ILLUSTRATING

FOR TOMORROW'S

PRODUCTION

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PREFACE

WHAT the world will be like tomorrow has been the concern of the social worker and the church, military and political leaders, manufacturers and financiers, industrial stylists, and artist-illustrators. Almost all have had specific dreams about what they would like to see developed, perfected, and originated in the days to come, but it is the illustrator who has made those dreams into pictorial representations which the man on State Street could understand and appreciate. It is, of course, a fact that today's world differs vastly from that of our grandfathers. Today foreshadows tomorrow, and tomorrow foreshadows the days and years to follow. But in this world of the present there must be thoughts and plans for the future.

It is with thoughts of *things to come* that ILLUSTRATING FOR TOMORROW'S PRODUCTION came to be written. Every drawing produced in the engineering drafting room, and every specification for newly designed items which can be put into assembly line production is a glimpse of tomorrow's business. So, in an effort to present a procedure for making essential illustrations for industrial production, this book has been prepared. It began with a series of elementary and advanced production illustration courses which were taught by the authors under the auspices of The University of Texas War Training Program. Therefore, it is fitting that thanks be given here to the University of Texas, which gave such splendid cooperation to these courses, and to those students who were, knowingly and unknowingly, "guinea pigs" for the experimentation and development of many short cuts for making perspective production illustrations.

ILLUSTRATING FOR TOMORROW'S PRODUCTION is presented in such a way as to make it a ready source of information and reference to both the layman and the illustrator.

J. H. Farmer
A. J. Hoecker
F. F. Vavrin

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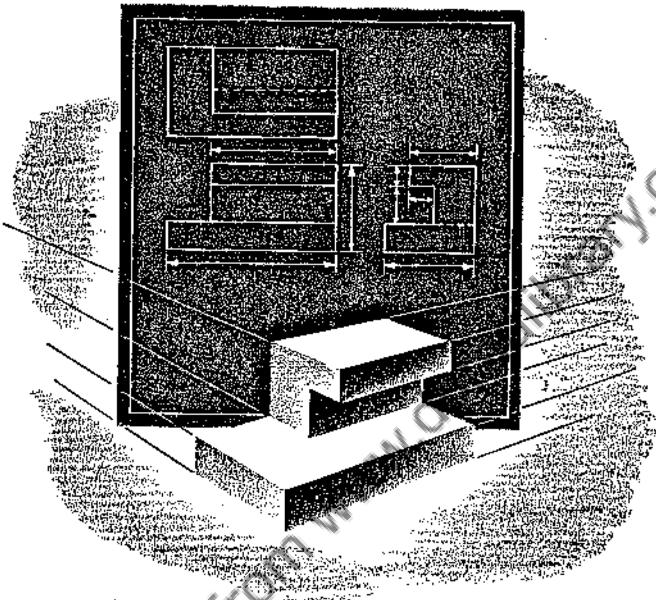
PART ONE
Preliminary to Production Illustration

Chapter 1 THE PURPOSE OF PRODUCTION ILLUSTRATION



PRODUCTION ILLUSTRATORS and artists are steadily becoming *indispensable* to modern manufacturing and industry. This is especially true today because of the rapidity of production. The talent and work of the industrial artist and the production illustrator have done their immeasurable share towards expediting production.

Thanks to the demands of industrial manufacturers, whose production and assembly lines mushroomed into existence almost over night with the advent of World War II, the illustrator was given the opportunity to combine technical data and artistic conception into a pictorial representation of the job at hand. That job was terrific! Although production illustration includes a variety of smaller tasks, the illustrator of today must be able to make accurate perspective drawings to scale and must be capable of making all kinds of drawings, sketches, and renderings. Production illustrations are of importance in industry where blueprints are extremely complicated and often difficult to interpret. For example, companies that manufacture electric switches, pumps, motor units, hydraulic equipment, radio equipment, instruments, and countless other more complicated articles may require pictorial drawings to help the assembly-line worker to understand the blueprints.

Because production illustration and pictorial representation of manufactured products is of such paramount importance, most industrial establishments have found it necessary to set up a well-organized production illustration department with various well-defined subdivisions. Usually such a department is headed by the production engineers of the company with a number of closely related groups such as the break-

FIGURE 1

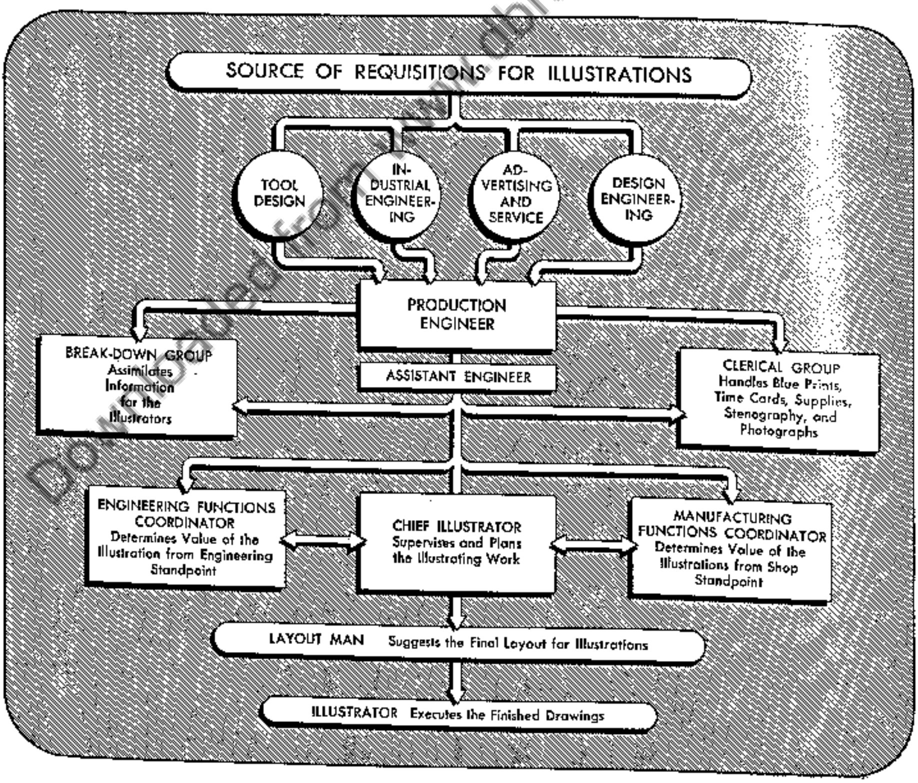
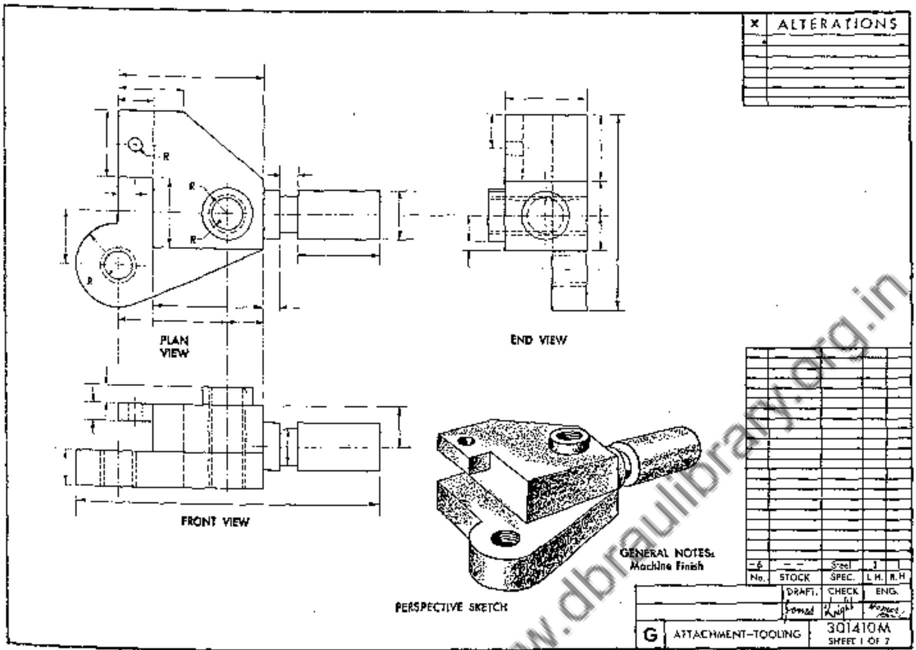


