

**Rip Weaver**

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## **MODERN BASIC DRAFTING**

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# About the Author



Rip Weaver has over 25 years experience in the drafting and engineering field for private business. During his career he has trained hundreds of drafting technicians, enabling them to advance to more responsible positions. He is president of Petrochemical Training Programs, a company devoted to training and upgrading personnel within the hydrocarbon and chemical processing industries.

With the Houston division of Fluor Engineers and Constructors, Inc. for more than 19 years, Weaver has worked on, or supervised, drafting and design for many major refiners. He is the author of *Process Piping Drafting* and *Process Piping Design*, 2 volumes, published by Gulf Publishing Company, and has published numerous articles in trade and technical magazines. His books are used as textbooks in hundreds of schools and in businesses in the United States, Canada and Great Britain as well as for apprentice and on-the-job training programs.



# Preface

“You people in the business should write our textbooks.”

“I want a modern textbook to teach basic drafting.”

“The textbook I’m now using is fine if all my students were interested in only machine drafting, but I’d like to have one that includes pipe drafting, pressure vessels, structural steel detailing and other subjects. This would introduce the students to other fields and they could pick the one that interested them for advanced training.”

These are a few of the many comments I have heard from high school drafting instructors in several states. The comments were valid and I couldn’t ignore them. I had been in the drafting and design business for 25 years. I certainly knew the kind of training needed by those entering the drafting profession, because I had furthered the training of hundreds of young people. And too many times I had heard their comments of, “I didn’t know that,” or “They didn’t teach me anything about that in school.” What they were saying was that those items were not in their textbooks.

After writing *Process Piping Drafting* and two volumes of *Process Piping Design*, I said I’d never write another textbook. But, I couldn’t turn my back on those drafting instructors. One year later I started *Modern Basic Drafting*.

Now that it is finished, I want to thank those drafting instructors who urged me to write it. I also wish to thank my high school drafting instructor, S.S. Orman, Tulsa Central High School, for providing me with a firm foundation in drafting. It has been a most enjoyable career.

Rip Weaver  
July, 1975

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# Introduction

A 50-state survey conducted by the Bruning Division of Addressograph-Multigraph pointed out areas of education that needed attention by drafting instructors and drafting textbooks. This survey was taken from over 600 companies that employ drafting personnel. This book was written to help instructors and students obtain expertise in those subjects employers said needed attention.

One area frequently mentioned was general math, the knowledge necessary to comfortably add, subtract, multiply and divide both whole numbers and fractions. Knowledge of the metric system is necessary, too, so this book has a chapter on each. Of all subject areas mentioned, unsatisfactory math knowledge led the list. Second on the list was lettering and line work, which has long needed attention. This subject can only be touched by a textbook. The drafting instructor must impress the importance of lettering and linework upon the student. Other subjects needing attention were general drafting techniques, English and spelling and dimensioning practices, in that order.

The Bruning survey also asked employers to cite drafting subject areas in which the new drafting technician was deficient. The leading four subjects were mechanical, electrical, structural and piping

drafting. The Bruning news release states "Although piping drafting is cited as fourth on employers' lists as *mandatory* background for a new employee, this subject is virtually ignored in the curricula of most schools, including some of the country's biggest and best". Responding to this need, this text has an extensive section on piping drafting.

A chapter is included on structural drafting, which was third on the most needed list. Structural drafting in many organizations means more than detailing structural steel. It also includes preparation of concrete foundation drawings and the detailing of reinforcing bar within the foundation.

This book is a new concept in basic drafting books. The first few chapters are traditional and explain the tools, instruments and other basics of the drafting field, but the remainder of the book emphasizes learning drafting skills requested by employers.

The author, Rip Weaver, has been doing drafting and design for more than 25 years with private business. He has written this book to place needed material before students and instructors alike, with the hope that both will benefit from his experience.



Today's drafting rooms are well lit, carpeted and roomy. Courtesy of Fluor Engineers & Constructors, Inc.



