CHAPTER 2

AIRCRAFT DRAWINGS

PRINTS

The exchange of ideas is essential to everyone, regardless of his vocation or position. Usually, this exchange is carried on by the oral or written word; but under some conditions the use of these alone is impractical. Industry discovered that it could not depend entirely upon written or spoken words for the exchange of ideas because misunderstanding and misinterpretation arose frequently. A written description of an object can be changed in meaning just by misplacing a comma; the meaning of an oral description can be completely changed by the use of a wrong word. To avoid these possible errors, industry uses drawings to describe objects. For this reason, drawing is called the Draftsman's Language.

Drawing, as we use it, is a method of conveying ideas concerning the construction or assembly of objects. This is done with the help of lines, notes, abbreviations, and symbols. It is very important that the aviation mechanic who is to make or assemble the object understand the meaning of the different lines, notes, abbreviations, and symbols that are used in a drawing. (See especially "The Meaning of Lines" section of this chapter.)

Prints are the link between the engineers who design an aircraft and the men who build, maintain, and repair it. A print may be a copy of a working drawing for an aircraft part or group of parts, or for a design of a system or group of systems. They are made by placing a tracing of the drawing over a sheet of chemically treated paper and exposing it to a strong light for a short period of time. When the exposed paper is developed, it turns blue where the light has penetrated the transparent tracing. The inked lines of the tracing, having blocked out the light, show as white lines on a blue background. Other types of sensitized paper have been developed; prints may have a white background with colored lines or a colored background with white lines.

A print shows the various steps required in building anything from a simple component to a complete aircraft.

WORKING DRAWINGS

Working drawings must give such information as size of the object and all of its parts, its shape and that of all of its parts, specifications as to the material to be used, how the material is to be finished, how the parts are to be assembled, and any other information essential to making and assembling the particular object.

Working drawings may be divided into three classes: (1) Detail drawings, (2) assembly drawings, and (3) installation drawings.

Detail Drawing

A detail drawing is a description of a single part, given in such a manner as to describe by lines, notes, and symbols the specifications as to size, shape, material, and methods of manufacture that are to be used in making the part. Detail drawings are usually rather simple; and, when single parts are small, several detail drawings may be shown on the same sheet or print. (See detail drawing at the top of figure 2–1.)

Assembly Drawing

An assembly drawing is a description of an object made up of two or more parts. Examine the assembly drawing in the center of figure 2–1. It describes the object by giving, in a general way, the size and shape. Its primary purpose is to show the relationship of the various parts. An assembly drawing is usually more complex than a detail drawing, and is often accompanied by detail drawings of various parts.

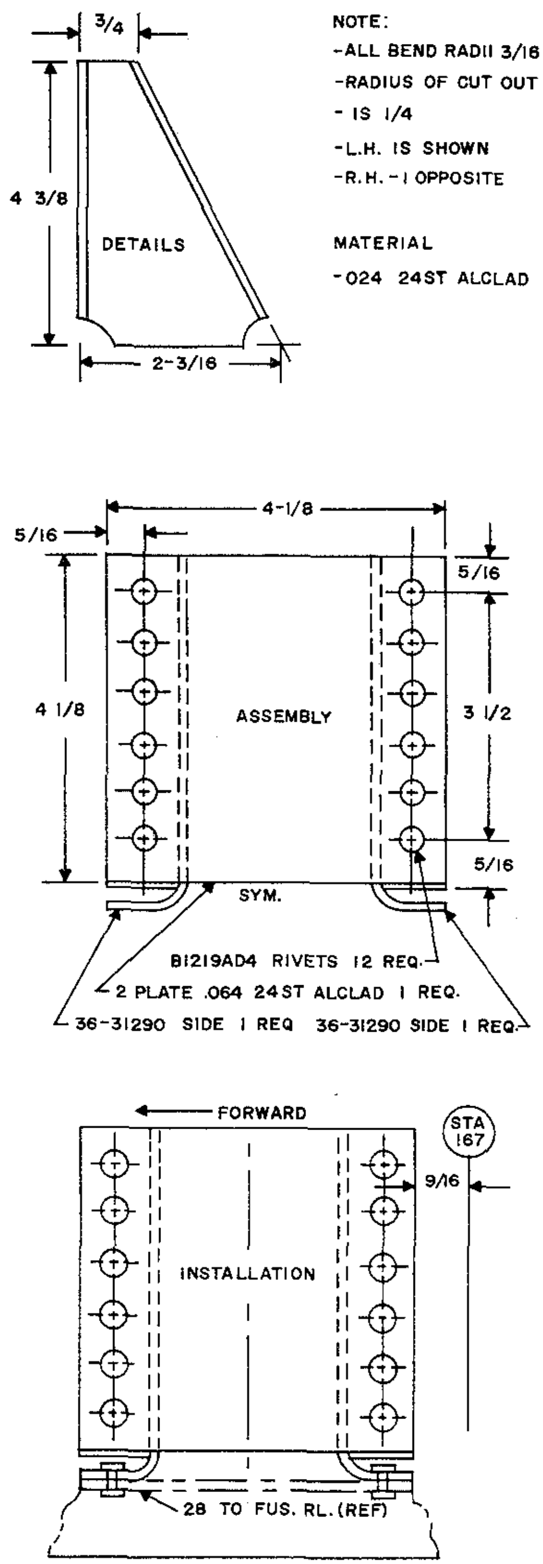


FIGURE 2–1. Working drawings.

Installation Drawing

An installation drawing is one which includes all necessary information for a part or an assembly of parts in the final position in the aircraft. It shows the dimensions necessary for the location of specific parts with relation to the other parts and reference dimensions that are helpful in later work in the shop. (See installation drawing at the bottom of figure 2–1.)

CARE AND USE OF DRAWINGS

Drawings are both expensive and valuable; consequently, they should be handled carefully. Open drawings slowly and carefully to prevent tearing the paper. When the drawing is open, smooth out the fold lines instead of bending them backward.

To protect drawings from damage, never spread them on the floor or lay them on a surface covered with tools or other objects that may make holes in the paper. Hands should be free of oil, grease, or other unclean matter than can soil or smudge the print.

Never make notes or marks on a print, as they may confuse other persons and lead to incorrect work. Only authorized persons are permitted to make notes or changes on prints, and they must sign and date any changes they make.

When finished with a drawing, fold and return it to its proper place. Prints are folded originally in a proper size for filing, and care should be taken so that the original folds are always used.

TITLE BLOCKS

Every print must have some means of identification. This is provided by a title block (see figure 2–2). The title block consists of a drawing number and certain other data concerning the drawing and the object it represents. This information is grouped in a prominent place on the print, usually in the lower right-hand corner. Sometimes the title block is in the form of a strip extending almost the entire distance across the bottom of the sheet.

Although title blocks do not follow a standard form, insofar as layout is concerned, all of them will present essentially the following information:

1. A drawing number to identify the print for filing purposes and to prevent confusing it with any other print.

FEDERAL AVIATION ADMIN. AERONAUTICAL CENTER OKLAHOMA CITY, OKLA.		
Nº1 ADF "T" ANTENNA LOCATION & DETAILS		
SCALE: FULL SIZE		
APPROVED: JOSEPH DOE		SUBMITTED: B. B. BLACK
DR. BY: HBF CK. BY: TDY	DATE 4-8-68	DR. AC-A-735

FIGURE 2–2. Title block.

2. The name of the part or assembly.
3. The scale to which it is drawn.
4. The date.
5. The name of the firm.
6. The name of the draftsmen, the checker, and the person approving the drawing.

Drawing or Print Numbers

All prints are identified by a number, which appears in a number block in the lower right-hand corner of the title block. It may also be shown in other places—such as near the top border line, in the upper right-hand corner, or on the reverse side of the print at both ends—so that the number will show when the print is folded or rolled. The purpose of the number is for quick identification of a print. If a print has more than one sheet and each sheet has the same number, this information is included in the number block, indicating the sheet number and the number of sheets in the series.

Reference and Dash Numbers

Reference numbers that appear in the title block refer a person to the numbers of other prints. When more than one detail is shown on a drawing, dash numbers are used. Both parts would have the same drawing number plus an individual number, such as 40267–1 and 40267–2.

In addition to appearing in the title block, dash numbers may appear on the face of the drawing near the parts they identify. Dash numbers are also used to identify right-hand and left-hand parts.

In aircraft, many parts on the left side are like the corresponding parts on the right side but in reverse. The left-hand part is always shown in the drawing. The right-hand part is called for in the title block. Above the title block will be found a notation such as: 470204–1LH shown; 470204–2RH opposite. Both parts carry the same number, but the part called for is distinguished by a dash number. Some prints have odd numbers for left-hand parts and even numbers for right-hand parts.

Universal Numbering System

The universal numbering system provides a means of identifying standard drawing sizes. In the universal numbering system, each drawing number consists of six or seven digits. The first digit is always 1, 2, 4, or 5 (figure 2–3), and indicates the size of the drawing. The remaining digits identify the drawing. Many firms have modified this basic system to conform to their particular needs. Letters may be used instead of numbers. The letter or number depicting the standard drawing size may be prefixed to the number, separated from it by a dash. Other numbering systems provide a separate box preceding the drawing number for the drawing size identifier. In other modification of this system the part number of the depicted assembly is assigned as the drawing number.