FIGURE 2



down group, the clerical group, the **engineering functions coordinator,** the **manufacturing functions coordinator,** the **chief illustrator,** the **lay-out man,** and the **illustrators.** See Fig. 1 for organization chart.

Let us now consider briefly the various types of work done by the illustrator in such an organization. First is the *Parts Catalog.* This is a pictorial representation of the entire stock of parts manufactured by the company for whom the catalog is being compiled. It is generally used as a replacement guide for repair of worn and broken parts of some unit manufactured by that particular company. Next is the *Structural Repair Manual* which is used as a guide for the repairing of structures which have been demolished or damaged. Then comes the *Erection and Maintenance Manual* which includes diagrams, retouched photographs, cross-section views and schematics. A *schematic* is a drawing which shows the location and routing of some specific system such as the deicing system of the Lockheed Constellation as illustrated by Fig. 141, Chapter 14. *Service Bulletins* and *Handbooks* are also compiled in the production illustration department for release to an agent, or buyer, of the manufactured product when such product is in use at some locality remote from the factory and when local company servicing cannot be maintained.

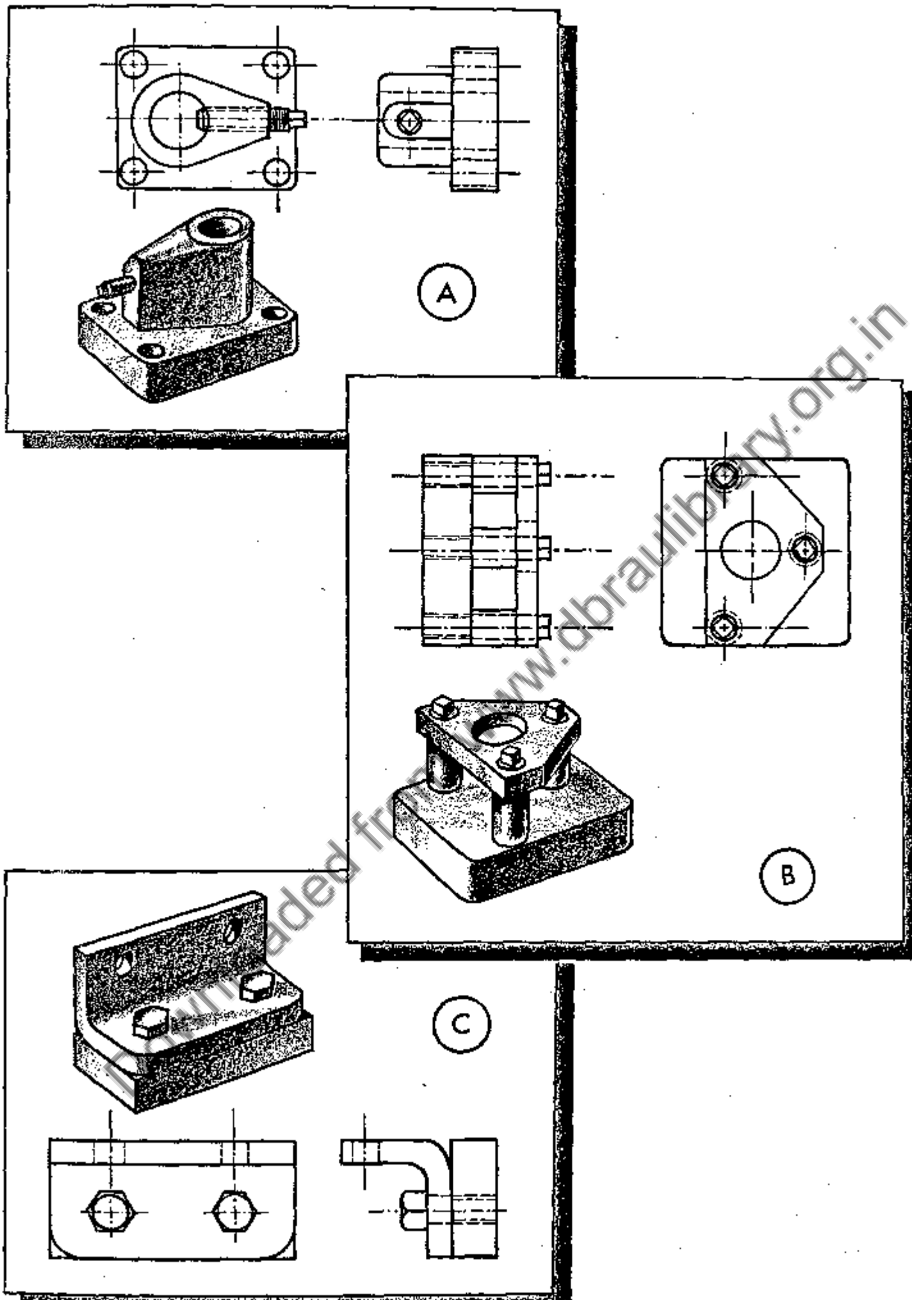
These bulletins, manuals, catalogs, and handbooks are a recognized part of almost every production illustration department in industry. However, there still remains a very important phase that must be considered and recognized if illustrating for tomorrow's production is to reach its maximum value to the manufacturer. Most engineering drafting is done by standard drafting methods which pertain to orthographic projection; that is to say, three or more views, drawn in detail with dimensions, are shown for each object. These views generally include the **top view, front view,** and **end,** or **side, view.** However, if the object is simple, fewer than three views may be required, whereas if the object is extremely complicated it is often difficult to interpret with three views. Sometimes complicated objects may require four or more views. But if a pictorial rendering of that object is shown in a section of the blueprint which sets forth the dimensions, interpretation of the orthographic drawing can readily be visualized.

