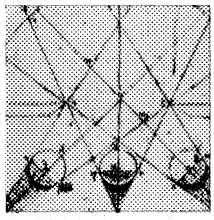
LETTERING AND ANNOTATION

Chapter 7



LEARNING OBJECTIVES

Upon completion of this chapter you will be able to:

1. Recognize the importance of freehand, mechanical, and machine lettering.
2. Differentiate between common lettering styles.
3. Develop the ability to use guidelines and lettering guides to determine lettering heights.
4. Produce standard single-stroke, uppercase Gothic characters with uniform size and spacing.
5. Identify and use mechanical lettering aids.
6. Identify machine lettering techniques.
7. Create annotations using a CAD system.

7.1 INTRODUCTION

Engineering drawings are never complete until they are explained by labels, dimensions, notations, and titles (Fig. 7.1). This information is either carefully lettered freehand or inserted using a **TEXT** or **DIMENSION** command when done on a CAD system.

All designers and engineers should master the art of freehand lettering. Through the study of letter forms and the direction of strokes, and with consistent practicing of lettering styles, an acceptable quality and style of lettering can be developed. The importance of good lettering cannot be overemphasized. Lettering can *make or break* an otherwise excellent drawing. In engineering and design, sloppy or misplaced lettering causes misconceptions and inaccurate communication of data.

CAD-generated drawings allow the engineer to access the database and therefore request the system to provide extra information, clarification, and verification of a part. Because drawings generated on the board can only be "read," the written information about the part, in the form of notes, labels, and dimensions, is of great importance. This is not to say that the written information on a CAD drawing is any less important. With a CAD system you can recall the part drawing and verify a location of a feature, check a dimension, or list out information about the part, but all written information is still important. However, manual lettering must stand completely on its own.

7.2 LETTERING METHODS AND STYLES

Lettering can be done by any of three separate methods: (1) manual (freehand), (2) mechanical, and (3) machine. Table

FIGURE 7.1 An Engineering Drawing

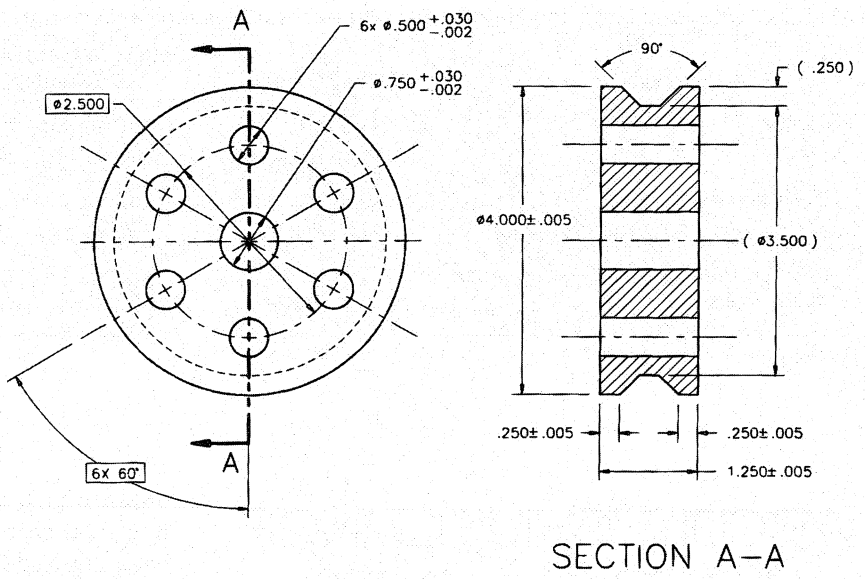


TABLE 7.1 Lettering Methods

Types of Letters	Manual	Mechanical	Machine
Vertical Inclined Uppercase Lowercase	Freehand Lettering aid (slot guide)	Template WRICO Leroy Letterguide Varigraph Kroy	Typewriter Printer Dry transfer Phototypesetter CAD

7.1 lists the three categories along with a few types of equipment and the techniques associated with each group.

A wide variety of lettering styles, or fonts, are available. A **font** is an assortment of type all of one size and style. For most engineering disciplines, the *single-stroke uppercase Gothic alphabet* is used. The Gothic alphabet does not have short bars, or **serifs,** at the ends of strokes as does the Roman alphabet. Figure 7.2 shows a few of the many fonts commercially available in phototypesetting and printing processes and in dry transfer letters. Note that the vertical uppercase DRAFTING STANDARD font is available.

Lettering of titles, subtitles, drawing numbers, and other uses may be made freehand, by typewriter, or with the aid of mechanical lettering devices such as templates and lettering machines. Regardless of the method used, all characters must conform with the recommended Gothic style and must be legible in full- or reduced-size copy by any accepted method of reproduction. The quality of your lettering after reduction will depend on the legibility of the original lettering and its height. The recommended minimum freehand and mechanical lettering heights for various size drawings are given in Table 7.2.

American Typewriter Condensed
American Typewriter Condensed Bold
CooperBl.Ital
CooperBlk.Out.
COPPERPLATE
DAVIDA
Dom Casual
Eurostile Med.Ex.
Eurostile Bold Ext.
Fette Fraktur
Folio Light
Folio Medium
Folio Bold
Folio Ex. Bold
Folio Bold Cond.
Gregorian
Helvetica Oblique
Helvetica Rounded
Meacher Regular
MESQUITE REGULAR

FIGURE 7.2 Examples of Lettering Fonts

7.3 MANUAL LETTERING

Many drawings are still made and revised with freehand lettering techniques. Both **vertical lettering** (Fig. 7.3) and **inclined lettering** (Fig. 7.4) are found throughout industry. Vertical lettering is preferred since it reduces and microfilms better than inclined lettering. Still, inclined lettering is easier for some to master and normally is faster to complete. Most companies accept only vertical lettering. At times, you may be called on to complete or revise an existing drawing. If you are given such a task, try to match the existing lettering style.

Uppercase letters are used for all lettering on drawings unless lowercase letters are required to conform with other established standards, equipment nomenclature, or marking. Lowercase lettering is seldom found on engineering draw-

TABLE 7.2 Blended Lettering Heights for Manual and Mechanical Lettering (Uppercase Letters)

Project	Size of Drawing	Height of Manual Letters, U.S. (Metric) Units	Height of Mechanical Letters, U.S. (Metric) Units
Numbers in a title block	A–C*	.250 in., $\frac{1}{4}$ in. (7 mm)	.240 in. (7 mm)
	D and above*	.312 in., $\frac{5}{16}$ in. (7 mm)	.290 in. (7 mm)
Title, section lettering	A–F	.250 in., $\frac{1}{4}$ in. (7 mm)	.240 in. (7 mm)
Zone letters and numerals in borders	A–F	.188 in., $\frac{3}{16}$ in. (5 mm)	.175 in. (5 mm)
Lettering in dimensions, tolerances, notes, tables, limits	A–C	.125 in., $\frac{1}{8}$ in. (3.5 mm)	.120 in. (3.5 mm)
	D and above	.156 in., $\frac{5}{32}$ in. (5 mm)	.140 in. (5 mm)

*Drawing sizes: A = $8\frac{1}{2} \times 11$ in., B = 11×17 in., C = 17×22 in., D = 22×34 in.

FIGURE 7.3 ANSI Standard Vertical Upper- and Lowercase Lettering

FIGURE 7.4 ANSI Standard Inclined Upper- and Lowercase Lettering

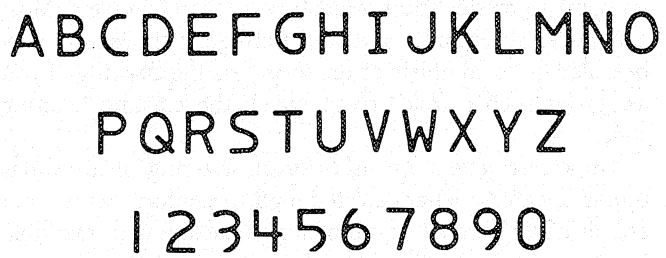


FIGURE 7.5 ANSI Standard Microfont Alphabet

ings except for the drawing *notes*, since long columns of uppercase characters are not as pleasing to the eye and are harder to read. The use of lowercase lettering is specified in company standards when acceptable. In general, only uppercase Gothic lettering is required on mechanical and electronic drawings. Piping, architectural, structural, and civil drawings sometimes employ lowercase lettering.

Though the recommended font style is single-stroke Gothic, adaptations such as the **Gothic-style Microfont alphabet** are also acceptable (Fig. 7.5). The Microfont alphabet is suggested for drawings requiring microfilm reproduction.

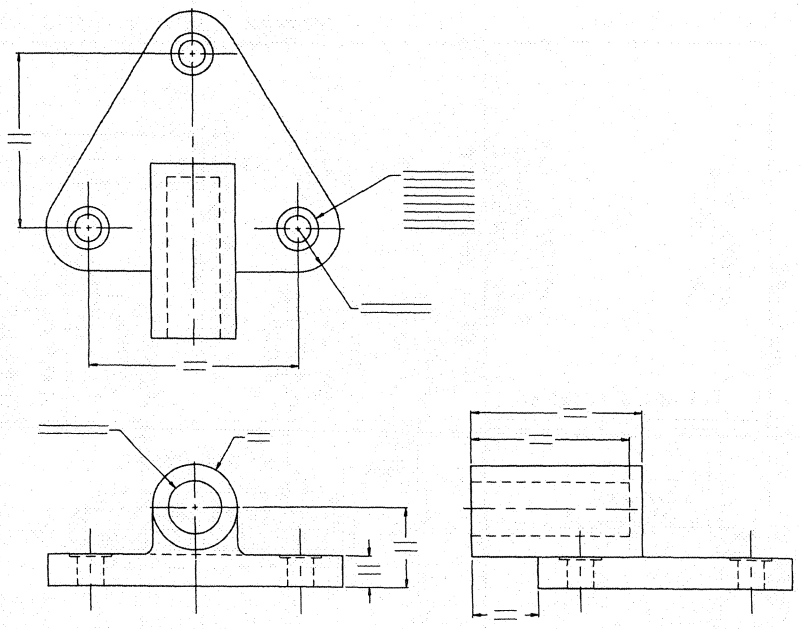
7.3.1 Guidelines and Lettering Heights

Freehand lettering requires guidelines at the top and bottom of the letters to determine the height of lettering on the drawing. Guidelines are not necessary if you use grid underlay or fadeout grid paper, but you should avoid using grid underlay until you have gained some experience with lettering from hand-drawn guidelines.

Guidelines (Fig. 7.6) are very thin, sharp, light gray, and drawn with 6H–3H grade lead or with nonreproducible-blue lead. Since most lettering is done with capital letters and whole numbers, only two guidelines are necessary. Guidelines can be drawn with a straightedge or with the aid of a line-spacing guide, such as the AMES lettering guide (Fig. 7.7) or the Braddock-Rowe triangle. For dimensions, notes, and labels, most lettering is between .125 and .156 in. high (in U.S. decimal units) or between 3.5 and 5 mm high (in SI units). Lettering height is determined by the drawing format size. For all problems in the text, use the standards for lettering heights and guideline spacing shown in Table 7.2. Lettering heights in the table correspond to *Conventions and Lettering* from the American National Standards Institute. (Metric sizes are not U.S. conversions.)

The distance between lines of lettering on manually drawn projects for notes and labels is equal to the full height of the letter being used. This spacing is best for reproducible, legible letters if they will be reduced and/or enlarged (for instance, when a microfilmed drawing is returned to its original size). When upper- and lowercase lettering is used

FIGURE 7.6 Mechanical Drawing with Guidelines



on "D"-size sheets and larger, the minimum uppercase height is a minimum of 5 mm for metric drawings and .156 in. for U.S. decimal-inch drawings. This will provide for legible enlargement for microfilmed drawings. Figure 7.8 is an example of a well-lettered "D"-size drawing of a refinery layout. This project was lettered freehand without guidelines, since it was drawn on a nonreproducible-blue grid sheet. Note that the designer had to letter the drawing from two directions. The drawing remained taped to the board, and the designer had to turn his or her body to complete the project. With a CAD system, the drawing's text can be rotated as it is inserted.

The **freehand lettering guide** is shown in Figure 7.9. This device eliminates the need for guidelines, since it limits the height of the lettering to the space within the slots. Lettering aids tend to flatten the upper and lower portions of some letters. Do not use lettering guides while attempting to learn and perfect freehand lettering. Guidelines are also unnecessary when you use vellum, or drafting film, with nonreproducible grid lines. The grid spacing (if the correct size) can be used as guidelines for the lettering. Guidelines are also unnecessary when you use a lettering template.

