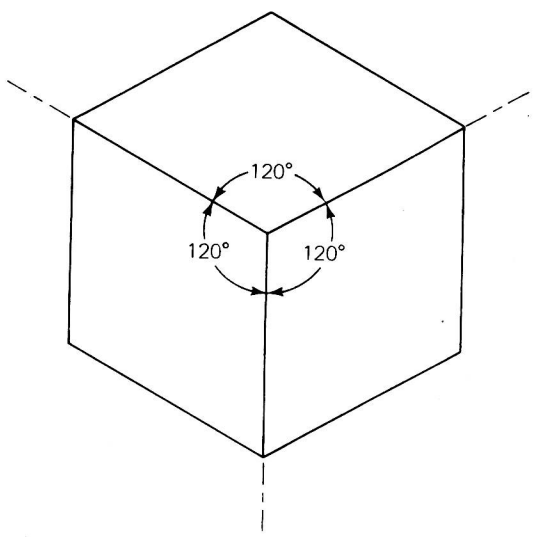


Figure 1-1. An isometric drawing of a cube showing the isometric axis 120 degrees apart.

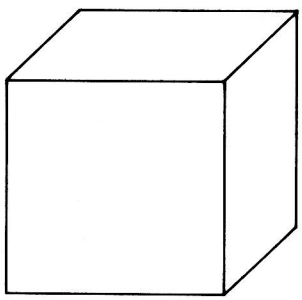


Figure 1-2. The oblique drawing shown here is another form of pictorial drawing.

The two methods of pictorial drawing described so far produce only approximate representations of objects as they appear to the eye, as each type produces some degree of distortion of any object so drawn. However, because of certain advantages (they can be drawn to scale, they are easy to draw, etc.) they are the types of pictorial drawings most often used in the electrical/electronic industry.

Sometimes—as for a catalog illustration—it is desired to draw an exact pictorial representation of an object as it actually appears to the eye. A drawing of this type is called a *perspective drawing;* one such drawing appears in Fig. 1-3.

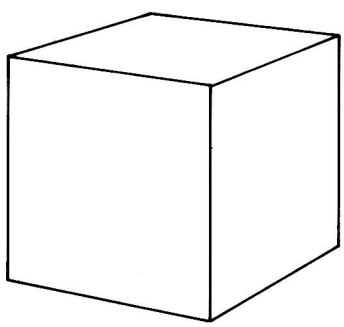


Figure 1-3. A perspective drawing is used when an exact pictorial representation of an object is required.

An *orthographic-projection drawing* is one that represents the physical arrangment and views of specific objects. These drawings give all plan views, elevation views, dimensions, and other details necessary to construct the project or object. Although the pictorial drawing in Fig. 1-4 suggests the form of a

block, it does not show the actual shape of the surfaces, nor does it show the dimensions of the object so that it may be constructed.

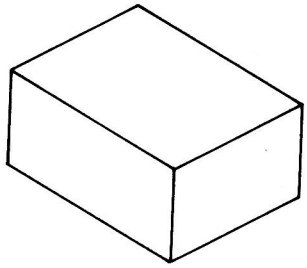


Figure 1-4. A pictorial drawing suggesting the form of a block.

An orthographic projection of the block in Fig. 1-4 is shown in Fig. 1-5. One of the drawings in this figure shows the block as though the observer were looking straight at the front; one, as though the observer were looking straight at the left side; one, as though the observer were looking straight at the right side; and one, as though the observer were looking at the rear of the block. The remaining view is as if the observer were looking straight down on the block. These views, combined with the dimensions, will allow the object to be constructed properly from materials such as metal, wood, plastic, etc.

Electrical diagrams are drawings that are intended to show, in diagrammatic form, electrical components and their related connections. Such drawings are seldom drawn to scale, and show only the electrical association of the different components. In diagram drawings, symbols are used extensively to represent the various pieces of electrical equipment or components, and lines are used to connect these symbols—indicating the size, type, and number of wires.

In general, the types of diagrams that will be encountered by the electrical/electronic draftsman will include: flow diagrams (Fig. 1-6), single-line block diagrams (Fig. 1-7), and schematic wiring diagrams (Fig. 1-8). The chapters to follow will show the reader exactly how to plan and draw all of these types of diagrams.

1.3 Survey of Electrical and Electronic Drawings

You have just reviewed the various types of drawings most often encountered in electrical and electronic drafting, but most of the examples given were of a cube or block—hardly the typical drawings you will be making as a professional draftsperson. The examples to follow are intended to show how the previous types of drawings relate to actual applications in the electrical and electronic drafting fields.

Electrical and electronic drawings that are prepared by consulting engineers, contractors, manufacturers, and others involved in the industry are very unique drawings. Most of these drawings will encompass all of the previously described drawings regardless of the firm involved. For example, drawings produced by manufacturers of electronic equipment (Radio Shack, Heath Company, etc.) usually consist of the following:

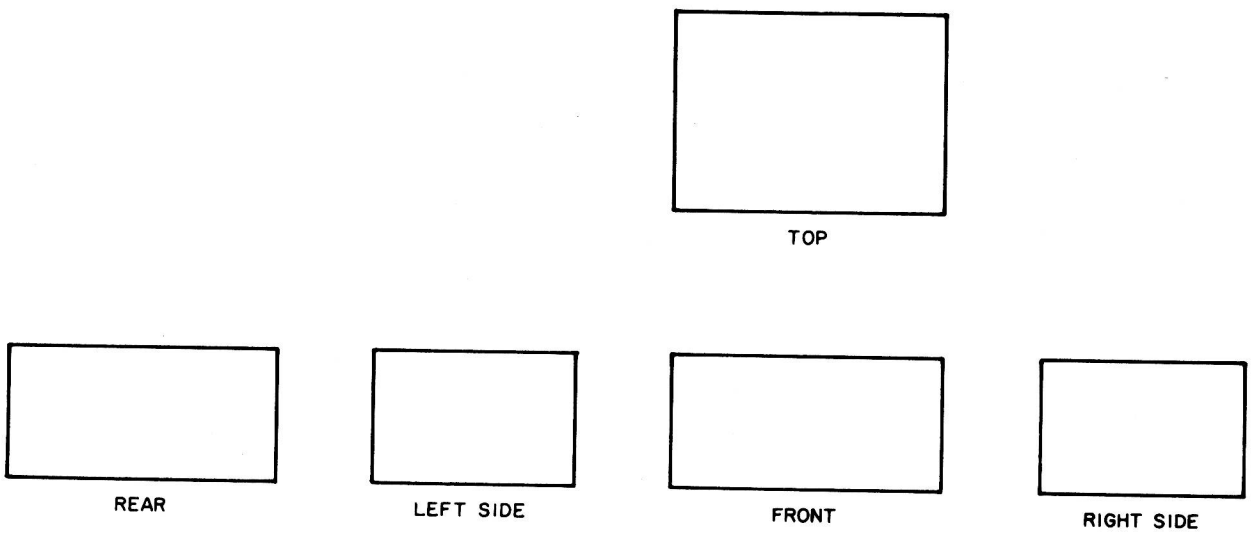


Figure 1-5. An orthographic projection of the block shown in Fig. 1-4.