Suppose an executive of a company wishes to suggest certain changes to the production engineer. They could be understood easily if pictorial sketches accompanied the drawing. Also, in discussing proposals of new designs with the sales staff or some other manufacturing concern, a thorough understanding can be obtained quickly by such a method. And in addition, innumerable hours of conversation may be eliminated where time is needed for more significant interviews with buyers of the company's product. A typical blueprint showing three views of a tooling attachment is shown in Fig. 2, and additional drawings with accompanying pictorial sketches are shown in Figs. 3 and 4.

To make pictorial sketches for blueprint reproduction, drawings are made on tracing, or layout, paper. The illustrator should first consider the details and the over-all dimensions of the object to be drawn, as indicated by the letters shown in the upper part of Fig. 5.

In the next step the illustrator draws the over-all dimensions of the object using the mechanical perspective method shown in Chapter 3. Note in the lower part of Fig. 5 that the sides on which appear the two threaded ends and the round cover plate (indicated by check marks in

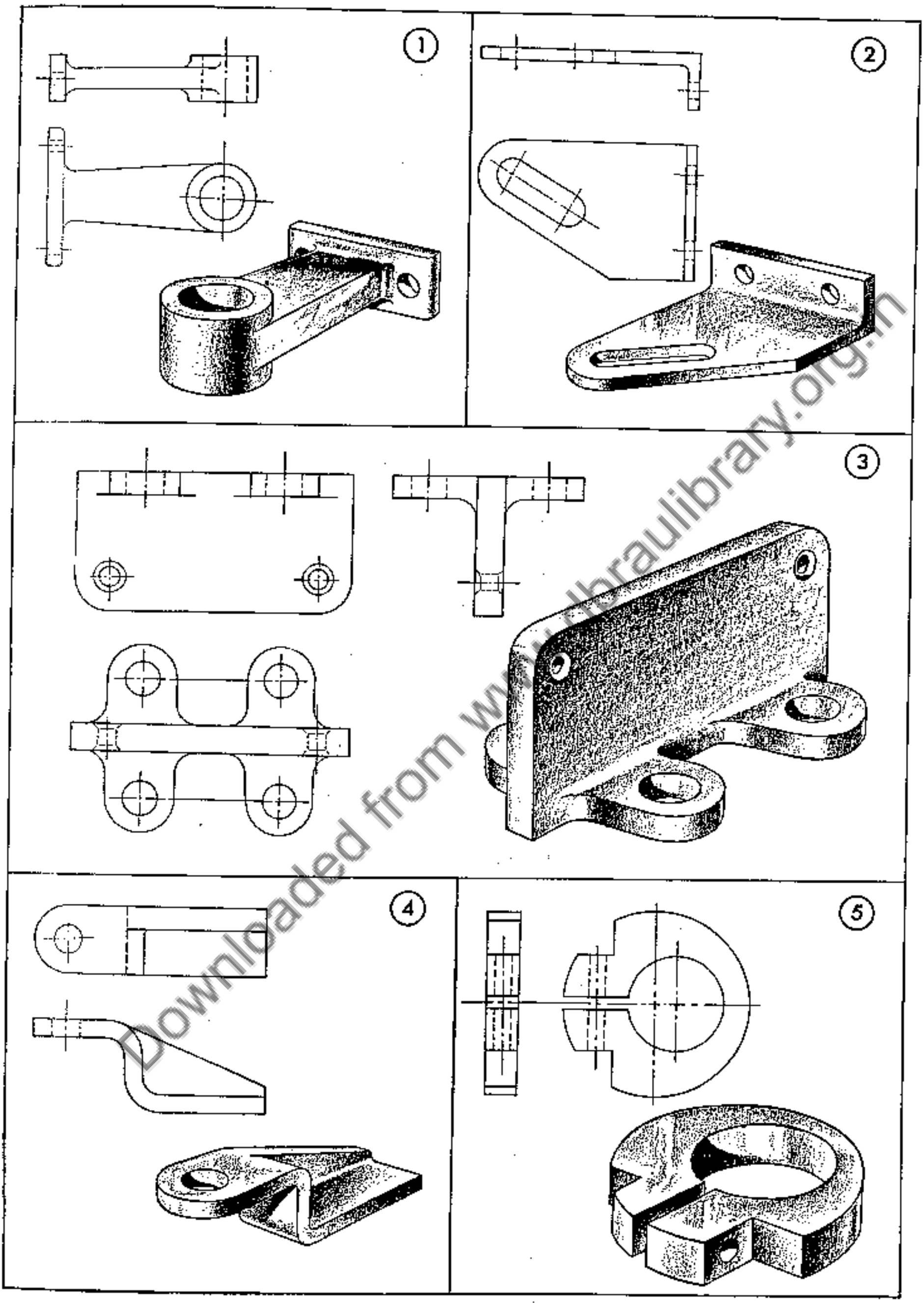
FIGURE 3

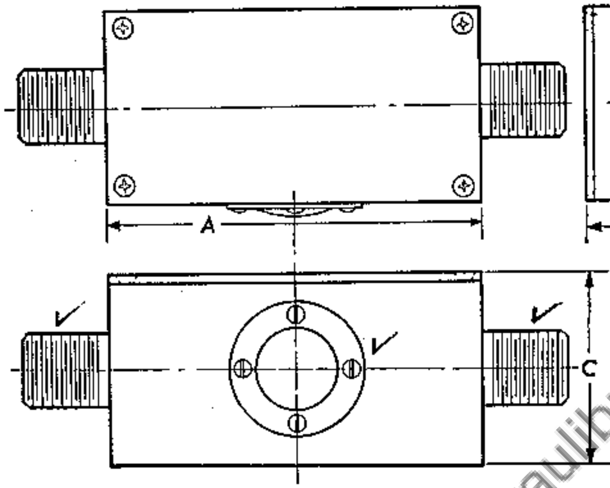


drawing) have been bisected to locate their centers, and are shown in blue lines. The illustrator is now ready to add details of the top cover plate, the round cover plate (on the front), and the two threaded ends. These details can be drawn freehand since the main directions of the vanishing points have already been established and there are enough reference lines to serve as guides. Once these details have been added, the