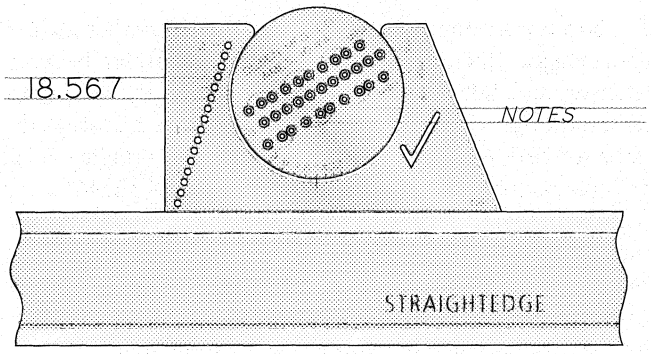


FIGURE 7.7 AMES Lettering Guide

You may wish to use vertical or inclined guidelines (Fig. 7.10) when practicing lettering, until some consistency is achieved. Vertical or inclined guidelines are *not* used on drawings.

Except when special emphasis is required, lettering should not be underlined. If underlining is required, it should not be less than 1.5 mm (.06 in.) below the lettering.

7.3.2 Pencil Technique

Freehand lettering places a requirement on linework that is different from that possible with instrument lines. Instrument lines are made more dense when the construction line is traced. For most people, it is impossible to trace freehand lettering consistently. Therefore, engineers and designers must draw lettering of the proper density in only one stroke. To help get the proper density, a soft lead is used. Depending on your preference, the H, HB, or F lead can be used with good results for all lettering.

Soft lead contributes to the dirt on the drawing because it "chalks" more easily. Frequent use of a brush is necessary. Due to its tendency to smear, lettering is usually the last step in the completion of a drawing. When lettering, do not let your hand come in contact with the drawing surface. Always place a sheet of clean paper between your hand and the drawing medium. This will help keep the drawing free of body oils and dirt as well as prevent smearing of the linework (Fig. 7.11).

Since it requires no sharpening, the fine-line pencil is an excellent lettering device. A 0.5 or 0.7 mm fine-line pencil is used for lettering when available. Rotating your pencil or lead holder minimizes depletion of the point and helps maintain consistency of character width.

By now you have developed lifelong habits regarding how to hold a pencil and how to form each character. The suggested hand orientation (Fig. 7.11) is provided to help

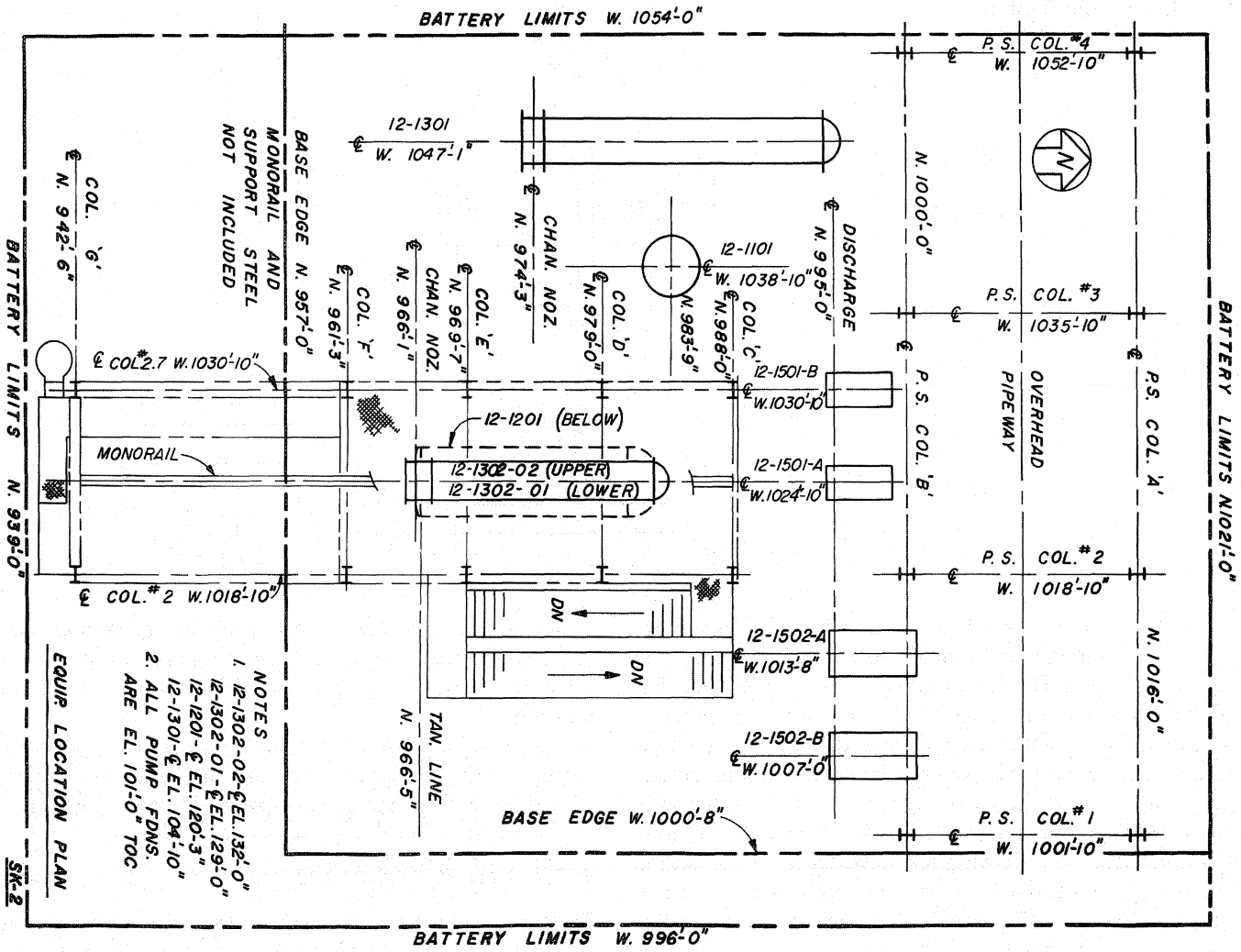


FIGURE 7.8 Example of a Well-Lettered "D"-Size Drawing

guide you, but is not meant to be interpreted as the only method of lettering. Left-handed and right-handed people have individualized methods, but the most important thing is that the end result must conform to the ANSI standard style and quality. To achieve this quality, *you must practice.*

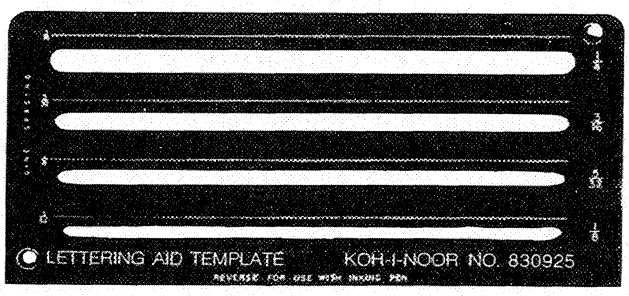


FIGURE 7.9 Freehand Lettering Aid

The six basic strokes used for freehand lettering are shown in Figure 7.12. Note that this suggested stroke sequence is meant only as a general guide. Your lettering style, your manner of holding the pencil, and whether you are right-handed or left-handed affect the choice of stroke sequence.

7.3.3 Lettering Strokes, Uniformity, and Form

The strokes of your letters must be consistent in both width and density. Obviously, variation in the densities between lettering and linework must be avoided. Strive for consistent, uniform, well-spaced letters. The stroke sequence is the same for both inclined and vertical lettering. In Figure 7.13, an alphabet of vertical and inclined lettering is shown along with a numbered suggested stroke sequence. This figure also highlights typical problems in forming letters. Lettering examples are provided below each comment. The examples used are reference designations found on electronic drawings. Note that guidelines were used throughout.

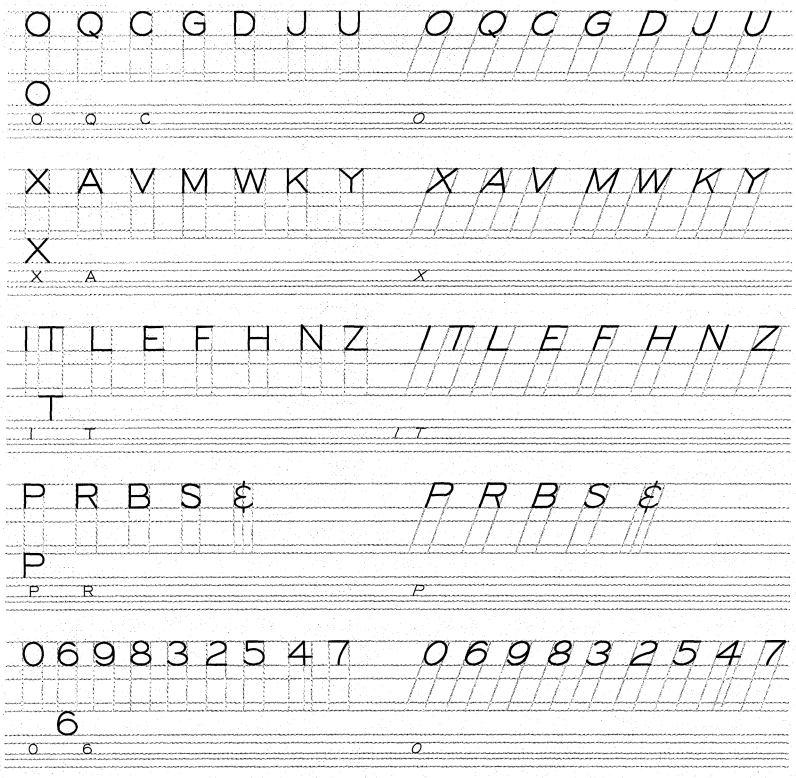


FIGURE 7.10 Using Horizontal and Vertical (or Inclined) Guidelines for Lettering Practice

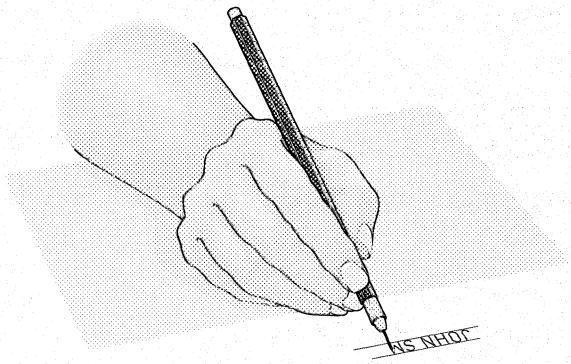


FIGURE 7.11 Hand Position When Lettering

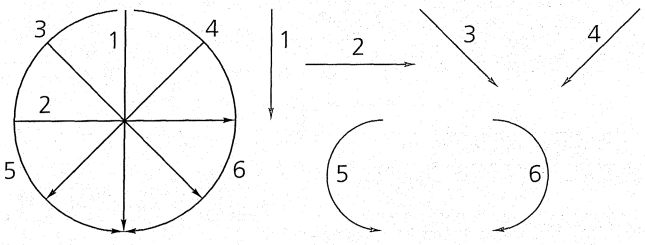


FIGURE 7.12 Basic Lettering Strokes

The grid pattern shown in Figure 7.13 gives the ideal width-and-height relationship for single-stroke Gothic lettering. All characters are six units in height and vary in width from the 1 and I to the W and M.

In Figure 7.14, the typical slant angle used for inclined lettering is shown. Any angle between 90° (vertical) and 65° is acceptable unless an individual company has a preferred practice. Left-handers sometimes slant their lettering backwards 1° to 5°. This method should be used only if it falls within your company's (or class's) standard practice.

Strive to develop a lettering style that is comfortable and that communicates the necessary engineering data without confusion and mistakes. It is very important to catch bad habits early in order not to ingrain them in your lettering style. Please note that in the beginning it is important to eliminate any individualized style, until your lettering becomes clear, concise, dark, and well formed. Through practice, a more attractive personal style will emerge and become your own.