# 1 Drafting Defined

A draftsman prepares drawings used to make a product or products. The draftsman communicates to the craftsman by pictures and words exactly how the item is to be built, piece by piece, and how the pieces are assembled to make the finished product. The draftsman's drawings are a form of graphic communication. Almost everything one sees or uses every day had its beginning on a drafting board—furniture, clothes, houses, roads, motorcycles, cars and thousands of other items. Everything made in volume for consumer use is made from a draftsman's drawing.

Early in life people come in contact with and are users of the draftsman's work. Boys and girls fly kites which are purchased unassembled. A draftsman's drawing and instructions explain how to assemble the kite and where to tie string or tail. Later they build model cars or airplanes. Again drawings and instructions are used. Doll clothes are made from drawings by a draftsman. Considering all the items requiring drawings it is easy to see why there is a need for many thousands of draftsmen in the United States alone.

## Drafting as a Job

Who should elect to become a draftsman? Almost anyone with patience enough to learn can do well. If you have the perception to be able to visualize an item and prepare a legible free-hand sketch of it,

you have the talent needed. Imagine a soft drink can. Can you prepare a free-hand sketch of it? Then you can become a draftsman. This is a high-paying field because there are more draftsmen needed than are available.

The *man* in draftsman is there because historically the work has been done by men. But lately women are entering this field in greater numbers. Normally a woman draftsman will earn 2-3 times the salary she would make as a typist or secretary. A recent government report shows that in 1973, 8% of United States draftsmen were women and this percentage was rapidly growing. So the term draftsman today can mean male or female.

Why should one become a draftsman? Besides a highly paid position the draftsman contributes to the welfare of his friends and neighbors by being an important part of the team that produces consumer products. For instance, a refinery is needed to produce gasoline and other hydrocarbon products. To build this refinery draftsmen must produce thousands and thousands of drawings detailing information and instructions to craftsmen who construct and erect the millions of individual components that totally make up the installation. All so gas and oil can be purchased at a service station. And don't forget that many drawings are made just to build that service station.

The draftsman's work is diversified, as each drawing is like preparing a custom made item. The

draftsman considers each drawing as an individual project, and is constantly challenged to combine past experience with creative thinking to produce a drawing which allows the finished product to be durable and be made at minimum cost to the consumer.

Many people visualize a draftsman as bent over a drawing board all day making lines on a piece of *vellum* or drawing paper. Not so; today's draftsmen will be in the shop or at the jobsite visiting with the people building the product and getting ideas on how to do things better. Much of the draftsmen's time is spent researching background data for the project. They will attend meetings with engineers and clients who outline much of the project's broad scope and review the final drawings. Senior draftsmen with several years experience spend much of their time doing technical engineering calculations they have learned on the job.

As a draftsman the author has been sent to foreign countries for terms of two months to 1½ years. So foreign travel is a possibility for today's draftsman.

In short, the limits of a draftsman's future is up to the individual man or woman. The work is creative, interesting, diversified and it contributes to the community. A draftsman receives good pay and enjoys a high community rating.

## Drafting for Pleasure

But suppose one doesn't want to become a professional draftsman. Why should this individual learn drafting? Throughout life one is exposed to drawings. To be able to read them requires some drafting knowledge. At one time or another everyone refers to a road map, also prepared by draftsmen. Someone with drafting training easily interprets the signs and symbols shown. To prepare a project to be made in a woodshop, drawings must be made. Try describing your dream house to someone without a drawing of some kind. If an architect were hired to prepare drawings of your dream home could you read the drawings and be sure you were getting the details you wanted? With basic drafting training you could.