SIZE	1	2	4	5
LENGTH	11"	17"	22"	INDEFINITE (ROLL)
WIDTH	8-1/2"	11"	17"	17, 22, 25.50, 34, and 36 inches

FIGURE 2–3. Standard blueprint paper sizes.

BILL OF MATERIAL

A list of the materials and parts necessary for the fabrication or assembly of a component or system is often included on the drawing. The list usually will be in ruled columns in which are listed the part number, name of the part, material from which the part is to be constructed, the quantity required, and the source of the part or material. A typical bill of material is shown in figure 2–4. On drawings that do not have a bill of material, the data may be indicated directly on the drawing.

On assembly drawings, each item is identified by a number in a circle or square. An arrow connecting the number with the item assists in locating it in the bill of material.

BILL OF MATERIAL			
ITEM	PART NO.	REQUIRED	SOURCE
CONNECTOR	UG-21D/U	2	STOCK

FIGURE 2-4. A typical bill of material.

OTHER DATA

Revision Block

Revisions to a drawing are necessitated by changes in dimensions, design, or materials. The changes are usually listed in ruled columns either adjacent to the title block or at one corner of the drawing. All changes to approved drawings must be carefully noted on all existing prints of the drawing.

When drawings contain such corrections, attention is directed to the changes by lettering or numbering them and listing those changes against the symbol in a revision block (figure 2-5). The revision block contains the identification symbol, the date, the nature of the revision, the authority for the change, and the name of the draftsman who made the change.

To distinguish the corrected drawing from its previous version, many firms are including, as part of the title block, a space for entering the appropriate symbol to designate that the drawing has been changed or revised.

2	CHANGED PART NO. 5	E.O.I	2/3/70	B.K.
I	REVISED DIMENSIONS	J.L.M.	7/1/69	E.K.P.
NO.	REVISION	AUTH.	DATE	SIGN.

FIGURE 2-5. Revision block.

Notes

Notes are added to drawings for various reasons. Some of these notes refer to methods of attachment or construction. Others give alternatives, so that the drawing can be used for different styles of the same object. Still others list modifications that are available.

Notes may be found alongside the item to which they refer. If the notes are lengthy, they may be placed elsewhere on the drawing and identified by letters or numbers. Notes are used only when the information cannot be conveyed in the conventional manner or when it is desirable to avoid crowding the drawing. Figure 2-1 illustrates one method of depicting notes.

When the note refers to a specific part, a light line with an arrowhead leads from the note to the part. If it applies to more than one part, the note is so worded that no mistake can be made as to the parts to which it pertains. When there are several notes, they are generally grouped together and numbered consecutively.

Zone Numbers

Zone numbers on drawings are similar to the numbers and letters printed on the borders of a map. They are there to help locate a particular point. To find a point, mentally draw horizontal and vertical lines from the letters and numerals specified; the point where these lines would intersect is the area sought.

Use the same method to locate parts, sections, and views on large drawings, particularly assembly drawings. Parts numbered in the title block can be located on the drawing by finding the numbers in squares along the lower border. Zone numbers read from right to left.

Station Numbers

A numbering system is used on large assemblies for aircraft to locate stations such as fuselage frames. Fuselage Frame-Sta 185 indicates that the frame is 185 inches from the datum of the aircraft. The measurement is usually taken from the nose or zero station, but in some instances it may be taken from the fire wall or some other point chosen by the manufacturer.

The same station numbering system is used for wing and stabilizer frames. The measurement is taken from the center line or zero station of the aircraft.

Finish Marks

Finish marks are used to indicate the surface that must be machine finished. Such finished surfaces have a better appearance and allow a closer fit with adjoining parts. During the finishing process the required limits and tolerances must be observed. Do not confuse machined finishes with those of paint, enamel, chromium plating, and similar coating.

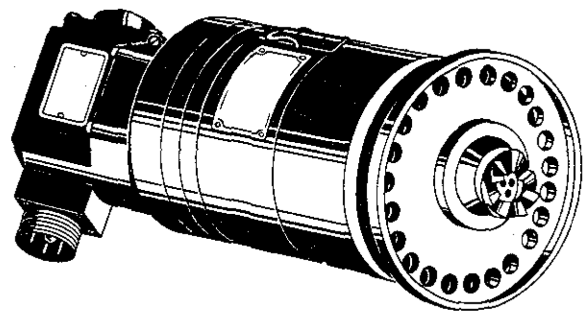


FIGURE 2–6. Pictorial drawing.

Tolerances

When a given dimension on a print shows an allowable variation, the plus (+) figure indicates the maximum, and the minus (−) figure the minimum, allowable variation. The sum of the plus and minus allowance figures is called tolerance. For example, using .225 + .0025 − .0005, the plus and minus figures indicate the part will be acceptable if it is not more than .0025 larger than the .225 given dimension, or not more than .0005 smaller than the .225 dimension. Tolerance in this example is .0030 (.0025 max. plus .005 min.).

If the plus and minus allowances are the same, you will find them presented as .224 ± .0025. The tolerance would then be .0050. Allowance can be indicated in either fractional or decimal form. When very accurate dimensions are necessary, decimal allowances are used. Fractional allowances are sufficient when close dimensions are not required. Standard tolerances of −.010 or −1/32 may be given in the title block of many drawings, to apply throughout the drawing.

METHODS OF ILLUSTRATING OBJECTS

A number of methods are used to illustrate objects graphically. The most common are pictorial drawings, orthographic projections, and diagrams.

Pictorial Drawings

A pictorial drawing, figure 2–6, is similar to a photograph. It shows an object as it appears to the eye, but it is not satisfactory for showing complex forms and shapes. Pictorial drawings are useful in showing the general appearance of an object and are used extensively with orthographic projection drawings. Pictorial drawings are used in maintenance, overhaul, and part numbers.

Orthographic Projection Drawings

In order to show the exact size and shape of all the parts of complex objects, a number of views are necessary. This is the system used in orthographic projection.

In orthographic projection there are six possible views of an object, because all objects have six sides—front, top, bottom, rear, right side, and left side. Figure 2–7(a) shows an object placed in a transparent box, hinged at the edges. The projections on the sides of the box are the views as seen looking straight at the object through each side. If the outlines of the object are drawn on each surface and the box opened as shown in (b), then laid flat as shown in (c), the result is a six-view orthographic projection.

It is seldom necessary to show all six views to portray an object clearly; therefore, only those views necessary to illustrate the required characteristics of the object are drawn. One-view, two-view, and three-view drawings are the most common. Regardless of the number of views used, the arrangement is generally as shown in figure 2–7, with the front view being the principal one. If the right-side view is shown, it will be to the right of the front view. If the left-side view is shown, it will be to the left of the front view. The top and bottom views, if included, will be shown in their respective positions relative to the front view.

One-view drawings are commonly used for objects of uniform thickness, such as gaskets, shims, and plates. A dimensional note gives the thickness as shown in figure 2–8. One-view drawings are also commonly used for cylindrical, spherical, or square parts if all the necessary dimensions can be properly shown in one view.

When space is limited and two views must be shown, symmetrical objects are often represented by half views, as illustrated in figure 2–9.

Aircraft drawings seldom show more than two principal, or complete, views of an object. Instead, generally there will be one complete view and one or more detail views or sectional views.

Detail View

A detail view shows only a part of the object but in greater detail and to a larger scale than the principal view. The part that is shown in detail elsewhere on the drawing is usually encircled by a heavy line on the principal view. Figure 2–10 is an example of the use of detail views. The