7.3.4 Spacing

Spacing is done by eye to create a pleasing and orderly set of words or numbers. The spacing between letters in a word is as important as the spacing between words. The background area between characters should *appear* equal even though it's not. The spacing between words should be a minimum of six units wide, that is, the width of the widest letter, such as W or M. The spacing between letters varies because the

CHARACTER	COMMENTS AND EXAMPLES	INCORRECT	POSSIBLE MISTAKES
	MAKE UPPER PART LARGER THAN BOTTOM PART.	A	4
	*ADAPTER, CONNECTOR (CP)*		
	LOWER PART SLIGHTLY LARGER THAN UPPER PART.	B	8
	*BARRIER PHOTOCELL (V)* *BLOCK, CONNECTING (TB)*		
	FULL OPEN AREA, ELLIPTICAL LETTER BODY.	C	O
	*COUPLER, DIRECTIONAL (DC)* *CUTOUT, FUSE (F)*		
	HORIZONTAL BARS AND STRAIGHT LINE BACK.	Ω	O
	*DIODE, SEMICONDUCTOR (CR)* *DELAY FUNCTION (DL)*		
	SHORT BAR SLIGHTLY ABOVE CENTERLINE.	E E	L
	*ELECTRONIC MULTIPLIER (A)* *EQUALIZER, NETWORK, EQUALIZING (EQ)*		
	SHORT BAR SLIGHTLY ABOVE CENTERLINE.	F F	T L
	*FIELD EFFECT TRANSISTOR (Q)* *FUSE HOLDER (X)*		
	BASED ON TRUE ELLIPSE, SHORT HORIZONTAL LINE ABOVE CENTERLINE.	G G G	C O 6
	*GENERATOR (G)* *GAP (HORN, PROJECTIVE, OR SPHERE) (E)*		
	BAR SLIGHTLY ABOVE CENTERLINE.	H H	
	*HARDWARE (COMMON FASTENERS, ETC.) (H)* *HEADSET, ELECTRICAL (HT)*		

FIGURE 7.13 Stroke Sequence, Comments, Examples, and Possible Errors in Lettering

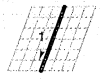
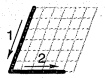
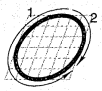
CHARACTER	COMMENTS AND EXAMPLES	INCORRECT	POSSIBLE MISTAKES
	NO SERIFS, EXCEPT WHEN NEXT TO NUMBER ONE (1).	1 1	
	*INDUCTOR (L)* *INDICATOR (EXCEPT METER OR THERMOMETER) (DS)*		
	WIDE FULL HOOK WITH NO SERIFS.	J J	
	*JUNCTION (COAXIAL)*		
	EXTEND LOWER BRANCH FROM UPPER BRANCH.	K K	R
	*WAVE GUIDE (CP)* *JACK (J)*		
	MAKE BOTH LINES STRAIGHT.	L	
	*LOOP ANTENNA (E)*		
	NOT AS WIDE AS W; CENTER PART EXTENDS TO BOTTOM OF LETTER.	M M	
	*MICROCIRCUIT (U)* *MULTIPLIER, ELECTRONIC (A)*		
	DO NOT CRAM LINES TOGETHER.	N N	U V
	*NETWORK, EQUALIZING (HY)* *DIODE, TUNNEL (CR)*		
	FULL TRUE ELLIPSE.	0 O	C Q 6
	*OSCILLOGRAPH (M)* *OSCILLOSCOPE (M)*		
	MIDDLE BAR INTERSECTS AT LETTER'S MIDDLE.	P P	K T D
	*PHOTODIODE (CR)* *POTENTIOMETER (R)*		

FIGURE 7.13 Stroke Sequence, Comments, Examples, and Possible Errors in Lettering—*Continues*

CHARACTER	COMMENTS AND EXAMPLES	INCORRECT	POSSIBLE MISTAKES
	BASED ON TRUE WIDE ELLIPSE.	Q	O
	*NETWORKING, EQUALIZING (HY) SWITCH, SEMICONDUCTOR CONTROLLED (Q)*		
	MAKE UPPER PORTION LARGER.	R R	K
	*REGULATOR, VOLTAGE (V) RESISTOR, THERMAL (RT)*		
	BASED ON NUMBER 8; KEEP ENDS OPEN.	S	8
	*SOLENOID, ELECTRICAL (L) SWITCH, INTERLOCK (S)*		
	DRAW FULL WIDTH OF LETTER E.	I T	7
	*THERMOCOUPLE (TC) TRIODE, THYRISTOR (Q)*		
	LOWER PORTION ELLIPTICAL, VERTICAL BARS PARALLEL.	U	V
	*COMPUTER (A) WAVE GUIDE (W)*		
	BRING BOTTOM TO POINT.	V	U
	*VARISTOR, SYMMETRICAL (RV) VARACTOR (D, CR)*		
	WIDEST LETTER; CENTER EXTENDS TO TOP OF LETTER.	W W	N
	*WAVE GUIDE FLANGE (CHOKE) (J) WINDING (L)*		

FIGURE 7.13 Stroke Sequence, Comments, Examples, and Possible Errors in Lettering—*Continued*

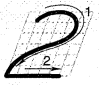
CHARACTER	COMMENTS AND EXAMPLES	INCORRECT	POSSIBLE MISTAKES
	CROSS LINES ABOVE CENTERLINE.	X	
	*LAMP HOLDER (X)* *INDICATOR (EXCEPT METER OR THERMOMETER (DS)*		
	UPPER PART MEETS BELOW CENTER.	Y Y	V 1
	*R R RELAY (K)* *POWER SUPPLY (PS)*		
	HORIZONTAL LINES PARALLEL.	Z	2
	*TUNER, E-H (Z)* *NETWORK, PHASE CHANGING (Z)*		
	SAME AS LETTER I.	1 1	7
	*10,000 OHMS* *Q4 2N1011*		
	BASED ON NUMBER 8; OPEN HOOK.	2 2	Z
	*QI 2N1925 1200 OHMS*		
	BASED ON NUMBER 8; UPPER PART SMALLER THAN LOWER.	3 3	8 5
	*VM103 IN673*		
	HORIZONTAL BAR BELOW CENTER OF FIGURE.	4 4	7 9 H
	*TB103/4-22G/R 2N38974*		

FIGURE 7.13 Stroke Sequence, Comments, Examples, and Possible Errors in Lettering—*Continues*

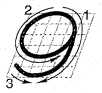
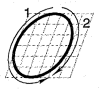
CHARACTER	COMMENTS AND EXAMPLES	INCORRECT	POSSIBLE MISTAKES
	BASED ON ELLIPSE; KEEP WIDE.	5 5	6 3 S
	XQ2-5 1.5 MS		
	BASED ON ELLIPSE; OPEN.	6	8
	42-020-6 68,000 OHMS		
	KEEP AS WIDE AS LETTER E.	7 7	1
	4.7 K 47,000 OHMS		
	BASED ON ELLIPSE; KEEP WIDE.	8 8	B
	3N58 IN678		
	COMPOSED OF TWO ELLIPSES; KEEP FULL.	9	8
	Q1 2N195 3.9 K		
	SAME AS LETTER D.	O	Q
	5473,000 OHMS 120 K		

FIGURE 7.13 Stroke Sequence, Comments, Examples, and Possible Errors in Lettering—*Continued*

shapes of the adjacent letters vary. Spacing for letters and words should correspond to the following specifications (Fig. 7.15):

- Background areas between letters in words are separated by approximately equal areas.
- Spacing for numerals separated by a decimal point (5.375, 2.54 mm, etc.) is a minimum of two-thirds of the character height used for the lettering.
- Spaces between words are approximately equal and a minimum of .06 in. (1.5 mm). A full character height for horizontal word spacing is suggested.
- The horizontal space between lines of lettering is at least half the height of the characters, but preferably one full character height of space is left between lines.
- Sentences are separated by at least one full character height and preferably two character heights if space permits.

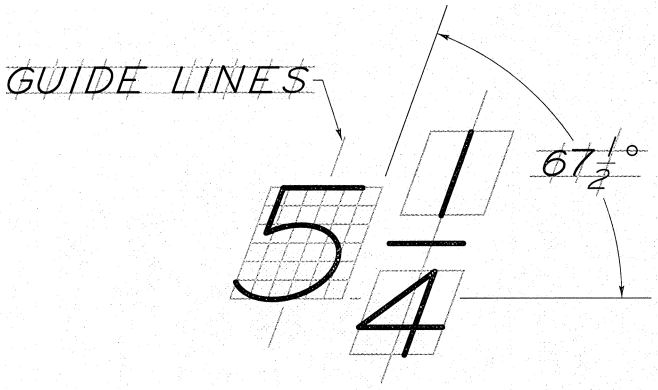


FIGURE 7.14 Using Guidelines for Inclined Lettering

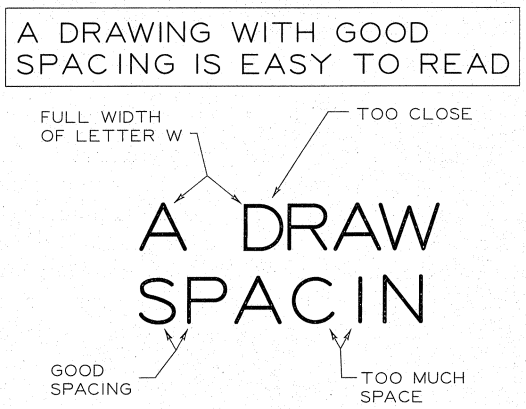


FIGURE 7.15 Spacing of Letters and Words

7.3.5 Lowercase Lettering

Lowercase lettering as shown in Figure 7.16 is seldom used except for construction drawings. Lowercase lettering, whether inclined or vertical, requires extra guidelines. Guidelines for the *waistline* (top of main body of letter) and *baseline* (bottom of main body of letter), as well as for ascender and descender lines, are added to the drawing before the letters are drawn. *Ascender lines,* or cap lines, designate the top of strokes for letters that extend above the waistline, such as b, d, f, h, k, and l. *Descender lines,* or drop lines, designate the bottom of strokes for letters below the baseline, such as g, j, p, and y.

7.3.6 Fractions on Drawings

Most drawings are dimensioned with decimal-inch or metric units. These are easier, more accurate, and quicker to draw, since all numbers are placed between two equally spaced guidelines. For some drawings, the tolerance and accuracy required for manufacturing and construction is loose enough to permit fraction dimensioning, such as for sheet metal work. Fractions are also widely used in piping, civil, architectural, and structural design.

In Figure 7.17, the height ratio of fraction number to whole number is provided. When a drawing is to be reduced, the size of lettering may need to be larger than normal for accurate enlargement (enlargement from reduction size). *The ANSI standard on lettering states that the height*

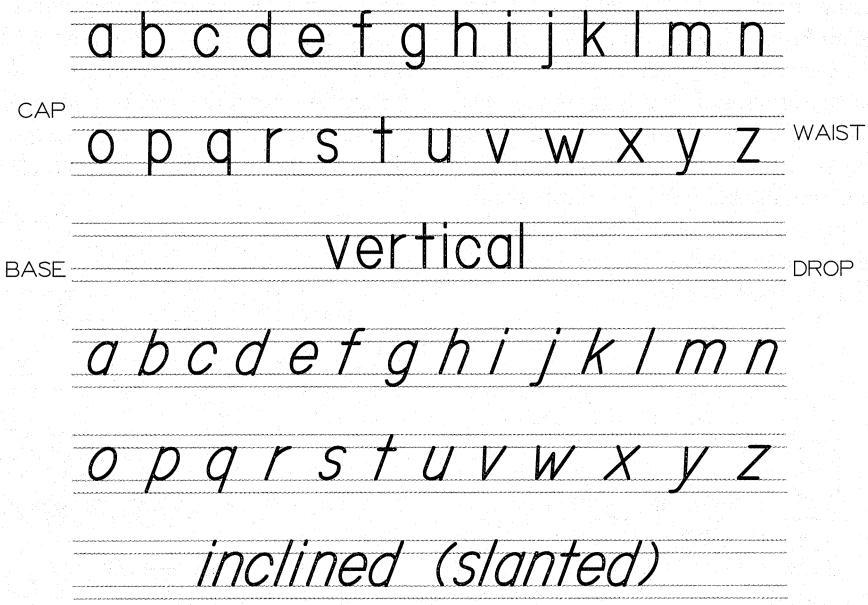


FIGURE 7.16 Lowercase Lettering

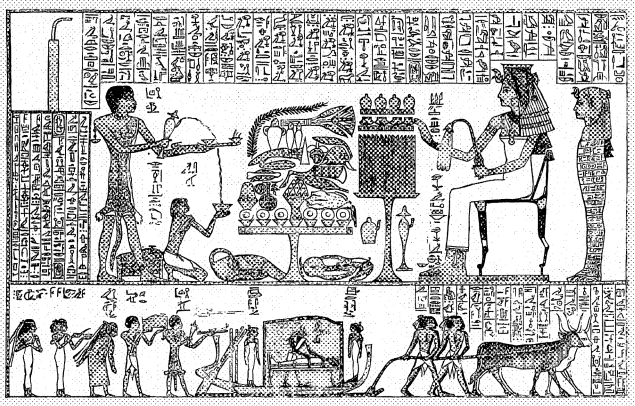
Focus On . . .

THE ALPHABET

The alphabet developed as a result of man's need to record events. In fact, our modern alphabet had its origin in Egyptian hieroglyphics. The word *hieroglyphics* means "picture writing" and is the oldest and most primitive of all writing. Some of the letters of the Roman alphabet in use today can be traced back to these crude pictures.

The Greeks adopted symbology from the Phoenicians, who had developed a 22 letter alphabet in about 1500 B.C. The adopted system evolved into two distinct alphabets in two parts of Greece. The Western type became the Latin alphabet (about 700 B.C.) and was used throughout the Old World. (The modern English word for *alphabet* comes from the first two letters of the Greek alphabet, *alpha* and *beta*.) The original Roman alphabet of twenty-three characters has remained unchanged except that characters have been added.