## Learning Drafting

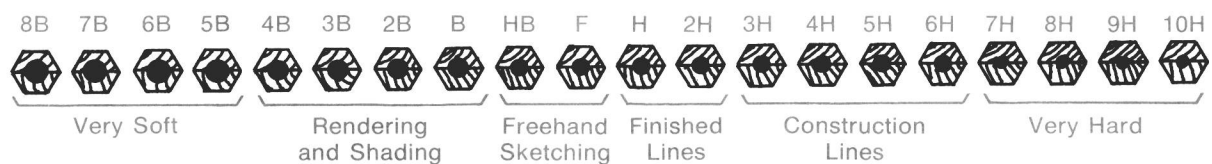
Like any trade or profession learning drafting requires time and effort. The language must be mastered and use of drafting tools must be learned. Like anything else, what a student learns from a drafting course is determined by how much effort is applied. In other words, you'll get out of it in direct ratio to what you put into it. Those that master the course may continue to advanced drafting training and later to the ranks of the professional draftsman.

# 2 The Draftsman's Tools

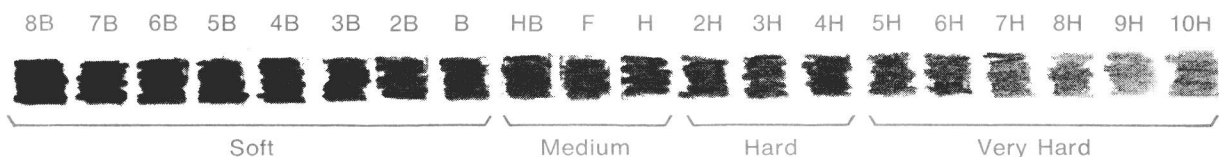
## Pencils

Everyone knows that pencils are comprised of wood with graphite centers. A draftsman uses wooden pencils with graphite of varying degrees of hardness. Figure 2-1 shows the 20 grades of drawing pencils and the terminology for each. The draftsman selects the proper lead hardness to depict the line weight desired, always considering that the drawing must be printed on a print machine. The softer leads will produce a darker, wider line than medium or harder leads. But the soft leads have a tendency to smear easily, and a smeared drawing will not supply good legible prints.

Figure 2-2 shows the markings of drawing pencils. The very hard 10H pencil will produce an extremely light line while the 8B is dark but doesn't have the necessary body to reproduce good on a print machine. Draftsmen normally use from 5H to F as their drawing lead. H or F is selected to do lettering and produce heavier linework. 2H, 3H and 4H leads are used to make lighter lines such as dimension or extension lines. To make light construction lines which are not to be reproduced on a print of the finished drawing, 5H pencils are used. This lead is also used for the light lines required as lettering guidelines.



**Figure 2-1.** Drawing pencils—nomenclature and uses.



**Figure 2-2.** Markings of drawing pencils.





**Figure 2-3.**  
Wood cased  
drawing pencils.  
Courtesy of  
Bruning Division,  
AM Corp.

### Types of Pencils

Normal drawing pencils come in wood-cased or mechanical which is refillable with a separate piece of lead. Figure 2-3 pictures wood-cased drawing pencils. Note that they do not have erasers. Each pencil shows the grade on one end, and the drawing point is at the other end. Should the wrong end be put in the pencil sharpener, the pencil grade would be sharpened away and the draftsman wouldn't know the grade.

The K series pencils have special plastic leads for use on drawing film or plastic. Many companies now require that all drawings be made on this film. Drawing paper or *vellum*, often called tracing paper, becomes brittle and cracks easily after