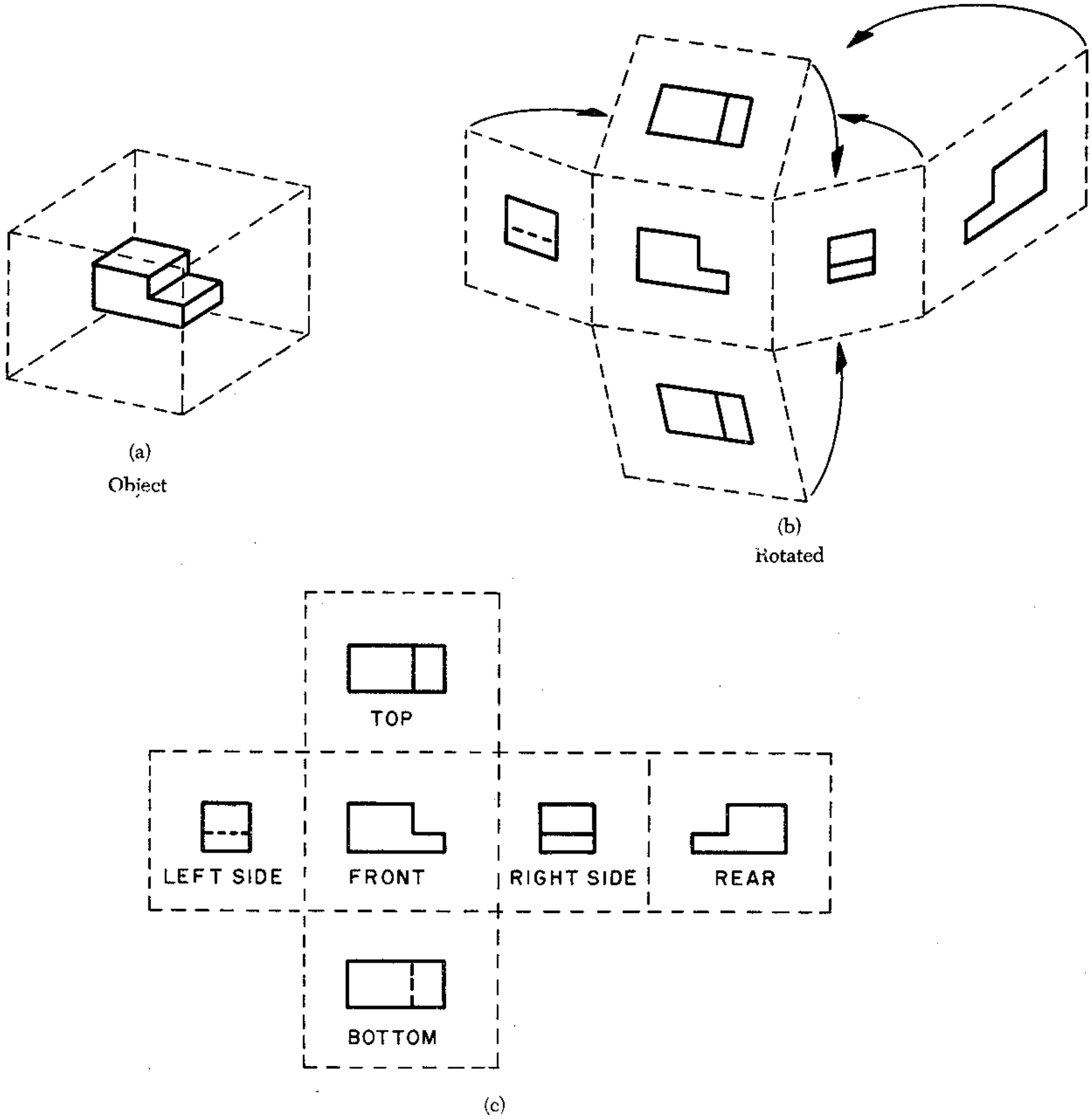


FIGURE 2–7. Orthographic projection.

principal view shows the complete control wheel, while the detail view is an enlarged drawing of a portion of the control wheel.

Sectional Views

A section or sectional view is obtained by cutting away part of an object to show the shape and construction at the cutting plane. The part or parts cut away are shown by the use of section (cross-hatching) lines.

Sectional views are used when the interior construction or hidden features of an object cannot be shown clearly by exterior views. For example, figure 2–11, a sectional view of a coaxial cable connector, shows the internal construction of the connector. This is known as a full section. Other types of sections are described in the following paragraphs.

Half Sections

In a half section, the cutting plane extends only halfway across the object, leaving the other half of the object as an exterior view. Half sections are

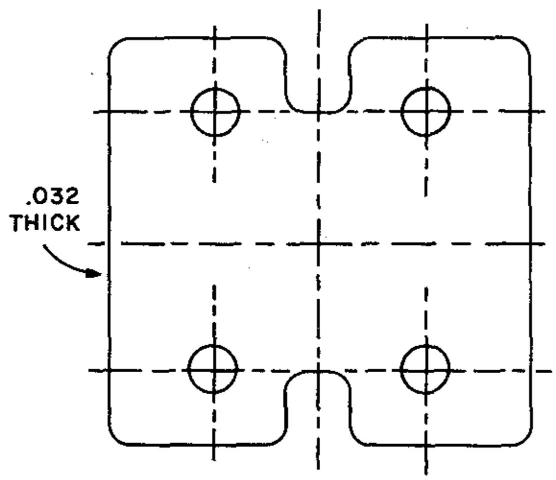


FIGURE 2-8. One-view drawing.

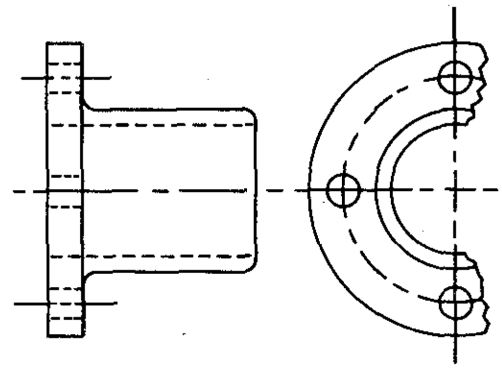


FIGURE 2-9. Symmetrical object with exterior half view.

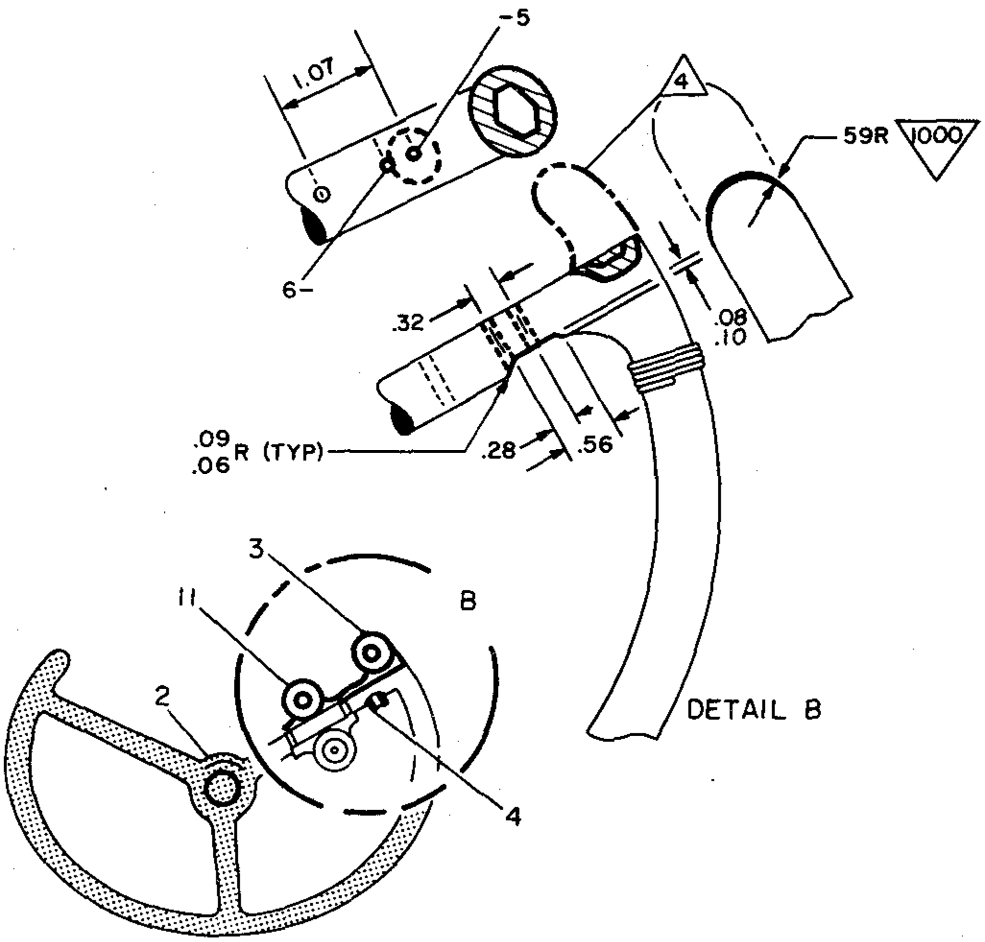


FIGURE 2-10. Detail view.

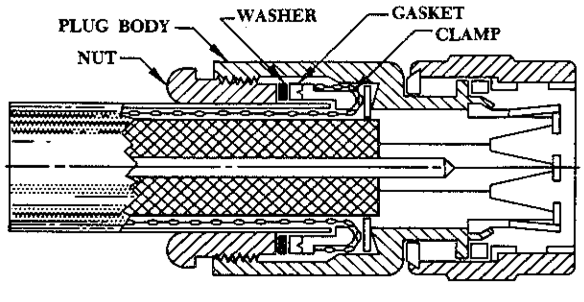


FIGURE 2–11. Sectional view of a cable connector.

used to advantage with symmetrical objects to show both the interior and exterior.

Figure 2–12 is a half-sectional view of a quick disconnect used in aircraft fluid systems.

Revolved Sections

A revolved section drawn directly on the exterior view shows the shape of the cross section of a part, such as the spoke of a wheel. An example of a revolved section is shown in figure 2–13.