People began communicating with each other through all forms of written communication once the alphabet was accepted. Unfortunately, books, even from the earliest times, were prepared by the laborious method of hand-copying onto papyrus, parchment, or vellum. The scribes cut quills and made ink from gum and lampblack. Before the fall of the Roman Empire, the copying of books was a thriving and important industry. When Rome fell, the rich patrons of literature were scattered and their libraries were left to be burned. Monks, fearful that all literature would be lost, took on as part of their religious duties the task of copying classical and religious books.



Hieroglyphics.

About fifty years before Columbus discovered America, Johannes Gutenberg revolutionized graphic communications. Gutenberg, in Mainz, Germany, perfected a way to cast individual letters. As a young man, he had studied the arduous task of scribes and wanted to invent a mechanical printing process to make the scribes' work easier and to make books more accessible. Until his time, all lettering was done by hand and it was left to the individual as to how each letter was made or decorated.

By three years after he started, Gutenberg had printed 200 copies of the Bible. Thirty of these were printed on a paper made from animal skins. These thirty copies used the hides of about 10,000 calves!

of the fraction number should be the same as that for the whole number. Most engineering books, and many companies, however, suggest the relationship shown in Figure 7.17.

The division line of the common fraction is drawn parallel to the direction in which the dimension reads and is separated from the numerals by a minimum of 1.5 mm (.06 in.) of space. The numbers must not touch the fraction division bar. The division bar is drawn horizontally between the numbers and not at an angle, except in notes, where the angled division bar is acceptable. Some company standards allow the angled division bar, but it is not an ANSI standard.

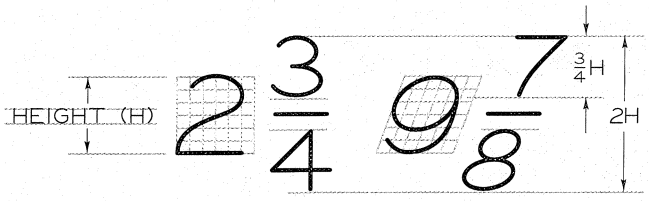


FIGURE 7.17 Fractions

7.3.7 Lettering Composition

Various special circumstances affect the composition and placement of letters on a drawing. Expanded (extended), compressed, stopline, centered, and symmetrical lettering are found on many types of diagrams and drawings. Figure 7.18 shows examples of compressed and extended letters. Note that these variations are easily accomplished using a

CONDENSED LETTERING

NORMAL LETTERING

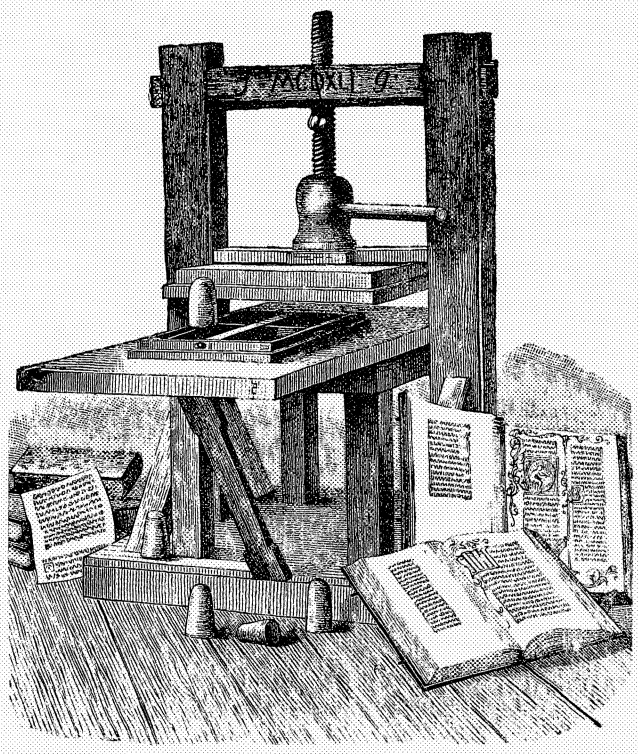
EXTENDED LETTERING

CONDENSED

NORMAL

EXTENDED

FIGURE 7.18 Lettering Variations

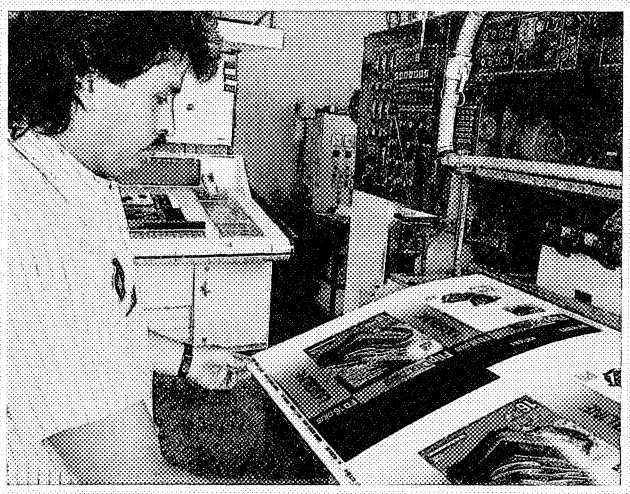


A Guttenberg printing press.

During the Industrial Revolution, the printing press needed for production was invented. Now with the printing process, more books could be printed and more people could afford to own them. Gutenberg's dream was realized at last!

It seems inconceivable not to know an alphabet or to have printed books. Even though we don't think much about our alphabet, most of what we do to communicate with each other is based on standard alphabets and printed material.

The computer is now the basis for another revolution in communications. The operators of modern CAD systems have a variety of *fonts* to choose from when inserting text into their drawings. A font is a series of patterns created by the CAD program to represent specific letters in certain styles (roman, italic, or script, for example). The font of the text can be changed at will. Computers can virtually link offices together across the country and the world. Regardless of how fast or sophisticated the method or the style of the text, our modern alphabet remains the basis for the way we communicate in written form.



A modern printing shop.

CAD system, since the lettering font, height, width, slant, and justification can be selected by the user.

By drawing letters and numerals in groups, going from simple to complex, you will learn an easy way to practice on the forms that you need to improve without having to letter the whole alphabet. The following groupings can be used during practice:

- Straight lines only
  A, E, F, H, I, K, L, M, N, T, V, W, X, Y, Z, 1, 4
- Straight and curved lines
  B, D, J, P, U, 2, 5, 7
- Curved lines only
  C, G, O, Q, S, 3, 6, 8, 9, 0

Stopline lettering is used on some drawings and charts. In most cases, lettering is *left-justified* (aligned on the left in a column). When lettering must stop along a given line or at a specific point it is called *right-justified.* Since the letters are normally drawn from left to right, right-justified freehand lettering (stopline lettering) is somewhat difficult to do. Stopline lettering is drawn from right to left.

The stability of lettering construction is very important to lettering composition. How does the lettering or number look on the paper? The construction of each letter and number is extremely important. This includes proportion, stability, uniformity, balance, consistency, thickness, and density. The combination of these factors to make notes is called *composition.* The beauty of machine lettering lies in its ability to do all the variations automatically.

7.3.8 Lists and Notes

Traditionally, notes have been placed above the drawing's title block area on the far right. The newest ANSI standards have reversed the placement of notes. *Notes are now to be placed on the lower left or the upper left of the drawing.* However, many companies still follow the older practice of placing notes above the title block on the right side of the

REF NO	COMPONENT	PART NO
R-401	33K	216480
R-402	24K	216477
R-403	9.1K	216467
R-404	33	549978
R-405	100K	216491
R-406	430K	216731
R-407	7.5K	216465
R-408	100	595359
R-409	1K	216445
R-410	5.1K	216461
R-411	15K	216472
R-412	47K	216484
R-413	100K	216491
R-414	680	216442
J	JUMPER	1207833
C-421	.15/35 MFD	491255
C-422	150 PF DISC	1207587
C-423	3.3/35 MFD	1207585
C-424	.47/35 MFD	1208599
C-425	.33/35 MFD	1208591
C-426	2.2/35 MFD	1208601
C-427	.0068/100 MFD	492500
C-428	.0027/100 MFD	491309
C-429	150 PF DISC	1207587
Q-441	GREEN	1207577
Q-442	GREEN	1207577
Q-443	BLACK	1207601

FIGURE 7.19 Hand-Lettered Parts List

NOTES:

1. MARK PER MIL-STD-130 APPROXIMATELY WHERE SHOWN, .093 HIGH CHARACTERS USING ITEM 48
2. SOLDER IN ACCORDANCE WITH NHB5300.4 (3A-1)
3. PARTIAL REFERENCE DESIGNATIONS ARE SHOWN FOR COMPLETE DESIGNATIONS PREFIX WITH UNIT NUMBER AND SUBASSEMBLY DESIGNATIONS
4. ELECTROSTATIC DEVICE, HANDLE PER DOD-STD-1686
5. TORQUE 2-2.5 INCH LBS
6. FINISH: CONFORMAL COAT PER GEN-PS5205 EXCEPT CONNECTOR AND DESIGNATED AREAS SHOWN
7. BOND ITEM 67 TO ITEM 1 PRIOR TO POPULATION OF CARD ASSEMBLY PER GEN-PS5402 CLASS 7
8. APPLY FILLET TO COMPONENTS INDICATED AFTER CONFORMAL COATING PER GEN-PS5402 CL II

FIGURE 7.20 Hand-Lettered Notes Added to Preprinted Company Notes

drawing. Hand-lettered lists (Fig. 7.19) and notes are time-consuming and tiring. Preprinted standard notes are easy to apply, and simplify the process of constructing long lists of notes. The notes in Figure 7.20 are standard preprinted company notes; 7 and 8 were added freehand.

You May Complete Exercises 7.1 Through 7.4 at This Time

7.4 MECHANICAL LETTERING AIDS

One of the most common lettering devices found in any engineering room is the **template.** Although freehand lettering is the rule rather than the exception on manually drawn projects, templates are used on some drawings. Templates are available for almost any size and style of lettering, and can be adapted for ink as well as pencil use (Fig. 7.21). The beauty of a template lies in its ability to produce repeatable,

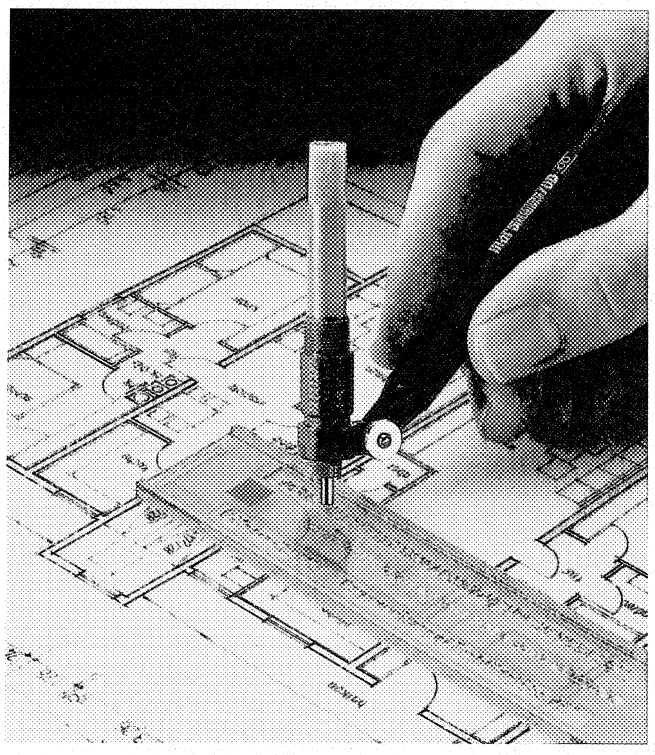


FIGURE 7.21 Lettering Guide Template

uniform letters and numerals. Template lettering, however, takes considerably more time than freehand lettering (Fig. 7.22).

With a template, guidelines are unnecessary. But a template must rest against a straightedge while in use so that all the letters are aligned properly. Template lettering is used on drawings that are inked, in title blocks, and for section letter identification. The major drawback of templates is that it is hard to ink perfectly formed letters without a great deal of practice. The pencil or inking pen must be kept almost perpendicular to the paper while the letters are drawn. The Koh-I-Noor Rapidometric Guide template in Figure 7.21 is an example of a template designed to be used for inking. Note that the inset drawing shows how the template shelf does not come in contact with the drawing surface. Thin stick-on pads may also be fastened to the bottom of templates and triangles. This eliminates potential smearing of the ink.

The **Leroy** lettering set uses a scriber and a template with a slot guide to produce close-to-perfect letters (Fig. 7.23). The scriber can be adjusted to alter the slant of the lettering. The drawing in Figure 7.24 was lettered with a Leroy set.