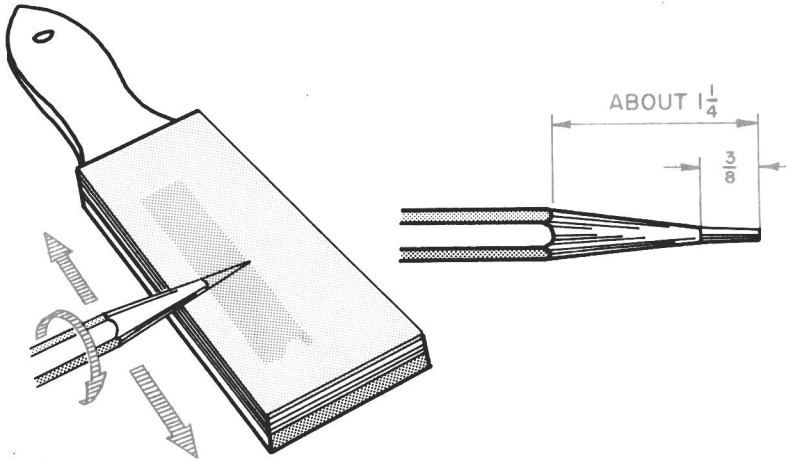
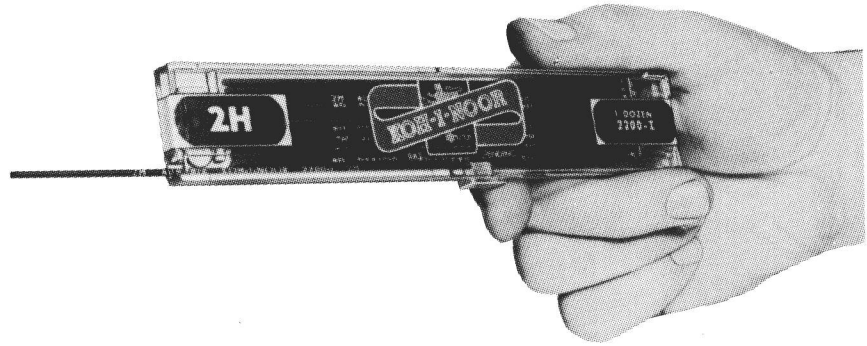
several years while the synthetic film will last for many years without any deterioration. The bottom pencil shown in Figure 2-3 is a Non-Repro type used for marking transparent originals when marks are not to appear on reproduced prints. The lead makes a bluish image on the original and will not reproduce. This pencil is handy for the draftsman wishing to make special marks or notes on drawings which should not show up on the prints.

Several types of mechanical pencils are pictured in Figure 2-4. When the top is pressed the chucks at the bottom open to release the lead. Normally  $\frac{1}{4}$ " of lead is left outside the chucks when drawing. Most professional draftsmen use the mechanical pencil and have one for each grade of lead they normally use.



**Figure 2-4.**  
Mechanical  
pencils.  
Courtesy of  
Bruning Division,  
AM Corp.

**Figure 2-5.**  
Mechanical pencil  
leads.  
Courtesy of  
Bruning Division,  
AM Corp.



**Figure 2-6.** Wood case pencil pointing.

Mechanical pencil leads are shown in Figure 2-5. They are available in the same hardness degrees or grades as wood-cased pencils. They are packed 6 to 12 per box and are about 5" long.

### Pencil Pointing

Everyone is familiar with a normal pencil sharpener. The draftsman uses one that looks like the normal pencil sharpener except it has special blades, called *draftsman blades*. When a wood-cased pencil is inserted in this sharpener only the wood is cut. The lead is not cut or pointed as a regular sharpener will do. This sharpener will cut the wood back about  $1\frac{1}{4}$ " from the end of the lead and leave about  $\frac{3}{8}$ " of pencil lead exposed. The draftsman points this lead by gently rolling it on a sandpaper pad until the proper point is attained (see Figure 2-6). If the point is needle sharp the pressure on the paper will break the point off resulting in a smear on the drawing. Most draftsmen keep a piece of scratch paper near their drafting board as a *point tester*. After sharpening their point they try it on the point tester to make sure it isn't too sharp. Some just roll it on the point tester and can feel if it is too sharp. Rolling the lead at a slight angle to the point tester will also wipe off any excess graphite that may be left on the lead after sharpening on the sand-



**Figure 2-7.** Lead pointer.  
Courtesy of Bruning Division, AM Corp.

paper pad. Compass lead points are also sharpened on the sandpaper pad.

Mechanical pencil leads are sharpened on sandpaper pads or with mechanical pointers as shown in Figure 2-7. These pointers are commonly called *coffee grinders* because the lead is inserted and, with the pencil held firm, the top part is turned clockwise to point the lead. After sharpening, the draftsman tries his point on the point tester and wipes away any loose graphite dust that may be attached to the lead. There are several types of mechanical lead pointers on the market; some are electric-powered—the draftsman has only to insert the lead, it starts and automatically provides a sharp point.