Removed Sections

Removed sections illustrate particular parts of an object. They are drawn like revolved sections, except that they are placed at one side and, to bring out pertinent details, are often drawn to a larger scale than the view on which they are indicated.

Figure 2–14 is an illustration of removed sections. Section A–A shows the cross-sectional shape of the object at cutting plane line A–A. Section B–B shows the cross-sectional shape at cutting plane line B–B. These sectional views are drawn to the same scale as the principal view; however, as already mentioned, they are often drawn to a larger scale to bring out pertinent details.

THE MEANING OF LINES

Every drawing is composed of lines. Lines mark the boundaries, edges, and intersection of surfaces. Lines are used to show dimensions and hidden surfaces, and to indicate centers. Obviously, if the same kind of line is used to show all of these things, a drawing becomes a meaningless collection of lines. For this reason, various kinds of standardized lines are used on aircraft drawings. These are illustrated in figure 2–15, and their correct uses are shown in figure 2–16.

Most drawings use three widths, or intensities, of lines: thin, medium, or thick. These lines may vary somewhat on different drawings, but there will always be a noticeable difference between a thin and a thick line, with the width of the medium line somewhere between the two.

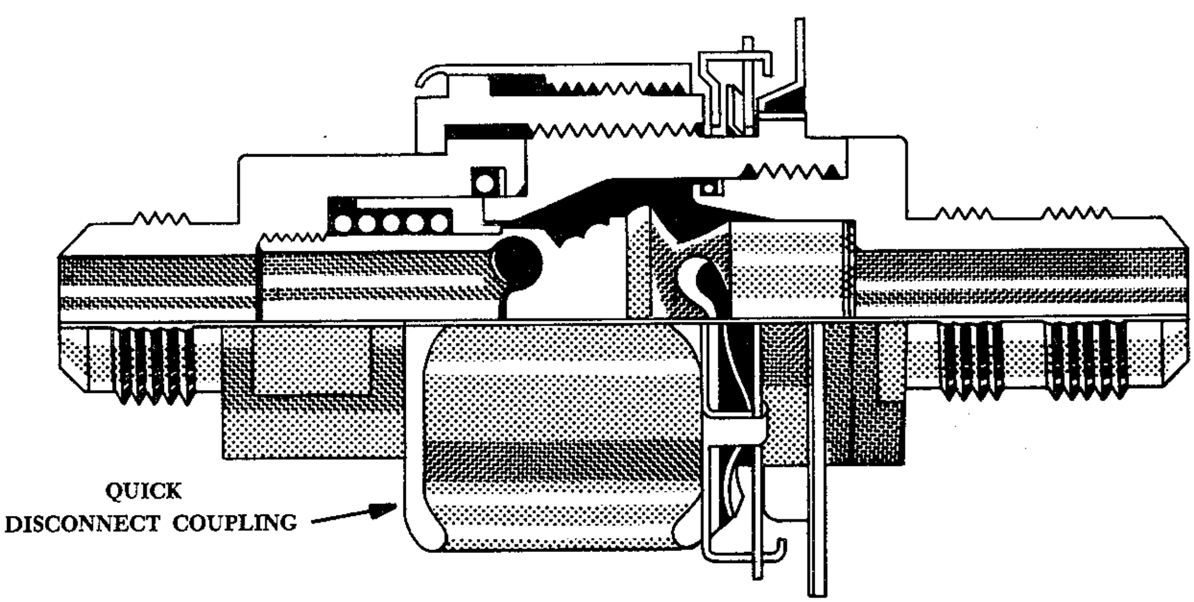


FIGURE 2–12. Half section.

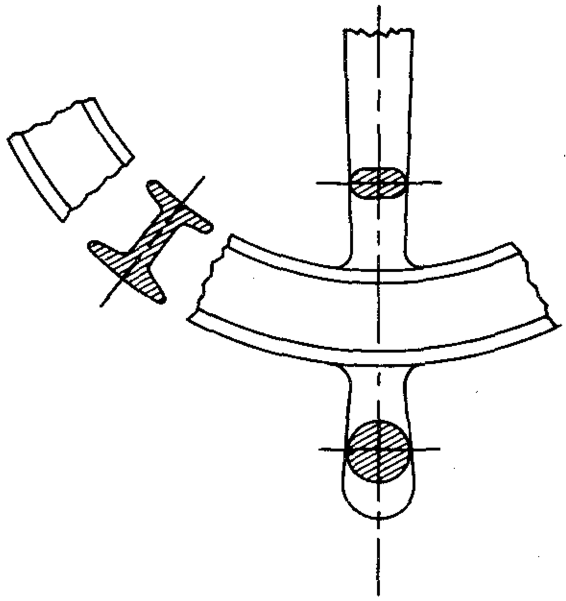


FIGURE 2–13. Revolved sections.

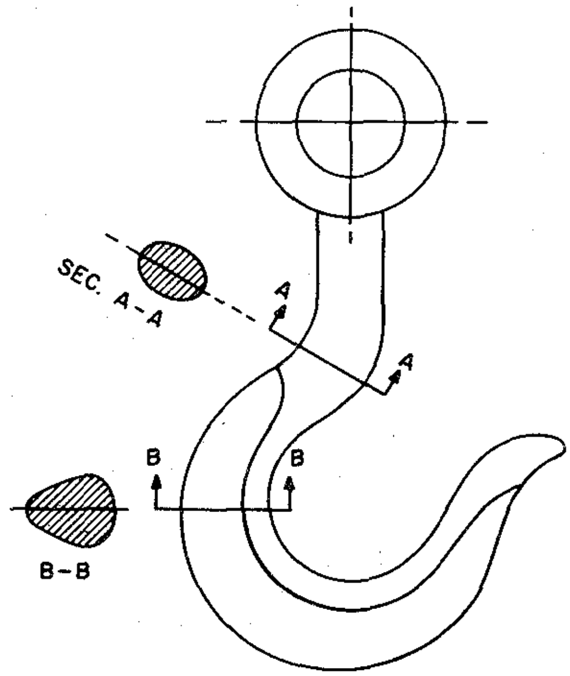


FIGURE 2–14. Removed sections.

Center Lines

Center lines are made up of alternate long and short dashes. They indicate the center of an object or part of an object. Where center lines cross, the short dashes intersect symmetrically. In the case of very small circles, the center lines may be shown unbroken.

Dimension Lines

A dimension line is a light solid line, broken at the midpoint for insertion of measurement indications, and having opposite pointing arrowheads at each end to show origin and termination of a measurement. They are generally parallel to the line for which the dimension is given, and are usually placed outside the outline of the object and between views if more than one view is shown.

All dimensions and lettering are placed so that they will read from left to right. The dimension of an angle is indicated by placing the degree of the angle in its arc. The dimensions of circular parts are always given in terms of the diameter of the circle and are usually marked with the letter D or the abbreviation DIA following the dimension. The dimension of an arc is given in terms of its radius and is marked with the letter R following the dimension. Parallel dimensions are placed so that the longest dimension is farthest from the outline and the shortest dimension is closest to the outline of the object. On a drawing showing several views, the dimensions will be placed upon each view to show its details to the best advantage.

In dimensioning distances between holes in an object, dimensions are usually given from center to center rather than from outside to outside of the holes. When a number of holes of various sizes are shown, the desired diameters are given on a leader followed by notes indicating the machining operations for each hole. If a part is to have three holes of equal size, equally spaced, this information is given. For precision work, sizes are given in decimals. Diameters and depths are given for counterbored holes. For countersunk holes the angle of countersinking and the diameters are given. Study the examples shown in figure 2–17.

The dimensions given for fits signify the amount of clearance allowable between moving parts. A positive allowance is indicated for a part that is to slide or revolve upon another part. A negative allowance is one given for a force fit. Whenever possible, the tolerance and allowances for desired fits conform to those set up in the American Standard for Tolerances, Allowances, and Gages for Metal Fits. The classes of fits specified in the standard may be indicated on assembly drawings.