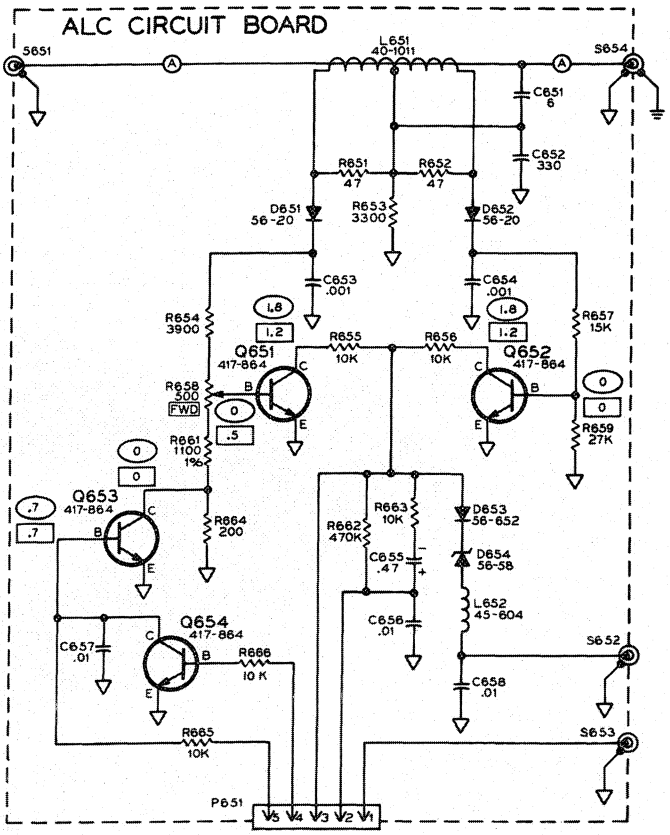


FIGURE 7.22 Template-Lettered Diagram

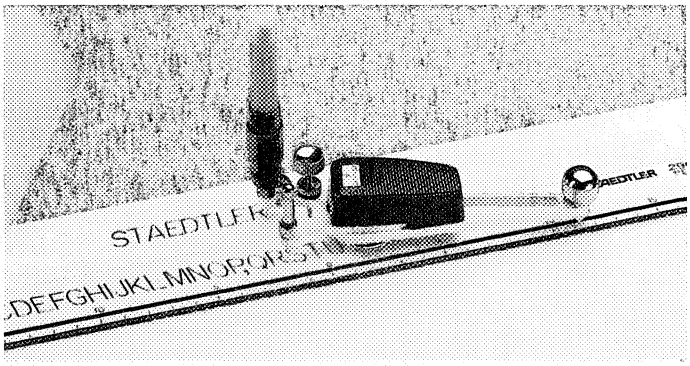


FIGURE 7.23 Lettering with a Leroy Set

Skill in using a lettering template and scriber can only be gained through practice. The most difficult part of lettering systems is mastering the spacing of characters.

All hand-operated lettering systems are expensive and take more time than traditional freehand lettering. Mechanical lettering devices and the inking of drawings are usually limited to drawings for publication. Manuals, catalogs, and sales literature require more precise lettering and linework than design, detailing, and assembly drawings.

Mechanical lettering devices enable you to make slightly smaller letters than manual techniques. (See Table 7.2 to compare sizes.) The variation in recommended minimum standard letter heights between freehand and mechanical devices is needed because freehand lettering does not reduce and enlarge as accurately as mechanically drawn characters.

7.5 MACHINE LETTERING DEVICES

In the past, typewriters with specially designed carriages and Gothic typefaces were sometimes used on A-, B-, and C-sized sheets. Figure 7.25 shows a panel drawing where the labels have been typed. Oddly enough, freehand lettering was used for markings on the panel itself. When using the typewriter for lettering, a special inking ribbon must be employed so that the characters do not smear.

Dry transfer lettering and **appliqués** are normally confined to artwork or headings (Fig. 7.26). It is time-consuming to apply each letter or number separately. The Kroy lettering system (Fig. 7.27) or the Merlin lettering system allows you to dial a sequence of letters or numbers, as required. The result is a dry adhesive-backed strip for easy attachment to the drawing. Notes, headings, and titles are easy to apply with this system (Fig. 7.28). The drawing in Figure 7.29 was lettered with a Kroy system.

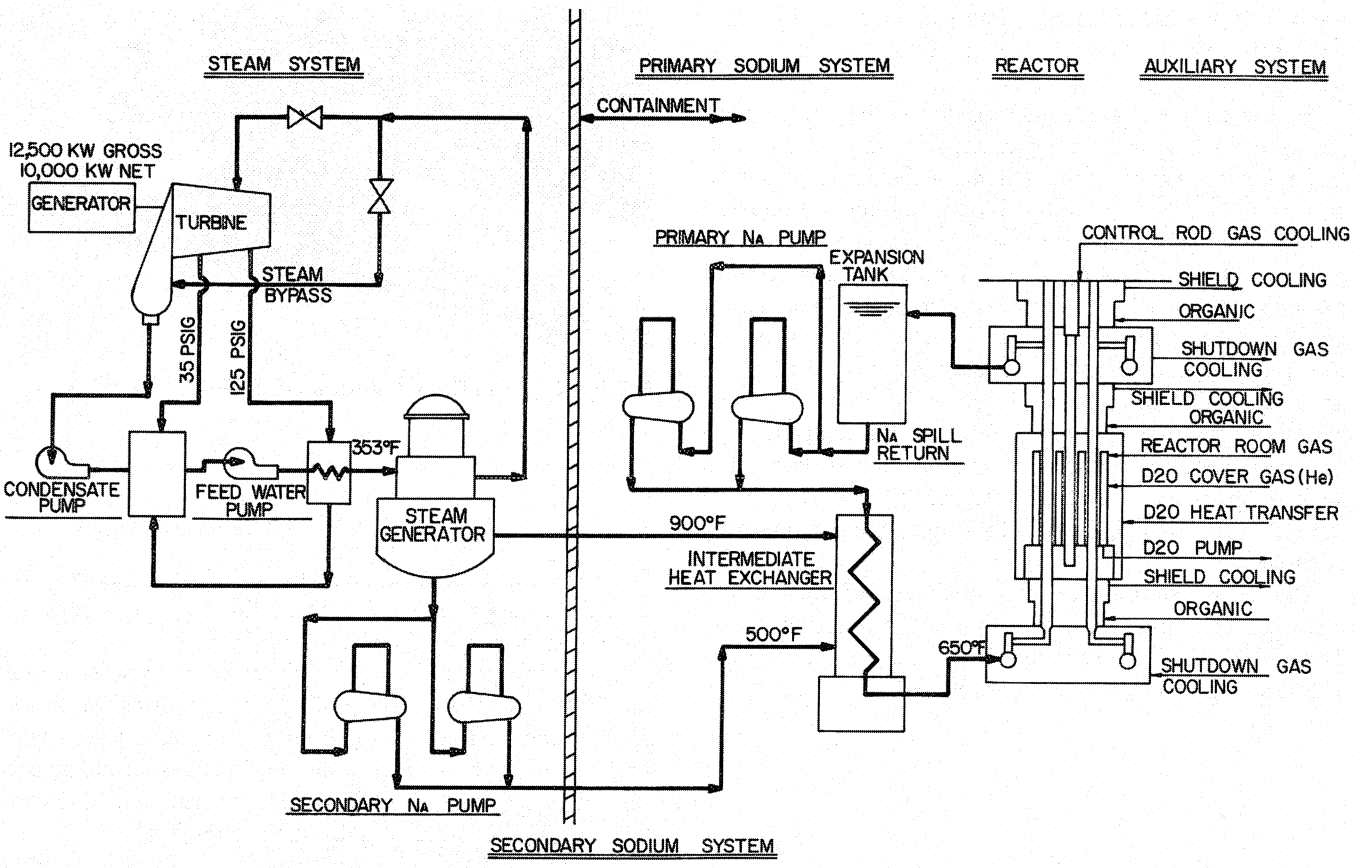


FIGURE 7.24 Drawing Lettered with a Leroy Set

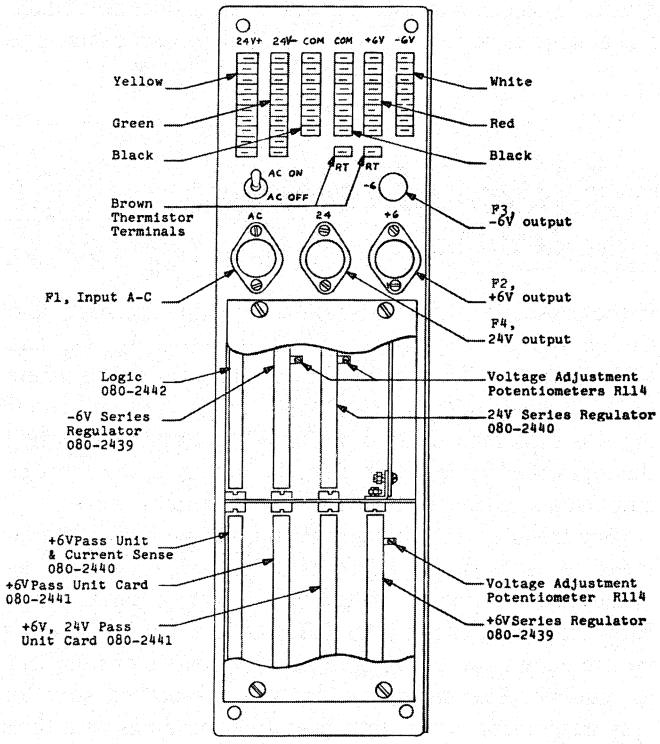


FIGURE 7.25 Typed Lettering on a Service Manual Panel Drawing

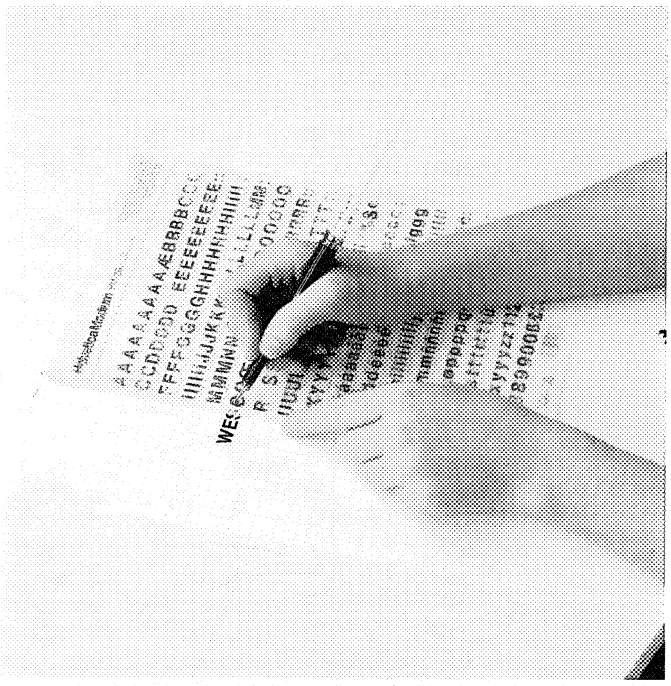


FIGURE 7.26 Transfer Lettering

FIGURE 7.27 Kroy Lettering Systems

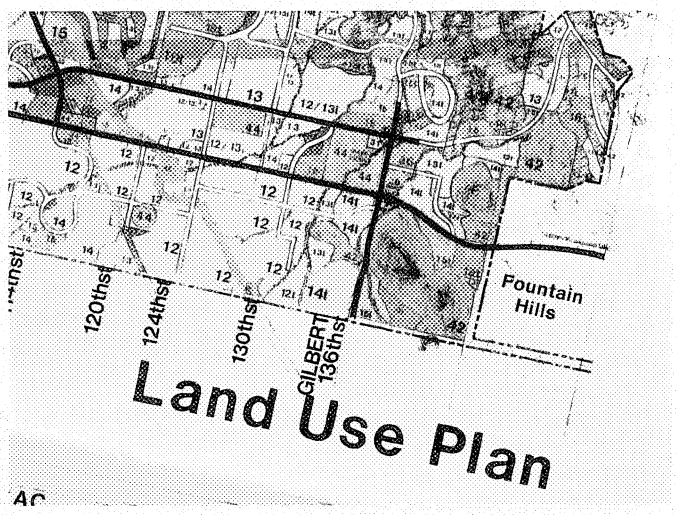


FIGURE 7.28 Kroy Lettering Applied to a Drawing

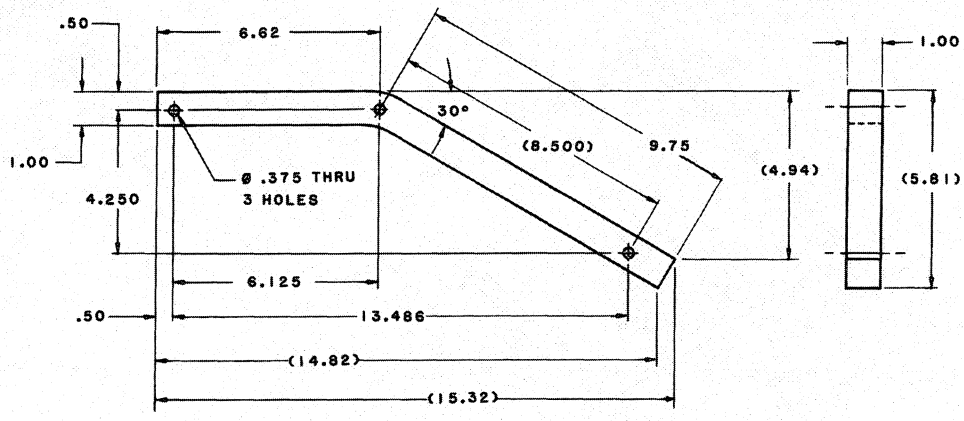


FIGURE 7.29 Kroy-Lettered Drawing

Phototypesetting and **printing** are used for publication-level artwork and drawings when quality is extremely important. Figure 7.30 is an example of phototypeset lettering on an illustration of a pressure vessel module.