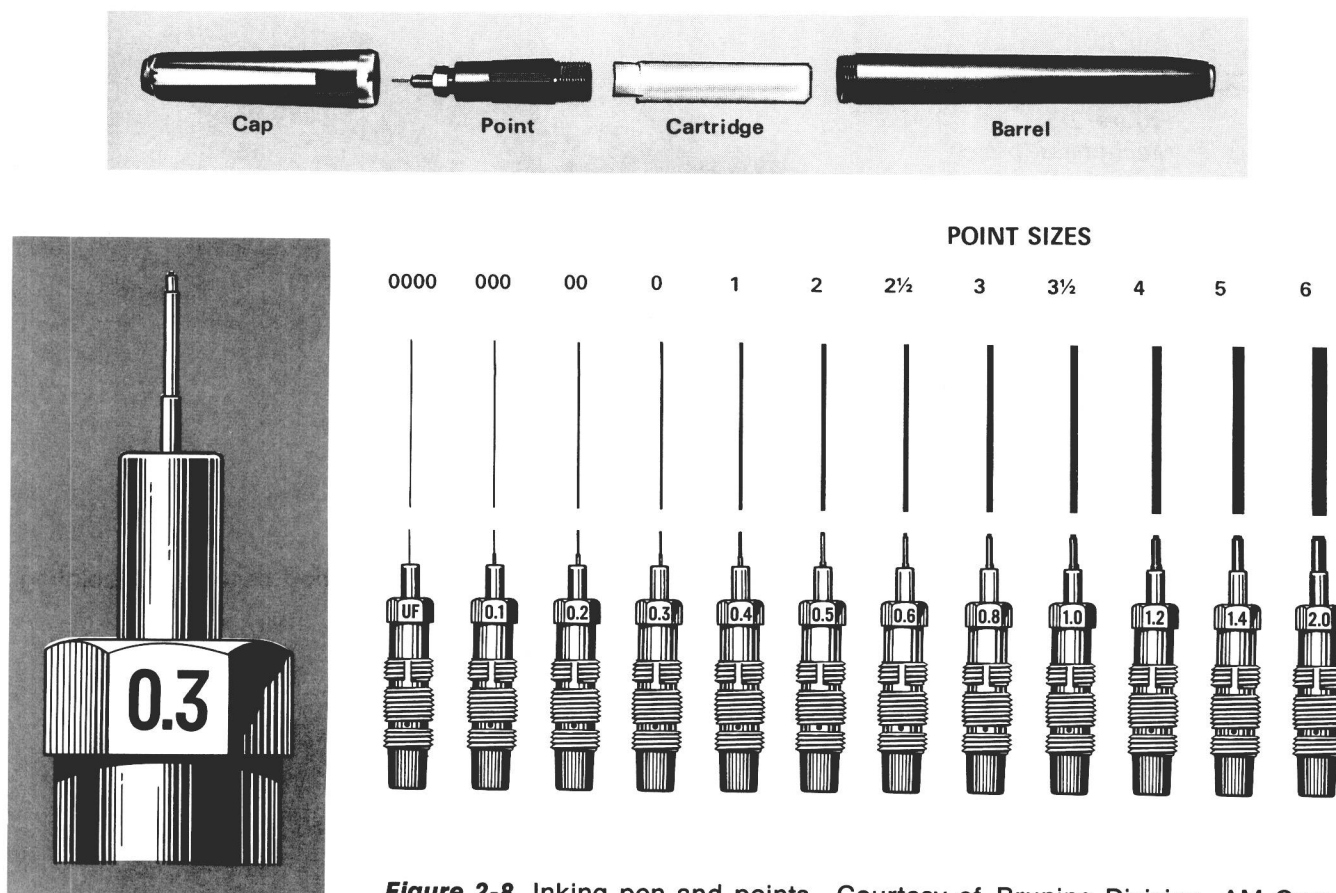


Figure 2-8. Inking pen and points. Courtesy of Bruning Division, AM Corp.