illustrator places the sketch under the layout paper or cloth on which the drawing for blueprinting is to be made, and traces the third-dimensional sketch. Finally, the perspective of the object may be left in **outline** as shown in the upper part of Fig. 6, or shaded if desired as shown in the lower part of Fig. 6. (A blueprint will show in reverse the shadows on the tracing.)

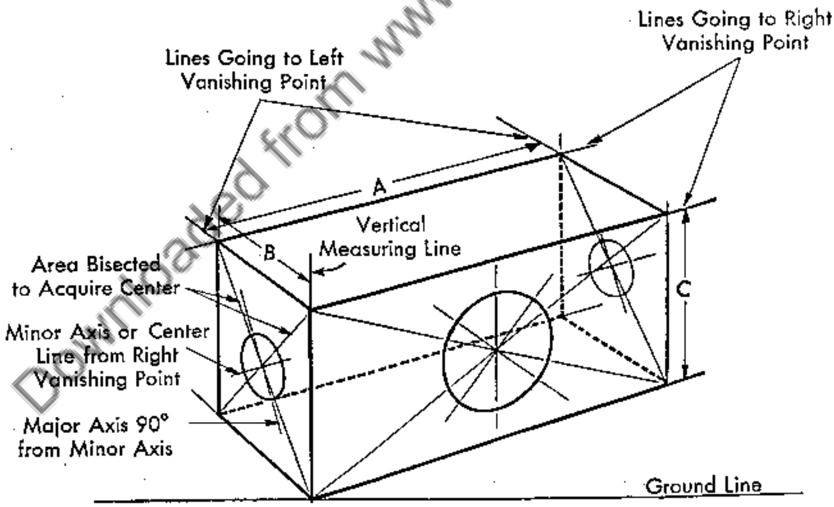
Often retouched photographs are used in the same manner as the pictorial drawing which occurs in a section of the blueprint. When photographs are used they are pasted to a blue line or Vandyke print, rather than reproduced on the print. The photograph therefore appears in black and white and is easily visualized by the workman. This method of pictorial representation, as shown in Fig. 7, is employed by the Bell Aircraft Corporation, Buffalo, New York; it has been very satisfactory in expediting production.

Besides the third-dimensional drawings and the photographs accompanying the prints there is one other method of expediting production, as shown in Fig. 8. This method employs photographs in loose-leaf booklet form to illustrate the sequence of operation and assembly.

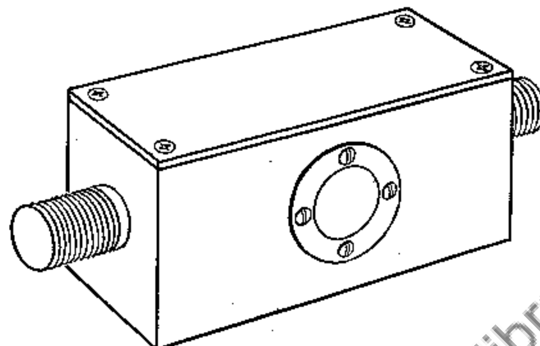

1
2
3
4
5



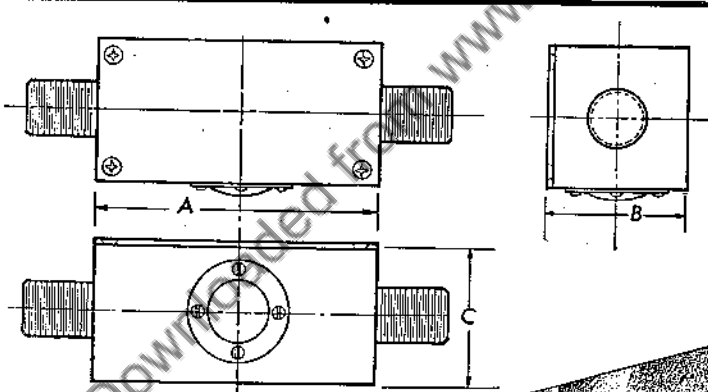
1. Example of a three view drawing that will be drawn in perspective and incorporated on blue print to help visualize the shape of the object.

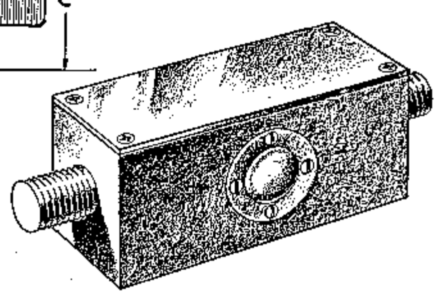


2. In this preliminary stage of a perspective drawing, we eliminated the vanishing points to enlarge the object and keep near the size of the three view drawing shown above. See the explanation of this method of perspective drawing as explained in Chapter Three.