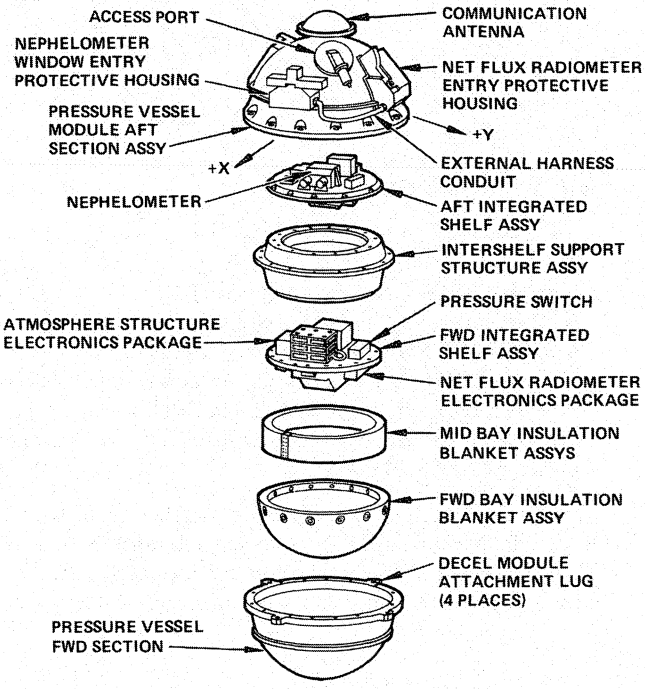


FIGURE 7.30 Typeset Lettering Used on a Technical Illustration

7.6 LETTERING WITH A CAD SYSTEM

The speed of lettering with a CAD system is only limited by the efficiency and speed of the engineer or designer entering the data at the terminal keyboard. CAD systems allow for almost unlimited lettering fonts and sizes. Figure 7.31 shows examples of CAD fonts and character modification.

CAD systems have the capability to letter at any angle, with any inclination to the vertical, and at almost any

Applying Parametric Design . . .

TEXT AND NOTES ON MODELS AND DRAWINGS

When modeling (see Fig. A), **text** can be included in a sketch for extruded protrusions and cuts, trimming surfaces, and cosmetic features. The characters in an extruded feature must use the "font3d" font for Pro/ENGINEER. For cosmetic features, any font may be used; this is done by modifying the text *after* creating the sketch.

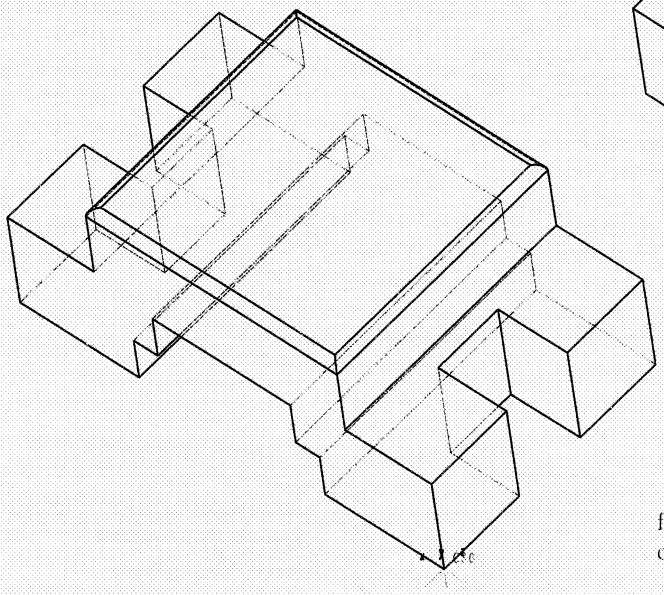


FIGURE A Model of Part

To include a text entry in a sketch:

1. From the GEOMETRY menu, choose **Text.**
2. Enter a single line of up to 79 characters of text. (Here, MARK PART NUMBER HERE was used.)
3. Place the text by picking two opposite corners of a text box. [The box determines the original text height, width factor, and location. After the text is placed, the box becomes invisible (see Fig. B).]

Dimension the text to the part or sketcher geometry (see Fig. C). To dimension the text, choose **Dimension** from the SKETCHER menu, pick anywhere on the text, pick a geometry entity, and place the dimension. The dimension will be created from the text origin (the lower left corner of the text box). The clamp has extruded lettering on its top face.

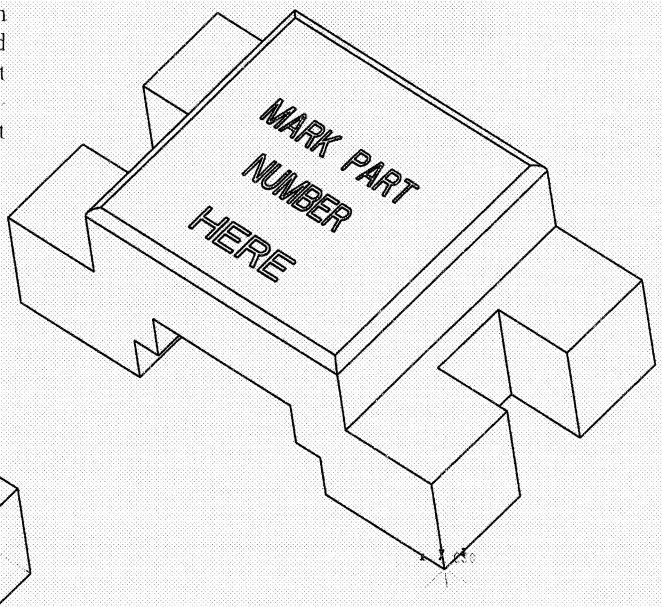


FIGURE B Parametric Model with Extruded Text

In Drawing Mode, **Notes** can be part of a dimension, be attached to one or many edges on the model, or float "free" (see Fig. D). You can add notes via the keyboard or by reading them from a text file. Notes are created with the default values (height, font, etc.) specified in the drawing setup file.

To add notes to the drawing, choose **Create** from the DETAIL menu and **Note** from the DETAIL ITEM menu. The NOTE TYPES menu will appear, allowing you to select options for the note you will create:

- **No Leader/Leader/On Item**—Create a note with or without a leader.
- **Enter/File**—Enter the note from the keyboard, or read the note from a text file.
- **Horizontal/Vertical/Angular**—Create a horizontal or vertical note, or enter an angular value between 0° and 359°.
- **Standard**—Create notes with multiple leaders.

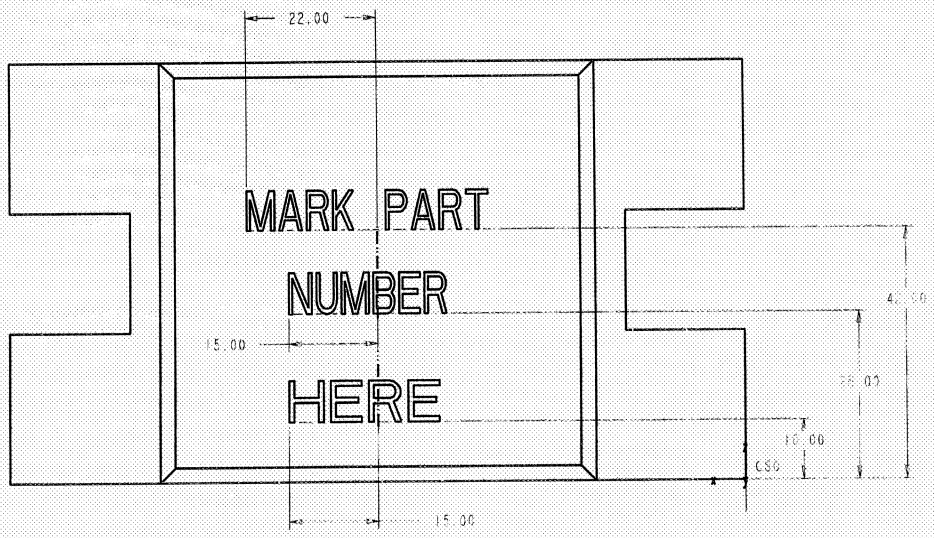


FIGURE C **Dimensioning Text Entities in Sketcher**

- **Normal Leader**—Create a note with a leader that is normal to an entity.
- **Tangent Leader**—Create a note that is tangent to an entity.
- **Left/Center/Right/Default**—Create the note text as left-, center-, or right-justified (see Fig. E). **Default** will be left-justified.

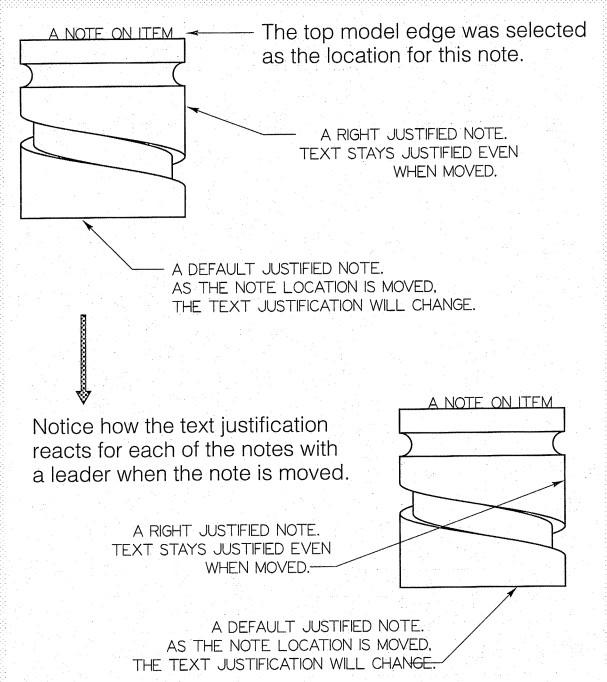


FIGURE D **Note Text Justification**

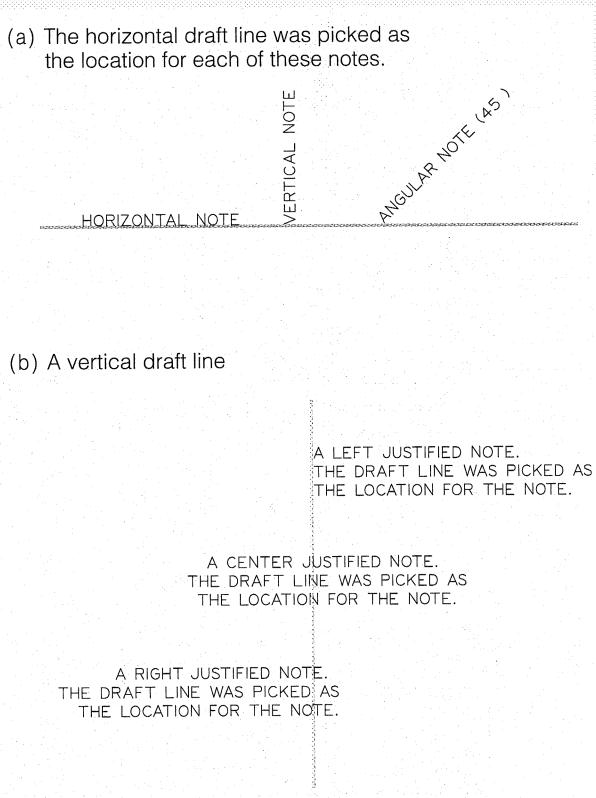


FIGURE E **Text Angle and Justification**

FIGURE 7.31 CAD Fonts and Character Modification

character height or width. Figure 7.32 is an example of an engineering drawing created on a CAD system. Notice the clarity of the lettering for the dimensioning and notes.

On a CAD system, the character spacing, position, and justification (right, left, or center) are easily selected as default parameters. The **SETVARS** command in AutoCAD is sometimes used to establish defaults for the lettering (**TEXT**) on a drawing. Normally, all defaults are selected before the annotation of the drawing is started.