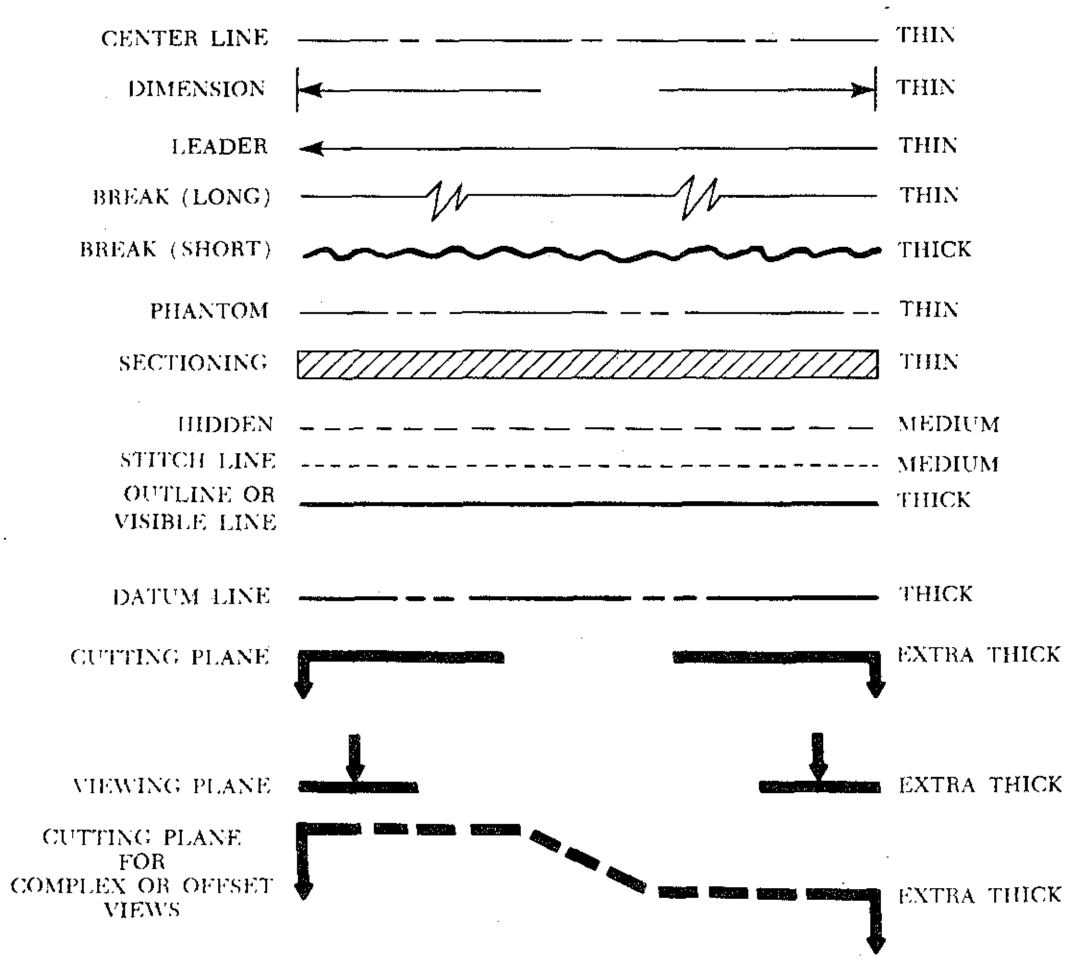


FIGURE 2–15. The meaning of lines.

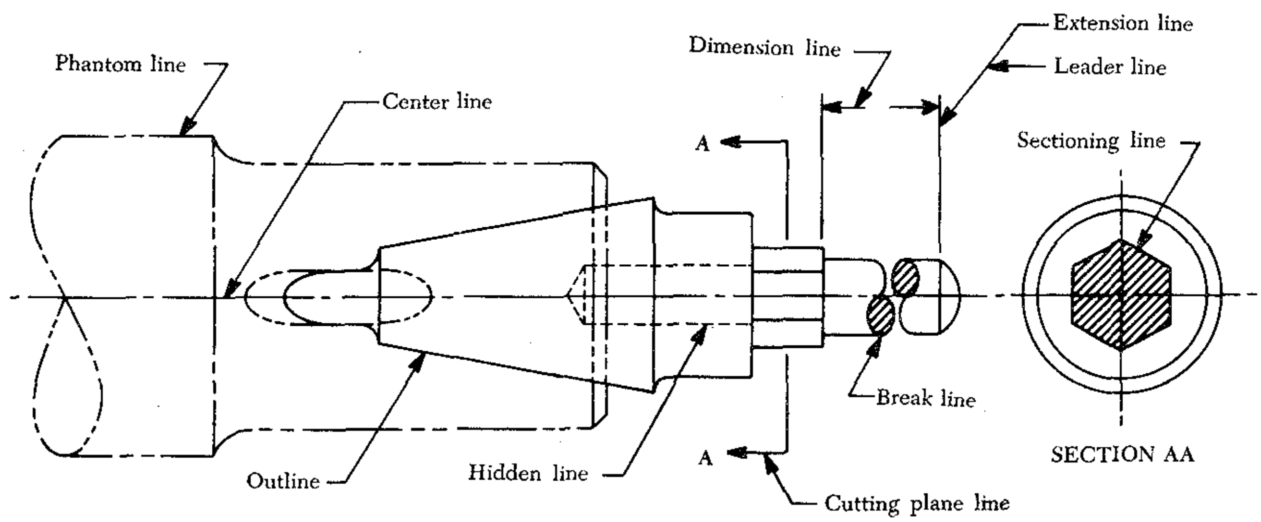


FIGURE 2–16. Correct uses of lines.

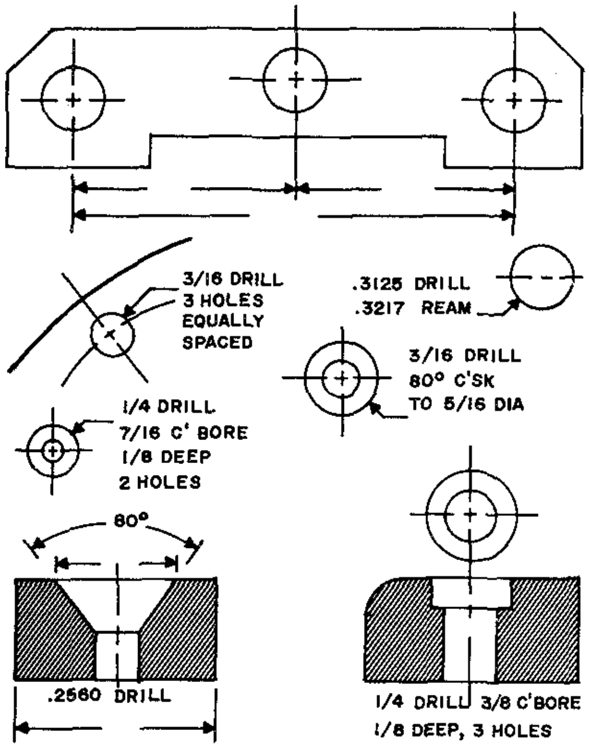


FIGURE 2–17. Dimensioning holes.

Leader Lines

Leaders are solid lines with one arrowhead and indicate a part or portion to which a note, number, or other reference applies.

Break Lines

Break lines indicate that a portion of the object is not shown on the drawing. Short breaks are made by solid, freehand lines. For long breaks, solid ruled lines with zigzags are used. Shafts, rods, tubes, and other such parts which have a portion of their length broken out, have the ends of the break drawn as indicated in figure 2–16.

Phantom Lines

Phantom lines indicate the alternate position of parts of the object or the relative position of a missing part. Phantom lines are composed of one long and two short evenly spaced dashes.

Sectioning Lines

Sectioning lines indicate the exposed surfaces of an object in sectional view. They are generally thin, full lines, but may vary with the kind of material shown in section.

Hidden Lines

Hidden lines indicate invisible edges or contours. Hidden lines consist of short dashes evenly spaced and are frequently referred to as dash lines.

Outline or Visible Lines

The outline or visible line is used for all lines on the drawing representing visible lines on the object.

Stitch Lines

Stitch lines indicate stitching or sewing lines and consist of a series of evenly spaced dashes.

Cutting Plane and Viewing Plane Lines

Cutting plane lines indicate the plane in which a sectional view of the object is taken. In figure 2–16, plane line A–A indicates the plane in which section A–A is taken.

Viewing plane lines indicate the plane from which a surface is viewed.

READING DRAWINGS

A drawing cannot be read all at once any more than a whole page of print can be read at a glance. Both must be read a line at a time. To read a drawing effectively, follow a systematic procedure.

Upon opening a drawing, read the drawing number and the description of the article. Next, check the model affected, the latest change letter, and the next assembly listed. Having determined that the drawing is the correct one, proceed to read the illustration(s).

In reading a multiview drawing, first get a general idea of the shape of the object by scanning all the views; then select one view for a more careful study. By referring back and forth to the adjacent view, it will be possible to determine what each line represents.

Each line on a view represents a change in the direction of a surface, but another view must be consulted to determine what the change is. For example, a circle on one view may mean either a hole or a protruding boss, as in the top view of the object in figure 2–18. Looking at the top view, we see two circles; however, the other view must be consulted to determine what each circle represents. A glance at the other view tells us that the smaller circle represents a hole, and the larger

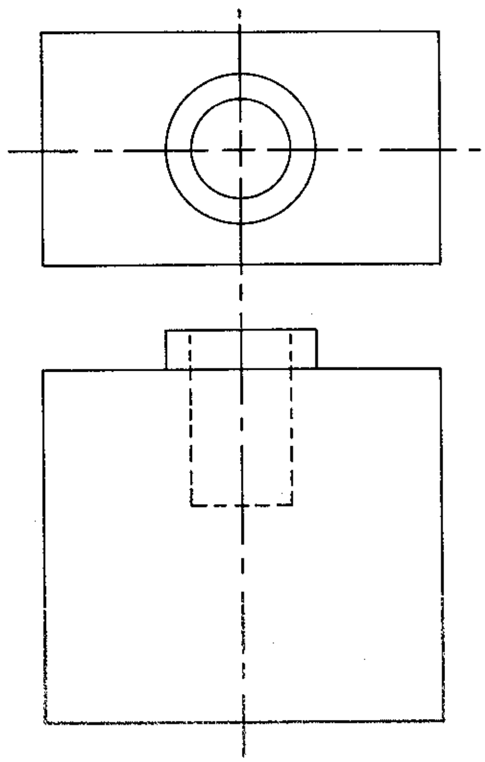


FIGURE 2–18. Reading views.

circle represents a protruding boss. In the same way, the top view must be consulted to determine the shape of the hole and the protruding boss.