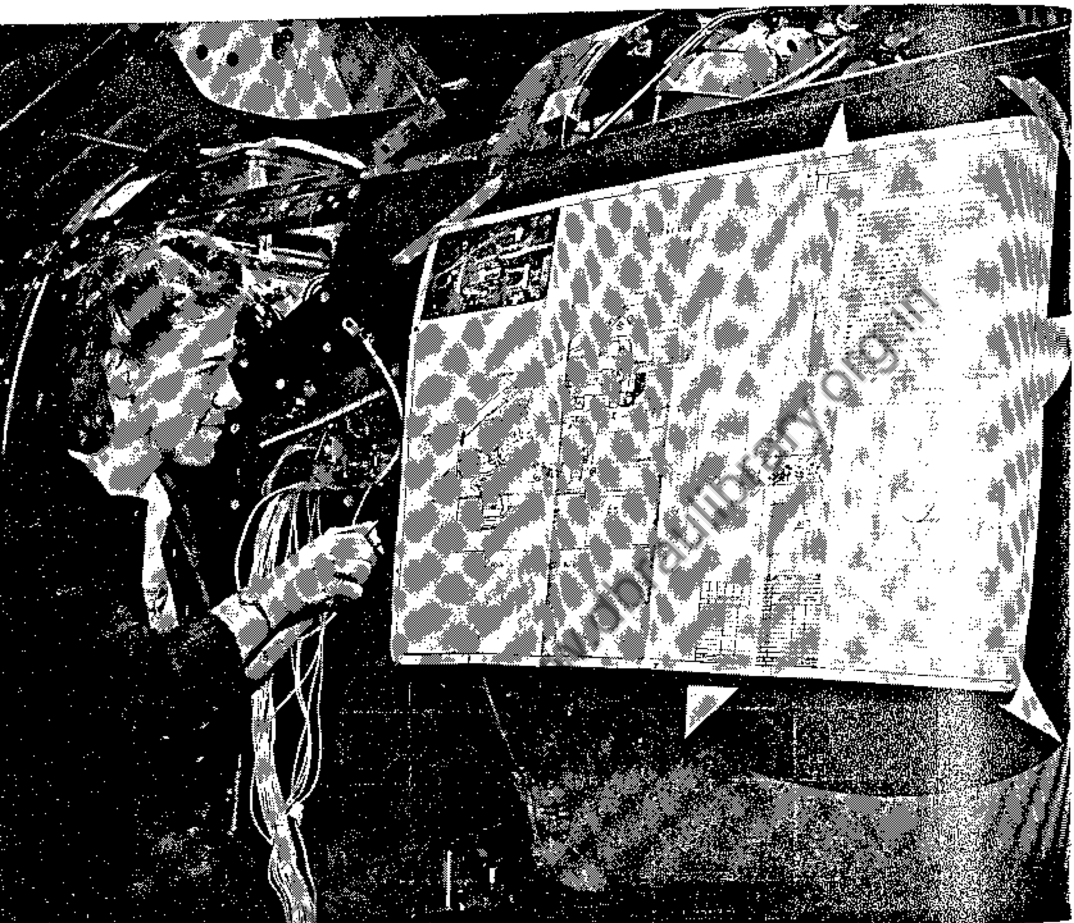
This drawing shows the object in perspective with construction lines erased. The next step is to shade (if desired) and incorporate it on the finished blueprint as shown below.





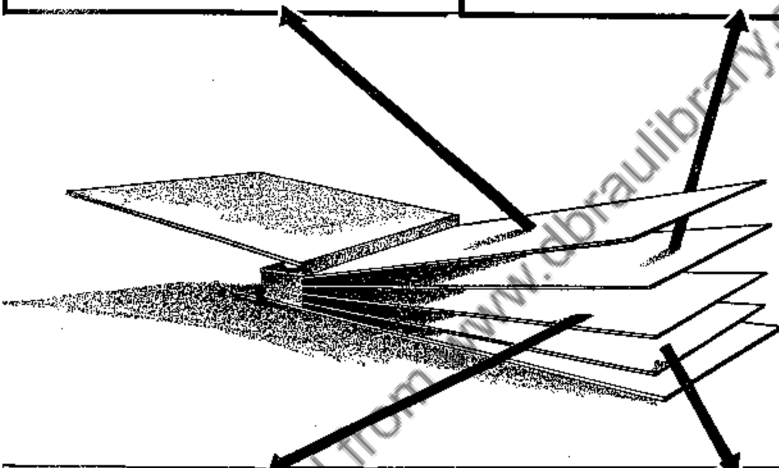
This example shows the three view drawing and the third dimensional drawing combined.

FIGURE 7



35. Insert T pins through door jamb detail to secure aft end of forward frame on L/R side.

36. Tighten C clamps at aft end of frame on L/R side to hold in position.

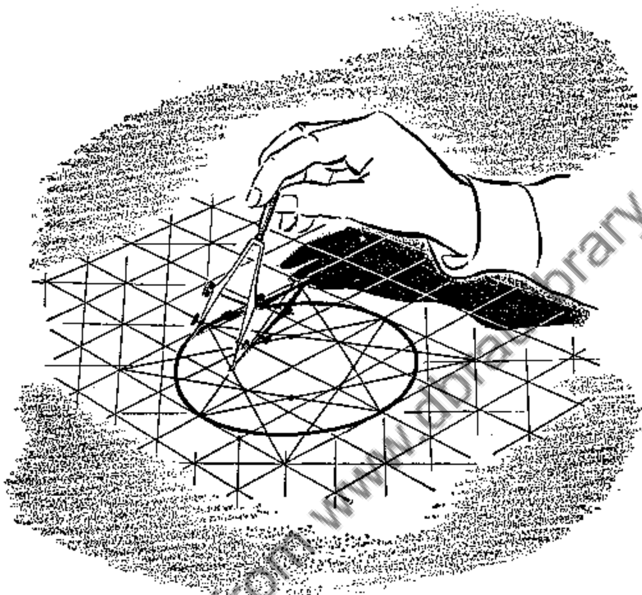


37. Position gun sight detail on camel back as additional support for forward frame.

38. Tighten C clamps at front end of forward frame on L/R sides.

Examples of visual training illustrations that have been disassembled from booklet #2 showing a part of the sequence of assembly for the P 39 cabin and issued to shop leadman by Visual Training Department, Bell Aircraft Corporation, Buffalo, N.Y.

Chapter 2 ISOMETRIC AND OBLIQUE DRAWING



THE FUNDAMENTAL PRINCIPLES of orthographic projection should be well understood before one attempts to draw an isometric or oblique drawing.

Orthographic drawings, sometimes called working drawings, are used to describe the shape of an object; by a system of marking and dimensioning they show specific over-all sizes and distances for locations of center lines for holes, size of holes, angles, and any finishes desired. For example, let us suppose that a rectangular solid, as shown in part A of Fig. 9, is placed within a transparent box, the surfaces of which are called the *top view plane*, the *front view plane*, and the *end view plane*. Then, projecting perpendicularly from the object, as illustrated by part B of Fig. 9, the various sides of the object can be established in their respective planes. After the top view, front view, and end view of the object have been projected, we may then assume that the transparent box is hinged between points *RS* and *ST*, as shown in part C.