7.6.1 Annotation

Annotation is the process of placing words and numbers (text) on a drawing. You can add text to a drawing by means of the **TEXT** command in AutoCAD. Text entities can be drawn with a variety of character patterns, or fonts, and can be stretched, compressed, obliqued, angled, slanted, thickened, or mirrored. A **text string** is one or more characters forming a single unit or block. A text string can contain as little as one text character or can be composed of many lines or paragraphs of text. CAD systems allow text to be saved in the same manner used to file a part or drawing. The **text file** (or block) can then be recalled and reused on any drawing. This ability is particularly helpful when a company uses the same set of notes or instructions for a number of parts.

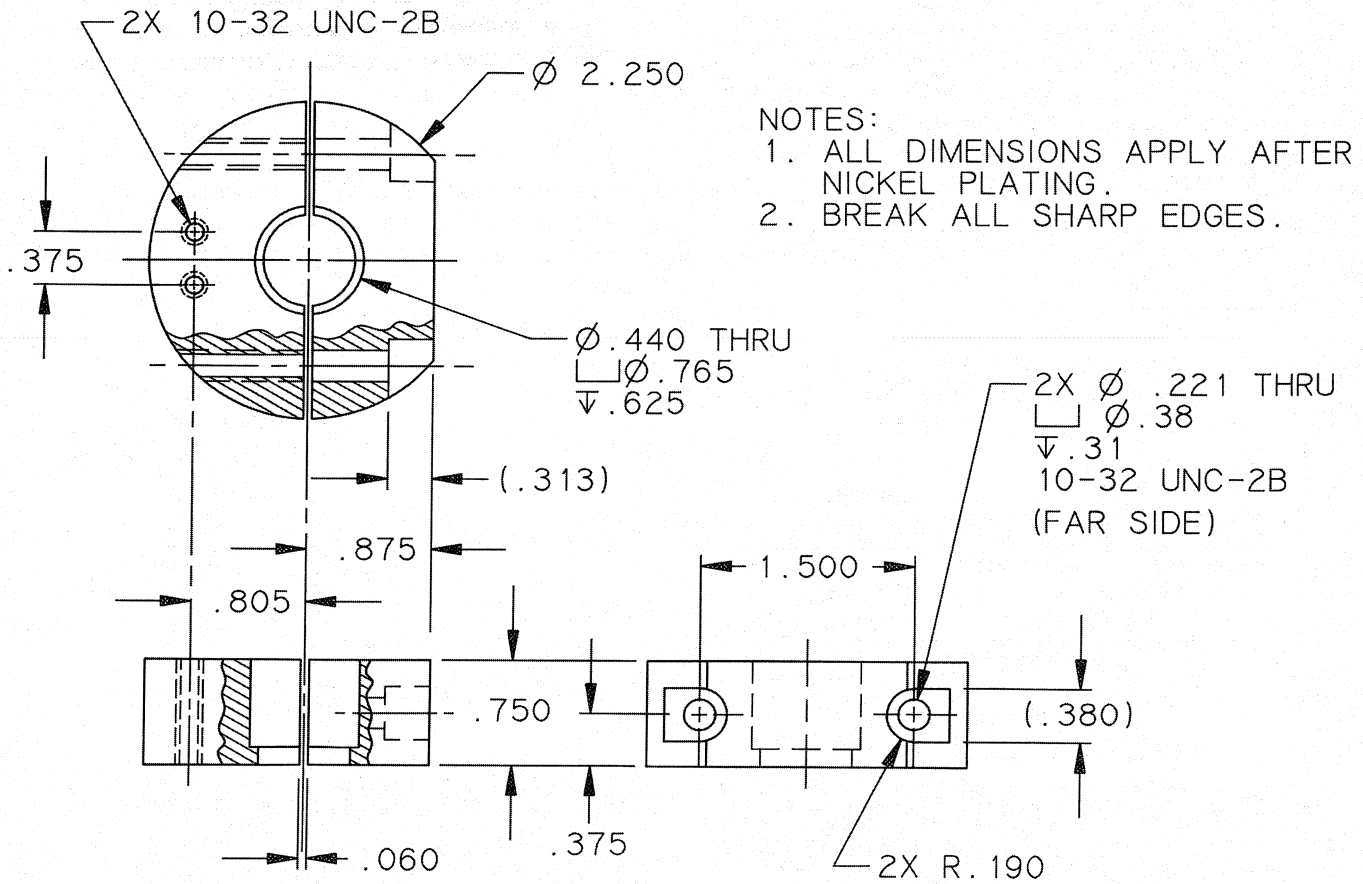


FIGURE 7.32 An Engineering Drawing with CAD Lettering

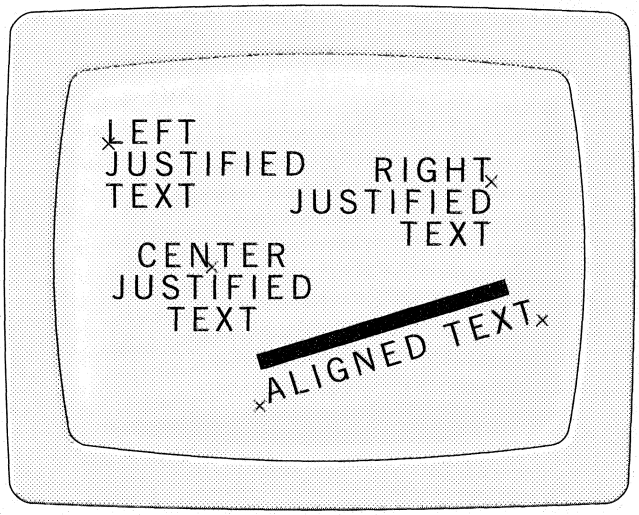


FIGURE 7.33 Text Justification

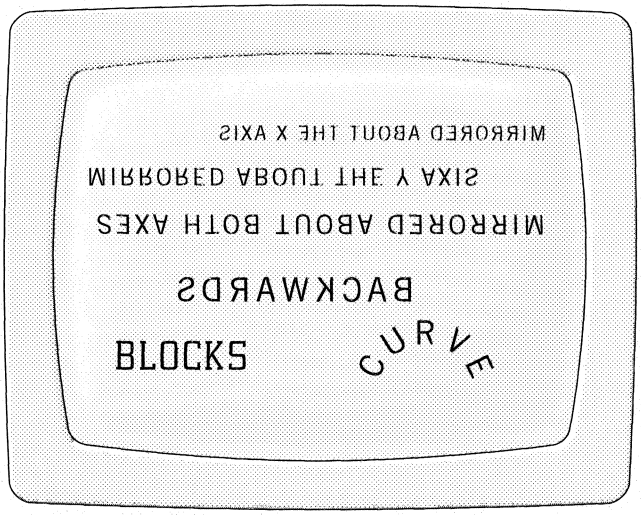


FIGURE 7.35 Text Variations

7.6.2 Text Justification and Height

Text is ordinarily left-justified at the starting point specified; that is, the left end of the text baseline is placed at the starting point. Right-justified (stopline) text aligns the text with the right side, as shown in Figure 7.33, where left-justified, center-justified, and aligned text samples are also given.

The text height specifies, in drawing units, how far above the baseline the capital letters extend. On some systems the height is specified by designating a point; the height will be the distance between this and the starting point. The height, width, slant, and angle can also be determined by the user (Fig. 7.34). Figure 7.35 shows a few text examples that can be created with some systems: mirrored, curved, block, and backwards. Lowercase lettering must be specified before inserting the text, because the default for many systems is uppercase characters.

7.6.3 Text Styles and Fonts

A text font defines the pattern used to draw text characters. Fonts are referred to as **STYLES** in AutoCAD. Text entities can be drawn using any number of character fonts. Several such fonts are supplied with most CAD software; samples of six AutoCAD styles are shown in Figure 7.36.

Many systems have a variety of text fonts available on the screen or tablet menu for quick and easy insertion on the drawing. A tablet menu can be used for selecting a text font, changing the font style of an existing text string, and inserting text with variations of height, width, thickness, angle, slant, and justification.

On many systems the default values have been set for standard drafting text (Fig. 7.37), and the user can change the values before adding text to the drawing. The **TEXT STYLE** command in AutoCAD affects all text, including the parameters for the text characters used in dimensions. The

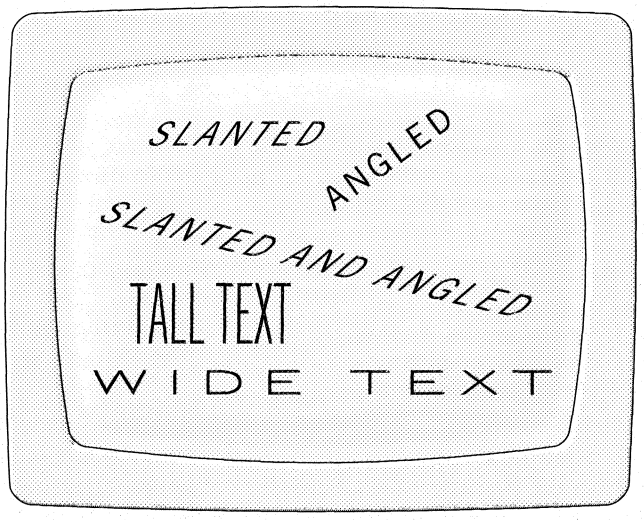


FIGURE 7.34 Slanted, Angled, Tall, and Wide Text

ROMAN SIMPLEX 1 2 3 4 5

ITALIC TRIPLEX 1 2 3 4 5

MONOTEXT 1 2 3 4 5

GOTHIC ENGLISH 1 2 3 4 5

SCRIPT COMPLEX 1 2 3 4 5

STANDARD 1 2 3 4 5

FIGURE 7.36 Text Fonts (Styles)

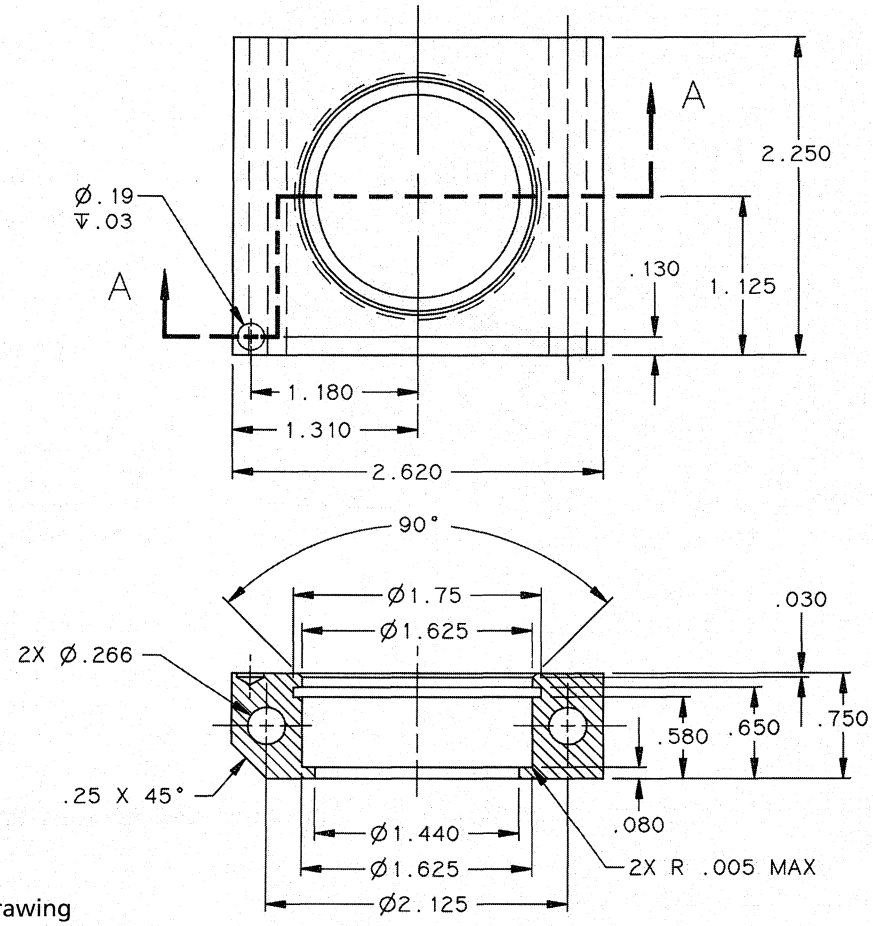


FIGURE 7.37 CAD-Drawn Engineering Drawing

STYLE command prompts you for the specific information that will set the defaults for the text. The **STYLE** command was used to set the text parameters for Figure 7.38.

```
Command: STYLE
Text Style (or ?) <default>: MONOTEXT
Existing Style.
Font file <default>: <RETURN>
Height <default>: .250
Width factor <default>: <RETURN>
Obliquing factor <default>: <RETURN>
Backwards? <N>: <RETURN>
Upside-down? <N>: <RETURN>
Vertical? <N>: <RETURN>
(MONOTEXT is now the current text style)
```

7.6.4 Entering Text on a Drawing

The process for entering text on a drawing involves picking the **TEXT** command and then digitizing the location (or giving coordinates) of the required text. You can add multiple positions of the same text by simply digitizing more than one location for the string.