It can be seen from this example that one cannot read a print by looking at a single view, when more than one view is given. Two views will not always describe an object, and when three views are given, all three must be consulted to be sure the shape has been read correctly.

After determining the shape of an object, determine its size. Information on dimensions and tolerances is given so that certain design requirements may be met. Dimensions are indicated by figures either with or without the inch mark. If no inch mark is used, the dimension is in inches. It is customary to give part dimensions and an overall dimension that gives the greatest length of the part. If the overall dimension is missing, it can be determined by adding the separate part dimensions.

Drawings may be dimensioned in decimals or fractions. This is especially true in reference to tolerances. Many firms, instead of using plus and minus signs for tolerances, give the complete dimension for both tolerances. For example, if a dimension is 2 inches with a plus or minus tolerance of 0.01, the drawing would show the total dimensions as: $\frac{2.01}{1.99}$. A print tolerance (usually found in the title block) is a general tolerance that can be applied to parts where the dimensions are noncritical. Where a tolerance is not shown on a dimension line, the print tolerance applies.

To complete the reading of a drawing, read the general notes and the contents of the material block, check and find the various changes incorporated, and read the special information given in or near views and sections.

DIAGRAMS

A diagram may be defined as a graphic representation of an assembly or system, indicating the various parts and expressing the methods or principles of operation.

There are many types of diagrams; however, those with which the aviation mechanic will be concerned during the performance of his job may be grouped into two classes or types— installation diagrams and schematic diagrams.

Installation Diagrams

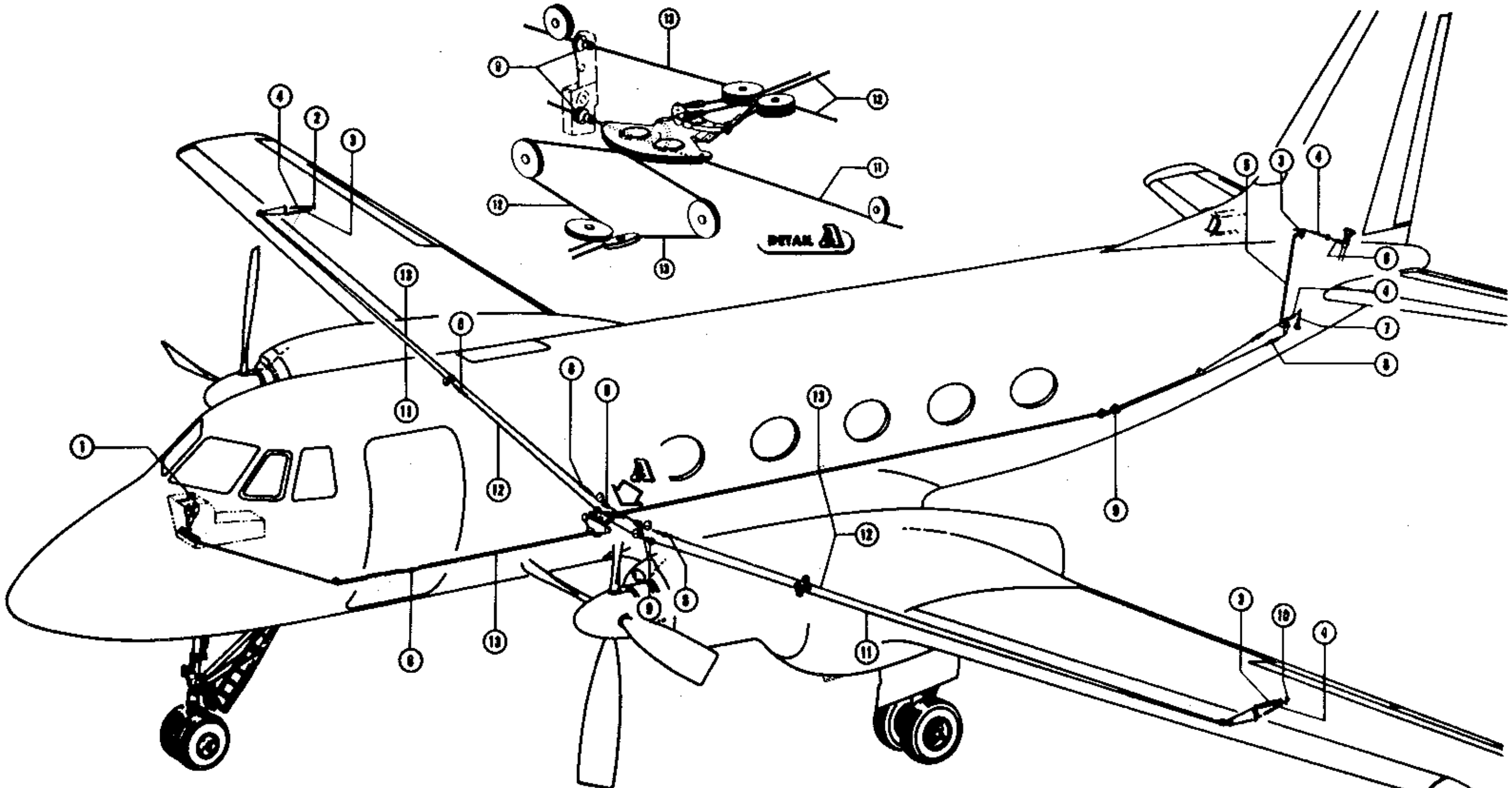
Figure 2–19 is an example of an installation diagram. This is a diagram of the gust lock systems of an aircraft. It identifies each of the components in the systems and shows their location in the aircraft. Each letter (A, B, C, etc.) on the principal view refers to a detail view located elsewhere on the diagram. Each detail view is an enlarged drawing of a portion of a system. The numbers on the various views are referred to as call outs, and serve to identify each component.

Installation diagrams are used extensively in aircraft maintenance and repair manuals and are invaluable in identifying and locating components and understanding the operation of various systems.

Schematic Diagram

Schematic diagrams do not indicate the location of individual components in the aircraft, but do locate components with respect to each other within the system. Figure 2–20 illustrates a schematic diagram of an aircraft hydraulic system. The hydraulic pressure gage is not necessarily located above the landing gear selector valve in the aircraft; however, it is connected to the pressure line that leads to the selector valve.

Schematic diagrams of this type are used mainly in trouble-shooting. Note that each line is coded



1. Gust lock handle
2. Right aileron latch
3. Retracting springs (3)
4. Spring bungee
5. Push Rod
6. Rudder latch
7. Elevator latch
8. Turnbuckles
9. Seals
10. Left aileron
11. Tie cable
12. Lock cable
13. Unlock cable

FIGURE 2–19. Example of installation diagram (gust lock system).