If the top view plane and end view plane are each revolved 90 degrees, the resulting picture then lies in a single plane. Part D of Fig. 9 shows an orthographic drawing of the rectangular solid.

If we have two views of an object and need to complete another view, this is easily done in any one of several accepted ways. For example, if we have the top view and front view, the right end view may be found by drawing a line *UT*, Fig. 10, part A, perpendicular to the bottom of the picture plane. This line may be any distance from the object and any length beyond the top and bottom of the top view and front view. A second line *RW* is drawn parallel to the bottom of the picture plane and anywhere between the top view and front view. Where the lines *UT* and *RW* cross, we have a point *S*. Each plane of the front view is then projected to the right in light construction lines passing across *UT* and extending about the same distance to the right of *UT* as the distance *SU*. The planes of the top view are projected to the right to the line *US*. From this point, there are several methods of continuing, parts B, C, D.

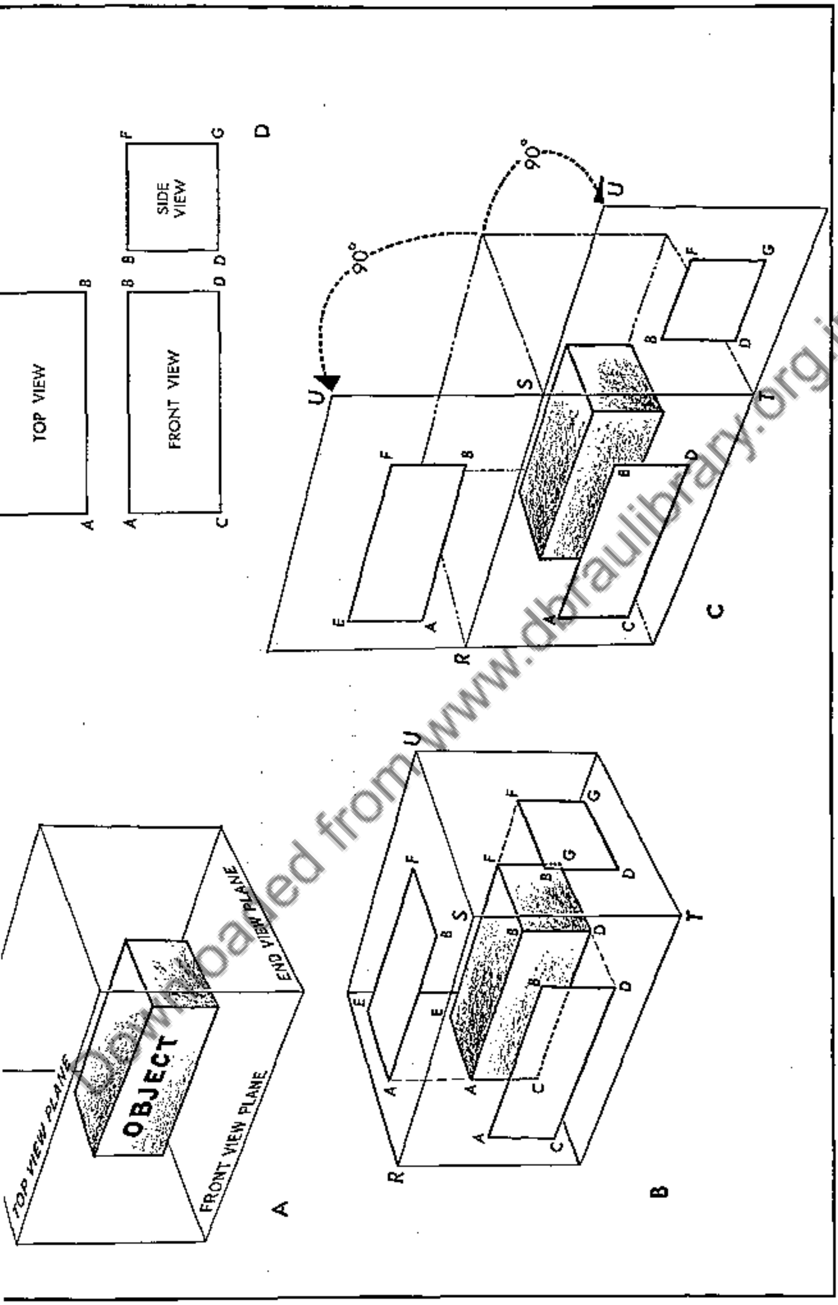
Part B is completed by constructing 45-degree angles from the points of intersection of the top view lines and line *US*. At the points at intersection of these lines and line *SW*, lines parallel to *UST* are constructed (these lines will be perpendicular to the bottom of the picture plane). The points 1, 2, 3, 4 formed by these lines and the line extended from the front view form the main corner points for the object.

Part C is completed in the same manner as part B, but in place of the 45-degree angle from the points of intersection, a series of arcs with a common center at *S* is used.

Part D is preferred because there are fewer changes in directions of lines, and therefore fewer chances for error.

If the top view and end view are known, the front view may be found by projecting the points in the views to form the corresponding point for the front view; likewise the top view may be formed from the front view and right or left side view.

The same procedure holds true for irregular-shaped objects; how-


TOP VIEW PLANE
OBJECT
FRONT VIEW PLANE
END VIEW PLANE
A
B
C
TOP VIEW
FRONT VIEW
SIDE VIEW
D
90°
90°

ever, there may be need for additional points to be projected from the known views to establish them on the unknown view, but these points are projected one at a time in exactly the same manner, Fig. 10, part E. For a more thorough treatment of orthographic projection, refer to any good mechanical drawing book.