Before the text can be drawn, you may have to determine the desired text height, the rotation angle from the baseline, and the text string itself. AutoCAD prompts you for this information when using the **DTEXT** command. The following **DTEXT** command was used after **STYLE** to insert the text in Figure 7.38:

```
Command: DTEXT
Start point or Align/Center/Fit/Middle/
Right/Style: <PICK LOCATION>
Height <.250>: <RETURN>
Rotation angle <default>: <RETURN>
Text: <RETURN>
NOTES: UNLESS OTHERWISE SPECIFIED
1. MATERIAL: ALUMINUM, AA ALLOY 6061-T6
2. ALL FILLETS AND ROUNDS R.25
3. BREAK ALL CORNERS
4. PERMANENT MARK PART NO. 000-000345-001
```

Whether using a CAD system or one of the many different lettering aids described in this chapter, mastering freehand lettering is still essential. Engineering and design sketches and other types of written communications require the mastery of freehand lettering to ensure proper and correct transferring of data. Regardless of future innovations in technology, handwritten communication will always be necessary for the designer and engineer in industry.

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NOTES: UNLESS OTHERWISE SPECIFIED

1. MATERIAL: ALUMINUM, AA ALLOY 6061-T6
2. ALL FILLETS AND ROUNDS R.25
3. BREAK ALL CORNERS
4. PERMANENT MARK PART NO. 000-000345-001
```

FIGURE 7.38 Text Entered with AutoCAD

QUIZ

True or False

1. Inclined lettering, .25 in. high, is preferred on mechanical drawings.
2. When hand-lettering a drawing, the distance between lines is equal to the specified character height.
3. The space between words should be a full four units or equal to the letter J.
4. Vertical lettering is preferred over inclined lettering, since it reduces better.
5. Vertical and inclined lettering should not be mixed on one drawing.
6. CAD systems eliminate the need to master freehand lettering.
7. There are eight basic strokes for forming letters and numbers.
8. Guidelines need only be used when learning how to letter.

Fill in the Blanks

9. Lettering is divided into three methods: _____, _____, and _____.
10. Guidelines must be used when hand-lettering except when using _____ paper.
11. The ANSI standard on lettering states that the height of a fraction number should be _____ to the whole number.
12. Notes and dimensions should be at least _____ in height on a "D"-size drawing.
13. Inclined lettering should be approximately _____ degrees.
14. Stopline lettering is the same as _____ _____.
15. ANSI lists and notes are placed in the _____ or _____ side of the drawing.
16. Templates and lettering guides should always be placed against a _____ when lettering.

Answer the Following

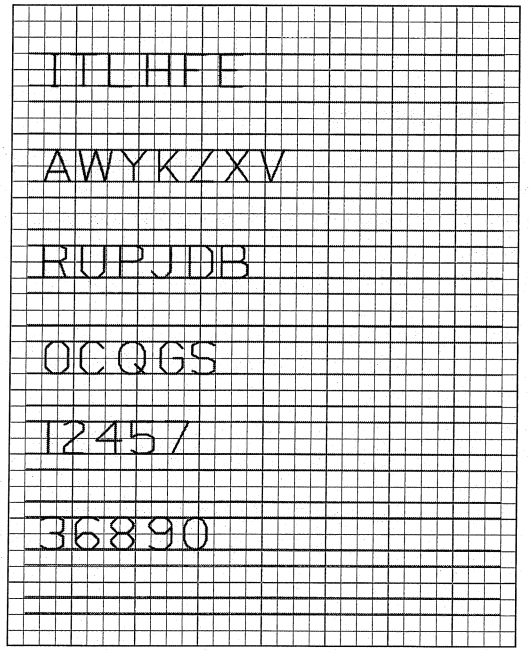
17. What ANSI standard covers lettering on engineering drawings?
18. When is lowercase lettering used, and on what type of drawings?
19. When are machine lettering devices normally used for a drawing?
20. Define the term *text font.*
21. Explain the difference between manual, mechanical, and machine lettering.
22. What is annotation?
23. Name five types of lettering characteristics available on CAD systems.
24. List the reasons for mastering manual lettering.

EXERCISES

Exercises may be assigned as freehand, template, or machine-lettering projects. Transfer the given information to an "A"-size sheet of .25 in. grid paper.

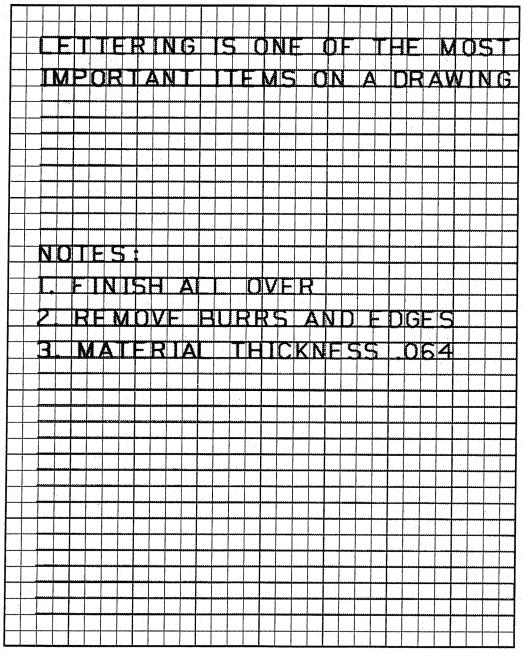
After Reading the Chapter Through Section 7.3.8, You May Complete the Following Exercises

Exercise 7.1 Practice lettering using the standard stroke sequence. You may add vertical or inclined guidelines for this exercise.



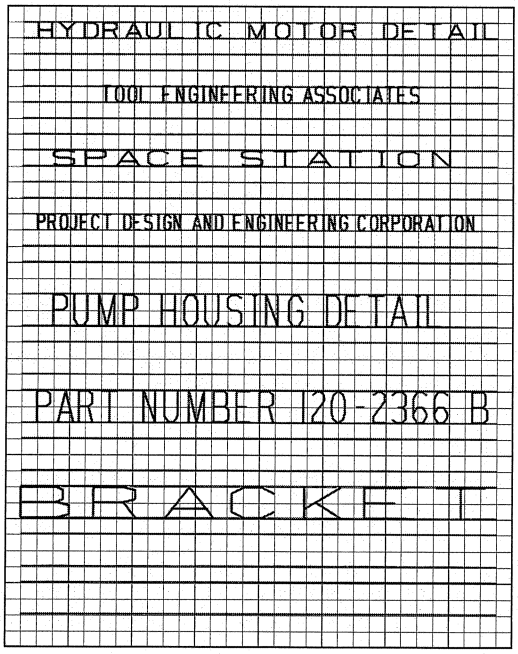
EXERCISE 7.1

Exercise 7.2 Letter the sentence and the notes three times each.



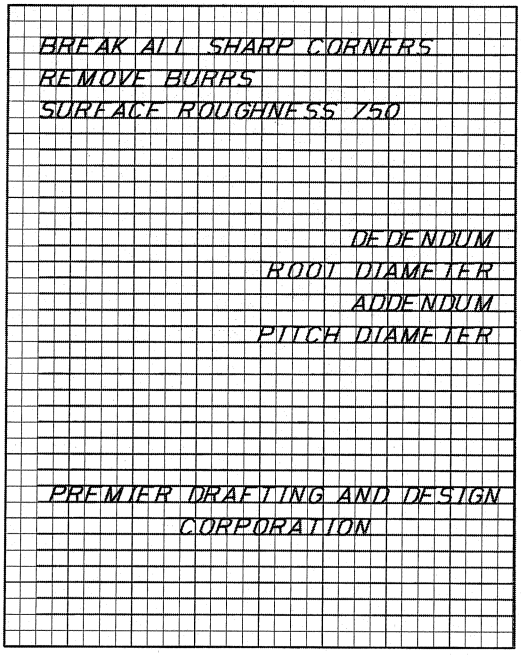
EXERCISE 7.2

Exercise 7.3 Letter the page as shown using compressed and extended lettering.



EXERCISE 7.3

Exercise 7.4 Letter the drawing notes as shown using right-justified, left-justified, and center-justified lettering.



EXERCISE 7.4

PROBLEMS

Problem 7.1 Using the layout sheet provided nearby, complete the lettering assignment as shown. Use this example to lay out the drawing format for the following problems.

Problem 7.2 Letter each of the following twice, using compressed and extended, vertical, .5 in. or 12 mm height, uppercase lettering. See Problem 7.1 for the page layout, or use the Problem Sheets.

ANGLE BRACKET ASSEMBLY
PUMP HOUSING DETAIL
DESIGN AND ENGINEERING, INC.

Problem 7.3 Letter the following note three times at 4 mm height in vertical uppercase lettering.

HEAT TREATMENT:
MC QUAID-EHN GRAIN SIZE 5-8 HEAT TO 1550 DEGREES F AND QUENCH IN OIL. DRAW TO BRINELL HARDNESS 241-285. 100% BRINELL REQUIRED

Problem 7.4 Letter the following note three times using .25 in. high inclined letters. Instructor may assign project to be inked using a lettering template or a Leroy set.

NOTE:
1. LOCATING POINTS TO BE CASE FLAT AND SMOOTH
2. CAST FEATURES ARE DETERMINED BY BASIC DIMENSIONS IN RELATION TO LOCATING SURFACES.

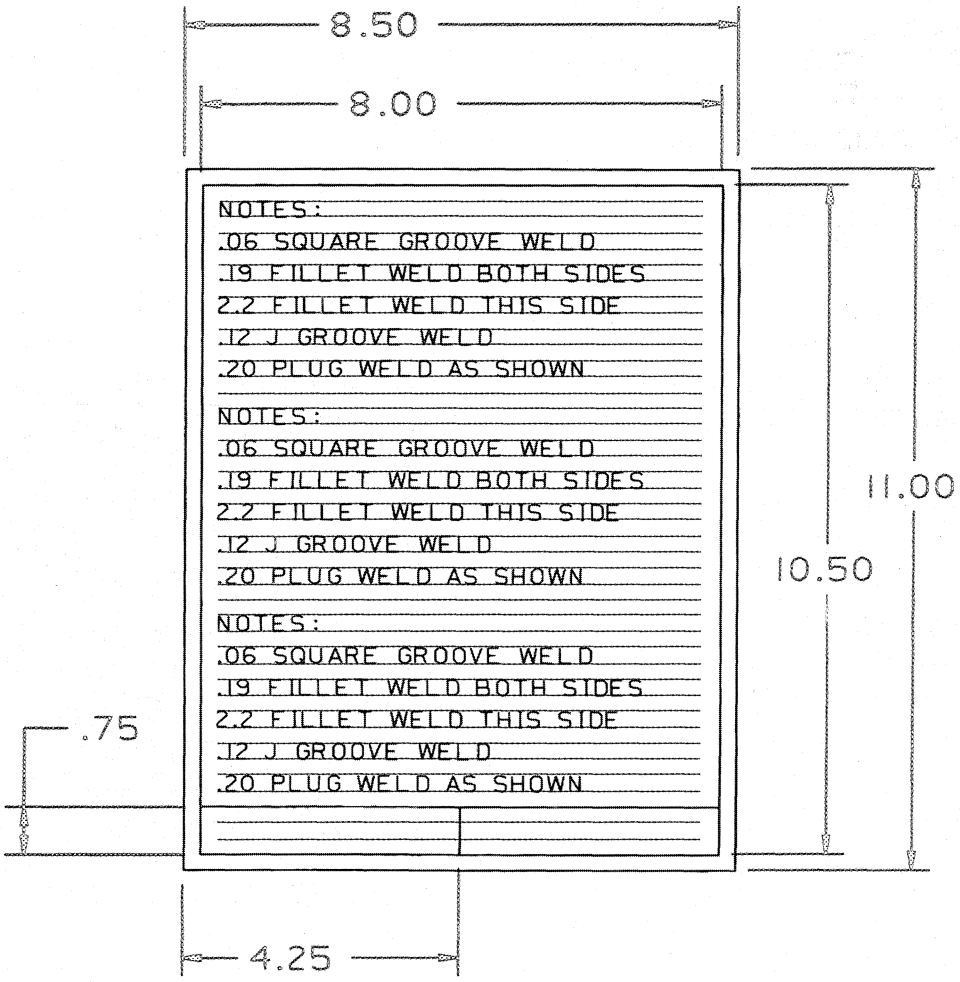
Problem 7.5 Letter the following specifications using vertical, mixed uppercase and lowercase characters .156 in. or 4 mm in height.

1. Casting to be pressure tight when tested at 100 P.S.I.
2. Finish all over 125 μin.
3. Do not apply piece mark.
4. Material thickness .125 in.

Problem 7.6 Reletter the parts list in Figure 7.19 using vertical uppercase lettering.

Problem 7.7 Using a CAD system, letter the notes in Figure 7.20.

Problem 7.8 Set up an "A"-size drawing as in Figure 7.10, and fill the entire page with lettering.



PROBLEM 7.1