### Inking Pens

Inking procedures have changed considerably in the last few years. No longer is this a difficult or messy procedure. Today almost all inking is done with technical pens on plastic film instead of vellum or inking cloth. These pens are easily filled with an ink cartridge and simple to handle. Figure 2-8 shows these pens and the variety of points available. When the draftsman is finished with a particular point a few seconds in an ultra-sonic pen cleaner cleans it like new.

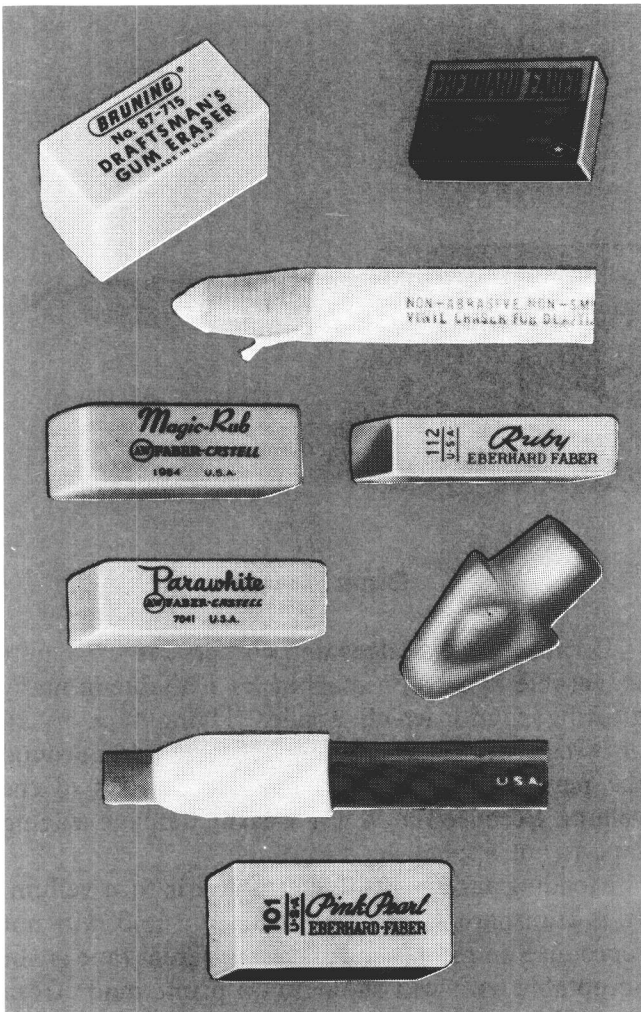
Modern ink is quick-drying, drying almost the instant it flows on the film. Should a smear occur or a change need to be made a damp cloth wipes away the old ink and the new ink can be applied to the surface. Waterproof inks are available. These are erased with a moist plastic eraser. When purchasing ink specify whether it will be applied to vellum, cloth or plastic film, as each surface requires a different type of ink.