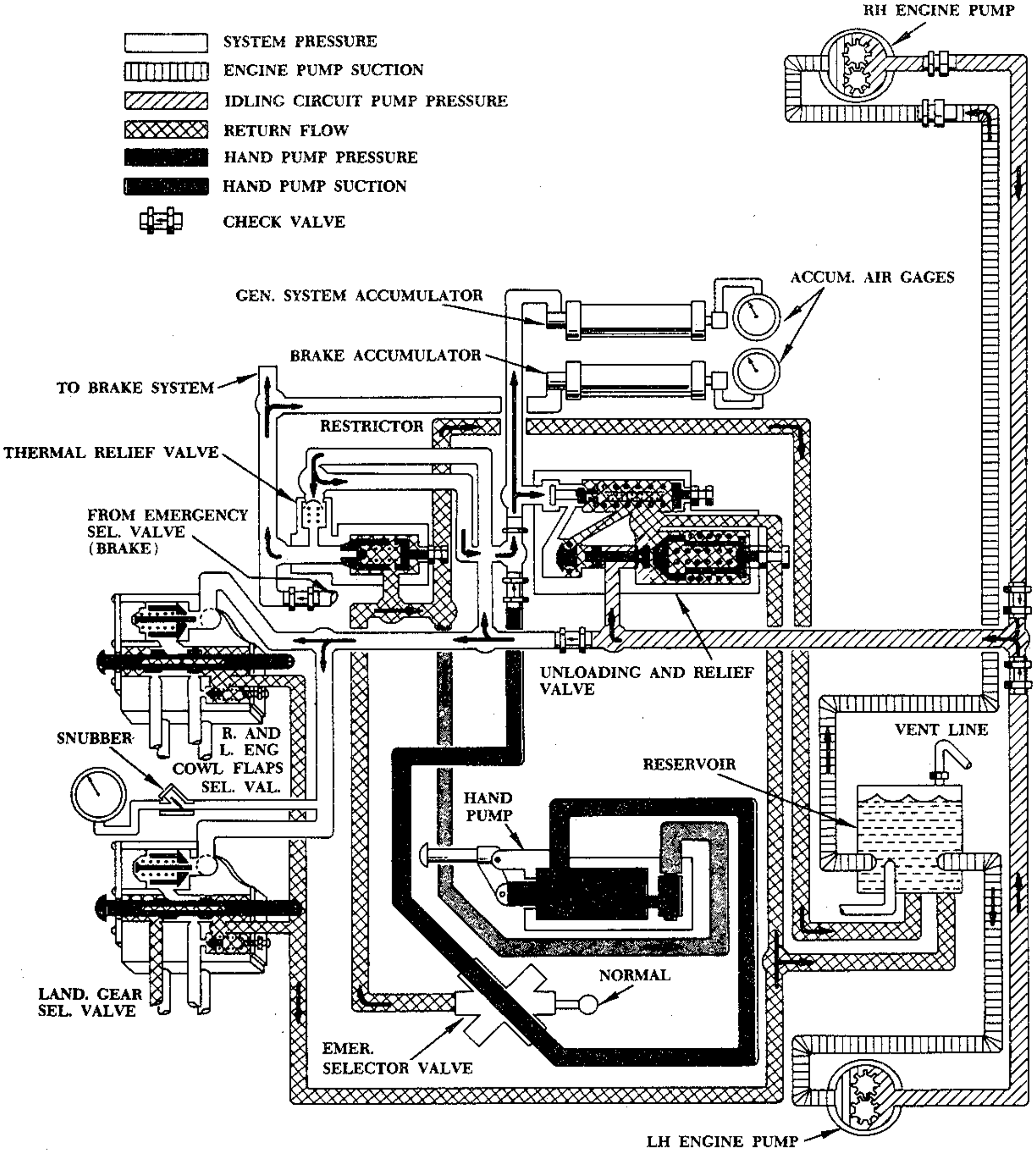


FIGURE 2–20. Aircraft hydraulic system schematic.

for ease of reading and tracing the flow. Each component is identified by name, and its location within the system can be ascertained by noting the lines that lead into and out of the unit.

In tracing the flow of fluid through the system, it can be seen that the engine-driven pumps receive a supply of fluid from the reservoir. One-way check valves are installed in both left and right pump pressure lines so that failure of one pump will not render the pressure from the other pump ineffective. Fluid flows to the relief side of the unloading and relief valve, and through the check valve, which will hold pressure built up beyond this point. Pressure is then directed through all lines leading to each selector valve, where it is checked if no units are being operated.

Pressure builds up in the line routed to the control port of the unloading valve and begins to

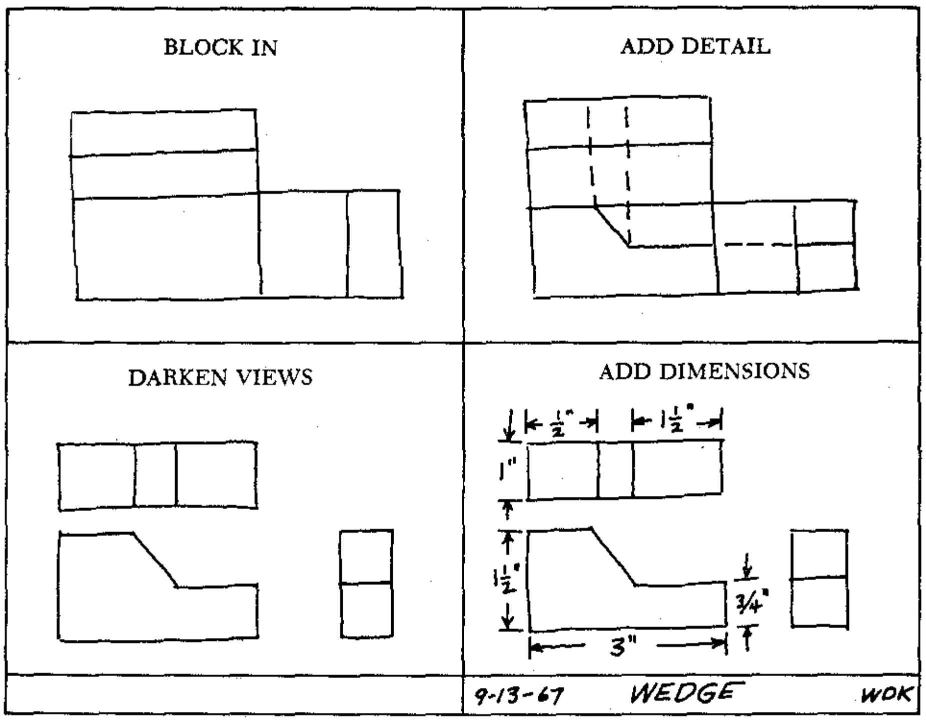


FIGURE 2–21. Steps in sketching.

charge the system accumulator. Pressure to charge the brake accumulator is routed through a check valve incorporated in the thermal relief valve; this prevents the pressure from returning to the general system.

Although the general system accumulator starts charging at the same time, it will not charge as fast, because the fluid passes through a restrictor valve. The general system pressure will bleed into the brake system whenever the brake pressure drops below system pressure.

As soon as the pressure reaches the relief valve setting, the valve will open slightly. General system pressure increases until it reaches the value established as the system operating pressure. At this point, through the line leading to the control part of the unloading valve, the pressure will force the unloading and relief valve completely open. The pressure trapped in the system by the one-way check valve holds the value open to create an idling circuit, which prevails until some unit of the hydraulic system is operated.

Schematic diagrams, like installation diagrams, are used extensively in aircraft manuals.

DRAWING SKETCHES

A sketch is a simple, rough drawing that is made rapidly and without much detail. Sketches may take many forms—from a simple pictorial presentation to a multiview orthographic projection.

A sketch is frequently drawn for use in manufacturing a replacement part. Such a sketch must provide all necessary information to those persons who must manufacture the part.

A mechanic need not be an accomplished artist. However, in many situations, he will need to prepare a drawing to present an idea for a new design, a modification, or a repair method. The medium of sketching is an excellent way of accomplishing this.

The rules and conventional practices for making mechanical drawings are followed to the extent that all views needed to portray an object accurately are shown in their proper relationship. It is also necessary to observe the rules for correct line use (figures 2–15 and 2–16) and dimensioning.

To make a sketch, first determine what views are necessary to portray the object; then block in the views, using light construction lines. Next, complete the details, darken the object outline, and sketch extension and dimension lines. Complete the drawing by adding notes, dimensions, title, date and, when necessary, the sketcher's name. The steps in making a sketch of an object are illustrated in figure 2–21.

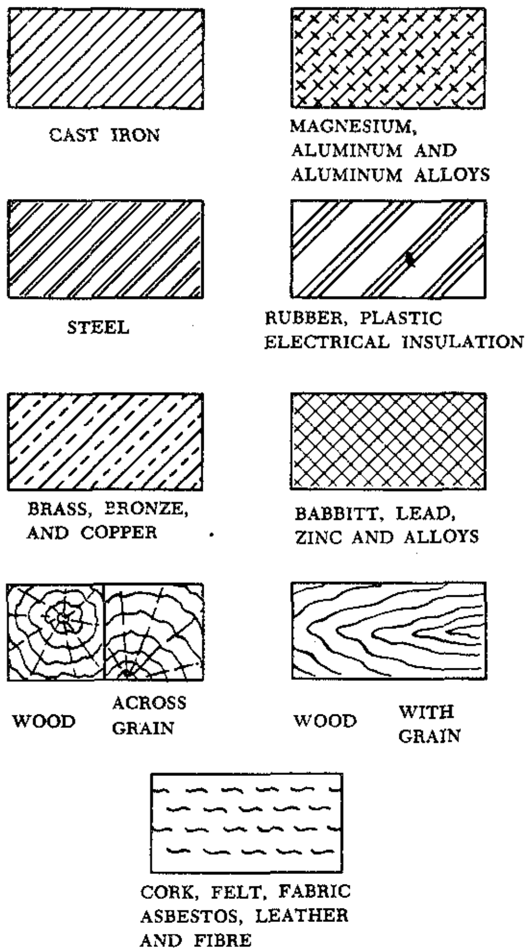


FIGURE 2-22. Material symbols.

The degree to which a sketch is complete will depend on its intended use. Obviously, a sketch used only to represent an object pictorially need not be dimensioned. If a part is to be manufactured from the sketch, it should show all the necessary construction details.

DRAWING SYMBOLS

The drawings for a component are composed largely of symbols and conventions representing its shape and material. Symbols are the shorthand of drawing. They graphically portray the characteristics of a component, with a minimum amount of drawing.