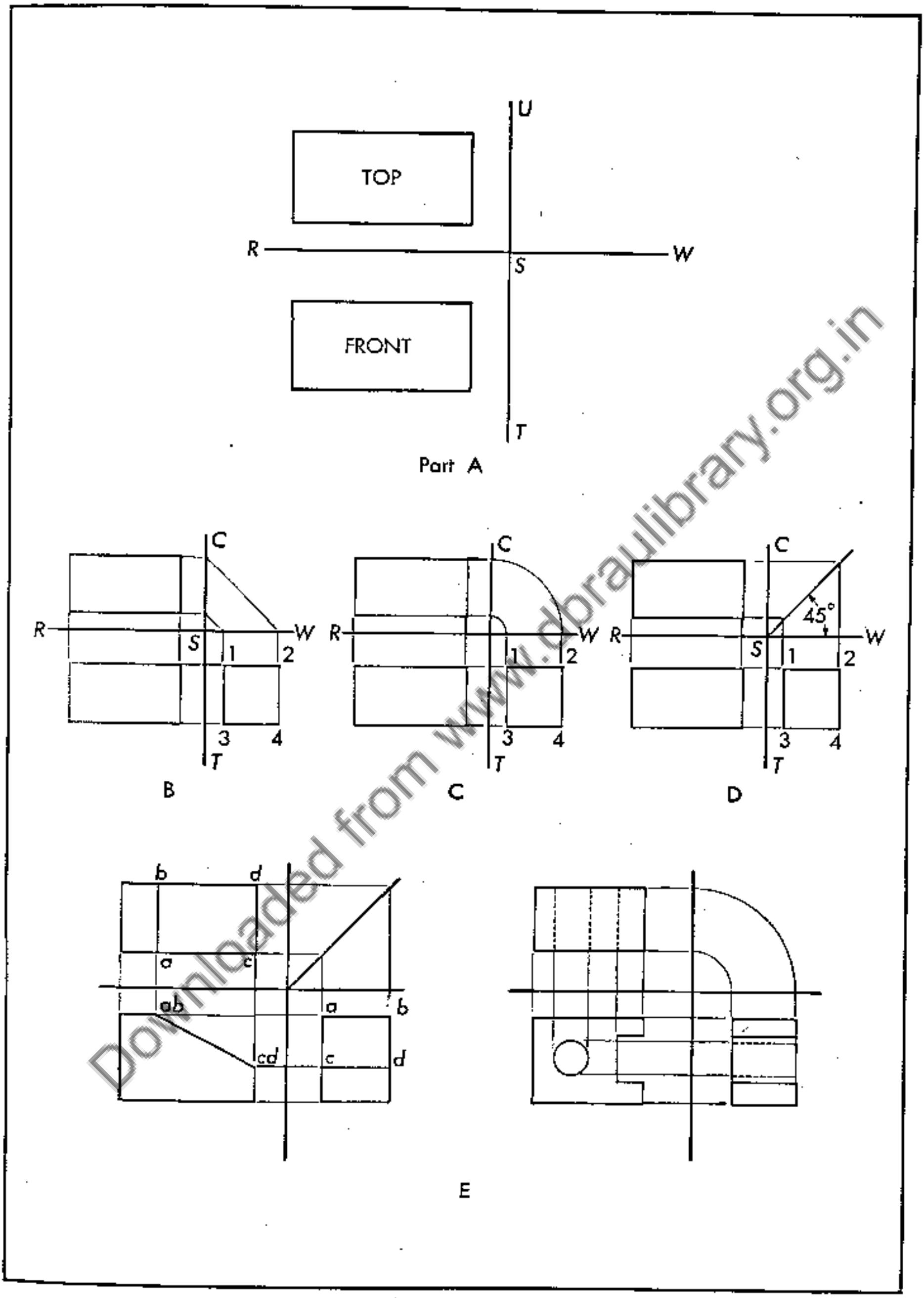
ISOMETRIC DRAWING

A. Isometric projection

An isometric drawing is a simple mechanical method for projecting a pictorial drawing, in third dimension, of an orthographic drawing with axes which are equal-angle with the plane of projection.

Revolve the plane of projection into its true front view as illustrated by part A, Fig. 11, and continue the diagonal line *RS* across the plane of projection. (*RS* will be the edge view of the body diagonal. Construct a perpendicular down this projected line at point *T*, which is placed near the center of the picture plane, in this case, and is placed according to the shape of the object to be drawn. If the right end view is longer than the front view, point *T* is placed nearer the left-hand side of the picture plane; likewise, if the front is longer than the right end view, point *T* is placed nearer the right side of the picture plane. From point *T* construct to the left and to the right an angle of 30 degrees above extended line *RS*. The angles formed by these lines and the perpendicular dropped from *T* will be 120 degrees and form what are known as the *isometric* axes.

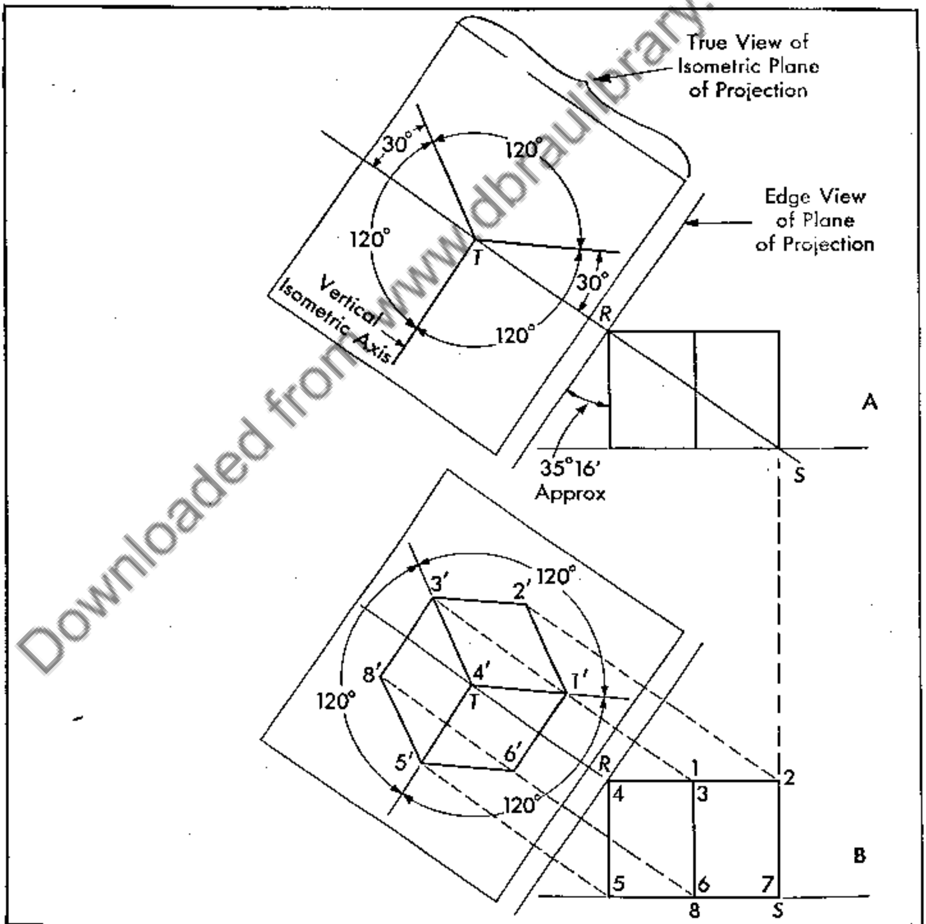
Project points *1–3* and *5* parallel to *RS* as shown in part B, Fig. 11, until they cross the three lines of the isometric axes, thus locating the points *1′*, *3′*, and *5′* on the isometric axes. From points *3′* and *5′* construct angles of 30 degrees to the right, parallel to the right side of the isometric axes. From *1′* and *5′* construct angles of 30 degrees to the left, parallel to the left side of the isometric axes. From points 2, 4, and 6–8 draw lines parallel to *RS*. Point *2′* is formed where the lines from *1′* and *3′* intersect. Point *2′* should fall on the line from point 2 drawn parallel to line *RS*. From *3′* and *1′* draw lines parallel to *T-5′*. Point *8′* is formed where the lines from *3′* and *5′* intersect. Point *6′* is formed where the lines from *1′* and *5′* intersect. Points *8′* and *6′* should fall on