### Erasers

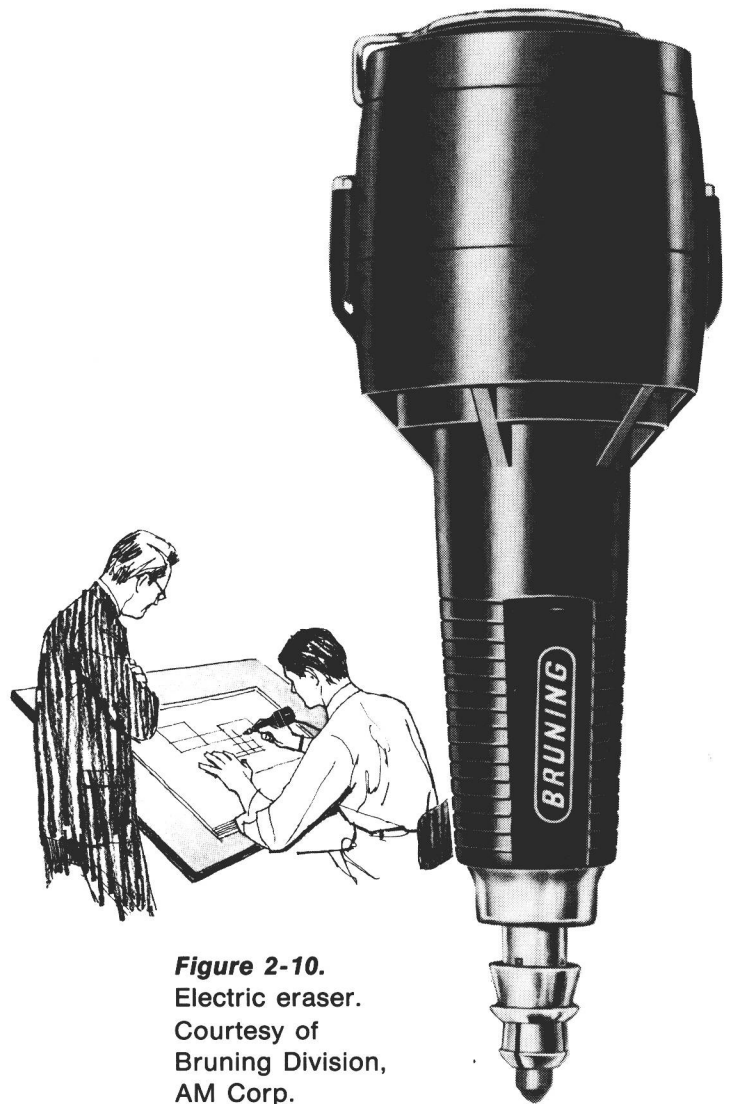
The draftsman's eraser is specially made to erase without smearing. Erasers are made to erase on paper or film and for pencil or ink. Many professional draftsmen own electric erasers. Like electric razors, electric erasers are available with or without cords. Figure 2-9 shows many of today's erasers. Figure 2-10 is an electric eraser. All manual eraser types are produced in short ( $\frac{3}{4}$ ") and long (7") cylindrical plugs for use in erasing machines with cords. The cordless erasing machine uses a  $4\frac{1}{4}$ " plug.

### Erasing Shield

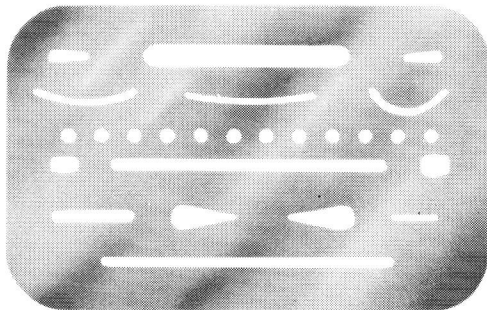
When a draftsman wishes to erase a line, number or letter in a particular spot on the drawing without disturbing adjacent linework, an erasing shield is used. Figure 2-11 shows the standard erasing shield which almost all draftsmen use. The area to be erased is exposed in one of the openings and the shield protects nearby linework from being smeared or partially erased.



**Figure 2-9.** Selection of draftsman's erasers.  
Courtesy of Bruning Division, AM Corp.



**Figure 2-10.**  
Electric eraser.  
Courtesy of  
Bruning Division,  
AM Corp.



**Figure 2-11.** Erasing shield. Made of flexible stainless steel which keeps in shape. Size:  $2\frac{3}{8}$ " x  $3\frac{3}{4}$ ". Courtesy of Bruning Division, AM Corp.

### The Draftsman's Brush

Loose graphite dust will smear a drawing. Every line made with a pencil contains loose graphite dust. To test this make a line on any piece of paper and immediately rub your finger across it. It will leave a slight smear which is not tolerated on a drawing. To

remove the loose graphite dust the draftsman keeps a brush always at his fingertips, and immediately after making a line or two on the drawing the loose graphite is brushed away. This brushing motion is always down to direct the dust to the floor and away from drafting tools. Figure 2-12 shows these brushes.