Material Symbols

Section-line symbols show the kind of material from which the part is to be constructed. The material may not be indicated symbolically when its exact specification must also be shown elsewhere on the drawing. In this case, the more easily drawn symbol for cast iron is used for the sectioning, and the material specification is listed in the bill of materials or indicated in a note. Figure 2-22 illustrates a few standard material symbols.

Shape Symbols

Symbols can be used to excellent advantage, when it is desired to show the shape of an object. Typical shape symbols used on aircraft drawings are shown in figure 2-23. Shape symbols are usually shown on a drawing as a revolved or removed section.

Electrical Symbols

Electrical symbols (figure 2-24) represent various electrical devices rather than an actual drawing of the units. Having learned what the various symbols indicate, it becomes relatively simple to look at an electrical diagram and determine what each unit is, what function it serves, and how it is connected in the system.

CARE OF DRAFTING INSTRUMENTS

Good drawing instruments are expensive precision tools. Reasonable care given to them during their use and storage will prolong their service life.

T-squares, triangles, and scales should not be used, or placed, where their surfaces or edges may be damaged. Use a drawing board only for its intended purpose, and not in a manner that will mar the working surface.

Compasses, dividers, and pens will provide better results with less annoyance, if they are correctly shaped and sharpened, and they are not damaged by careless handling.

Store drawing instruments in a place where they are not likely to be damaged by contact with other tools or equipment. Protect compass and divider points by inserting them into a piece of soft rubber or similar material. Never store ink pens without first cleaning and drying them thoroughly.

MICROFILM

The practice of recording drawings, parts catalogs, and maintenance and overhaul manuals on microfilms was introduced in recent years. Microfilm is regular 16-mm. or 35-mm. film. Since 35-mm. film is larger, it provides a better reproduction of drawings. Depending on the size of

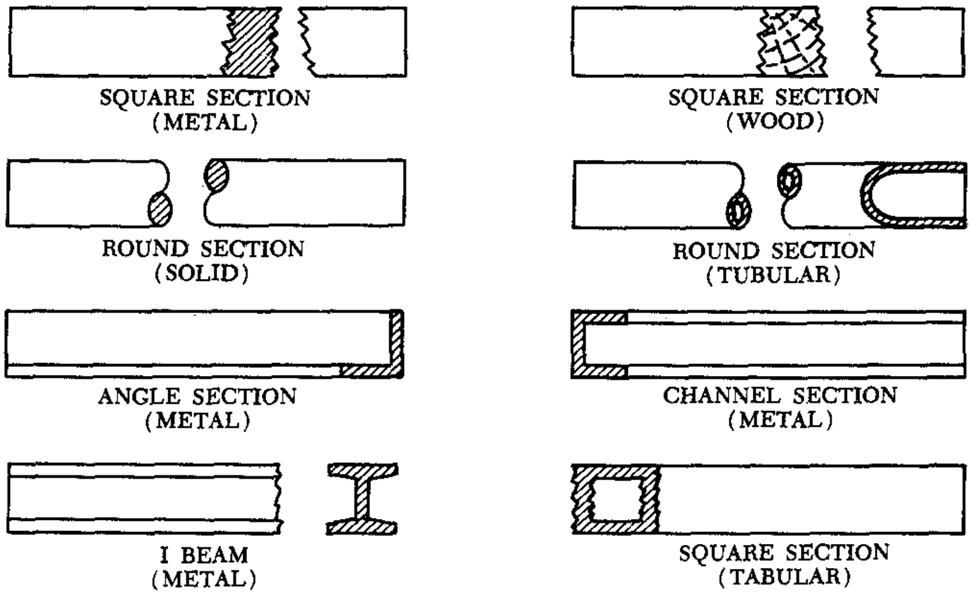


FIGURE 2–23. Shape symbols.

the drawing to be reproduced, a varying number of drawings can be photographed on one reel of 35-mm. film. To view or read drawings or manuals on a reel of film, you need either a portable 35-mm. film projector or a microfilm reader or viewer.

The advantage of microfilm is that several reels, which represent perhaps hundreds of drawings, require only a small amount of storage space. Too, a person working on an aircraft may need to refer to a specific dimension. He can place the reel of microfilm in a projector, locate the drawing or desired information, and read the dimension. If he has to study a detail of the drawing, or work with the drawing for a long period of time, an enlarged photographic reproduction can be made, using the microfilm as a negative.

Microfilm of drawings has many other uses and advantages. However, microfilm is not intended to replace the need for original drawings, especially where the originals are modified and kept current over a long period of time.

When drawings are filmed on continuous reels, corrections can be made by cutting out superseded drawings and splicing in the revised ones. When these corrections become numerous, the procedure becomes impractical and is discarded in favor of again filming all the related drawings.

A method that allows corrections to be made easily is to photograph the drawings and then cut up the film into individual slides. This has one disadvantage; it requires considerable time to convert the film into slides, insert them into transparent protective envelopes, and arrange them in sequence so that desired drawings can be located quickly.

A 70-mm. microfilm has become available very recently. With it, larger size drawings can be reproduced as individual frames or slides, and these can be inserted in regular paper envelopes and kept in an ordinary file. When held to the light, this large microfilm can be read with the naked eye.

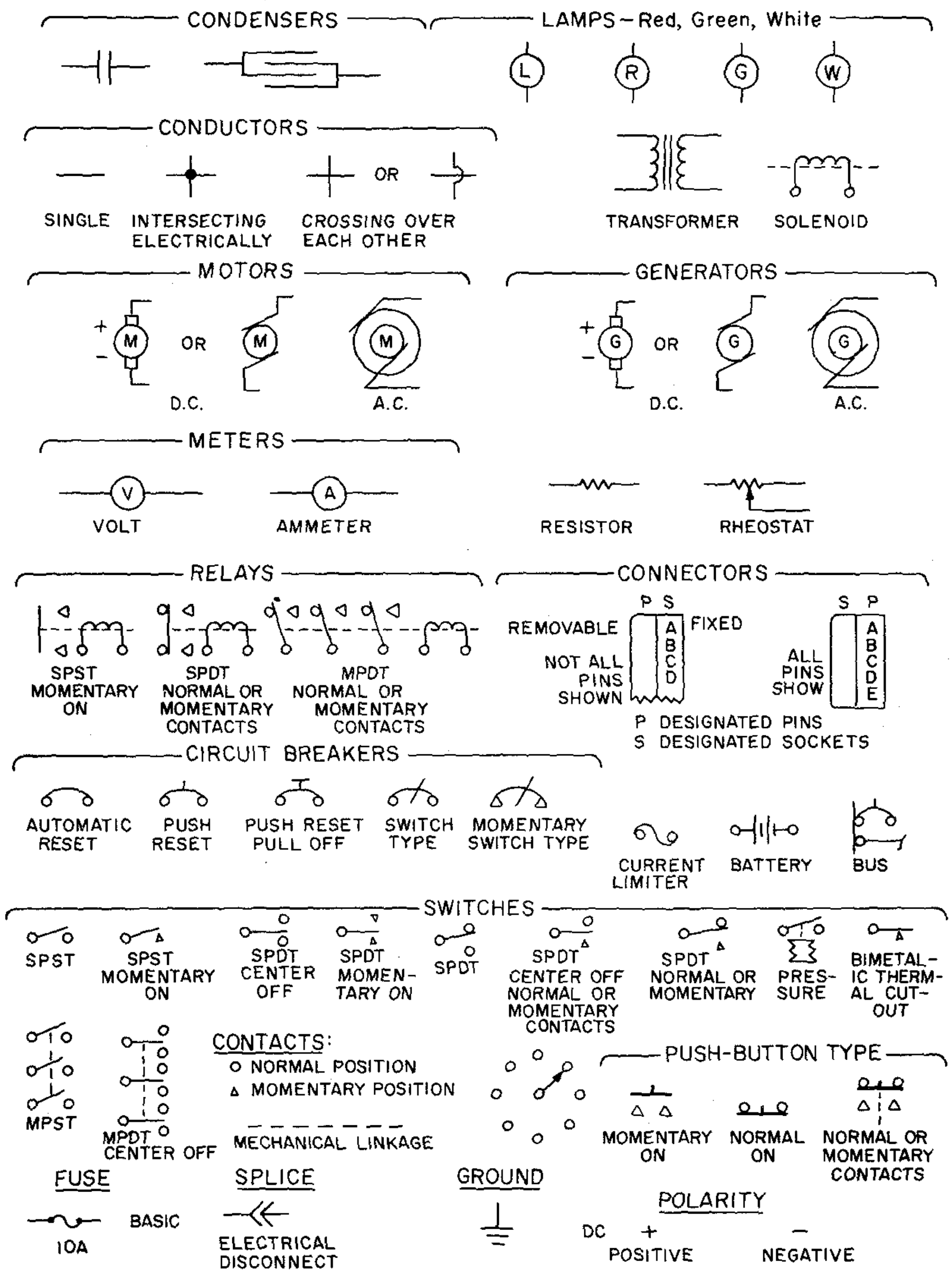


FIGURE 2–24. Electrical symbols.