U
TOP
R
W
S
FRONT
T
Part A
C
R
W
S
1
2
3
4
T
B
C
R
W
1
2
3
4
T
C
C
45°
R
W
S
1
2
3
4
T
D
b
d
a
c
ab
a
b
cd
c
d
E

the line from point 8–6 drawn parallel to line *RS*. This isometric projection is true in shape but with foreshortened sides, or approximately 82 per cent full size.

The vertical isometric axis is parallel to the edge view of plane of projection (see A, Fig. 11). The angle formed by the plane of projection and the vertical axis of the object which touches the plane of projection at point *R* is found to be approximately 35°16′. When lines are projected through any point on the object, parallel to *RS*, into the plane of projection the true-length of the side of the object is fore-

FIGURE 11



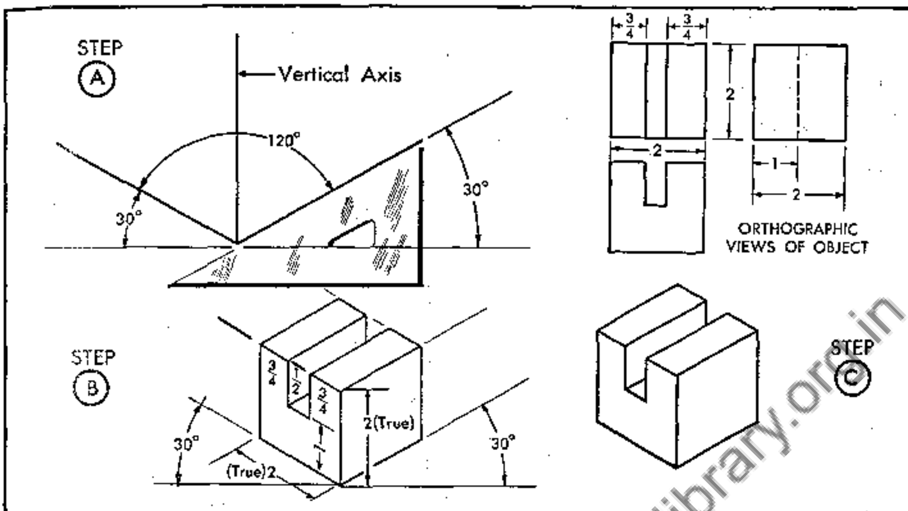
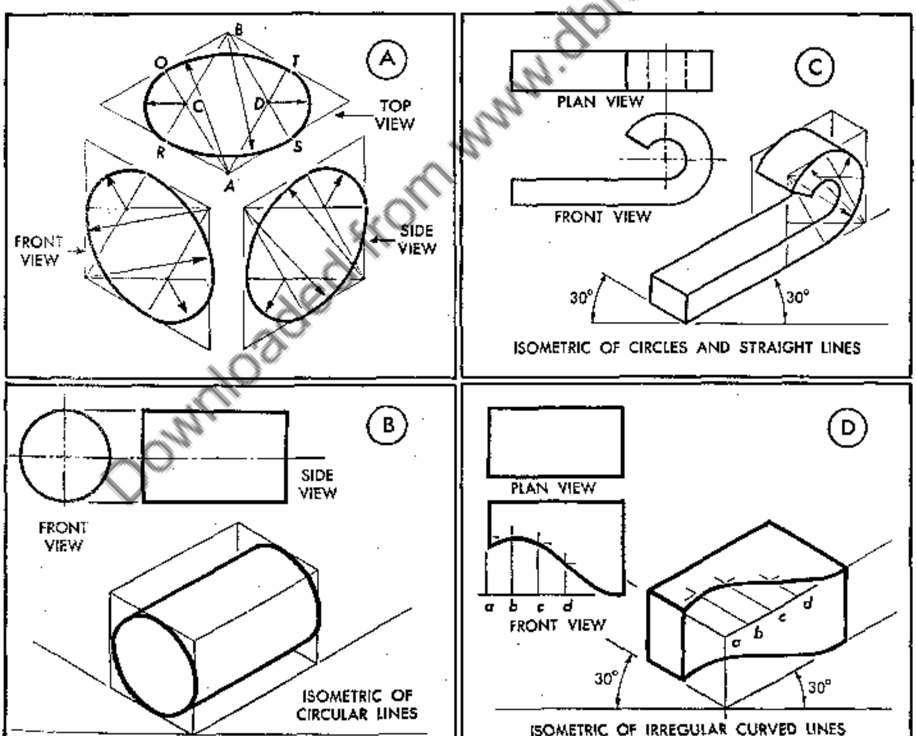

STEP
A
Vertical Axis
120°
30°
30°
3/4
3/4
2
2
1
2
ORTHOGRAPHIC VIEWS OF OBJECT
STEP
B
3/4
1/2
3/4
2(True)
1
(True)2
30°
30°
STEP
C

Fig. 12

Fig. 13


A
B
O
T
C
D
R
S
A
TOP VIEW
FRONT VIEW
SIDE VIEW
C
PLAN VIEW
FRONT VIEW
30°
30°
ISOMETRIC OF CIRCLES AND STRAIGHT LINES
B
FRONT VIEW
SIDE VIEW
ISOMETRIC OF CIRCULAR LINES
D
PLAN VIEW
a b c d
FRONT VIEW
a b c d
30°
30°
ISOMETRIC OF IRREGULAR CURVED LINES

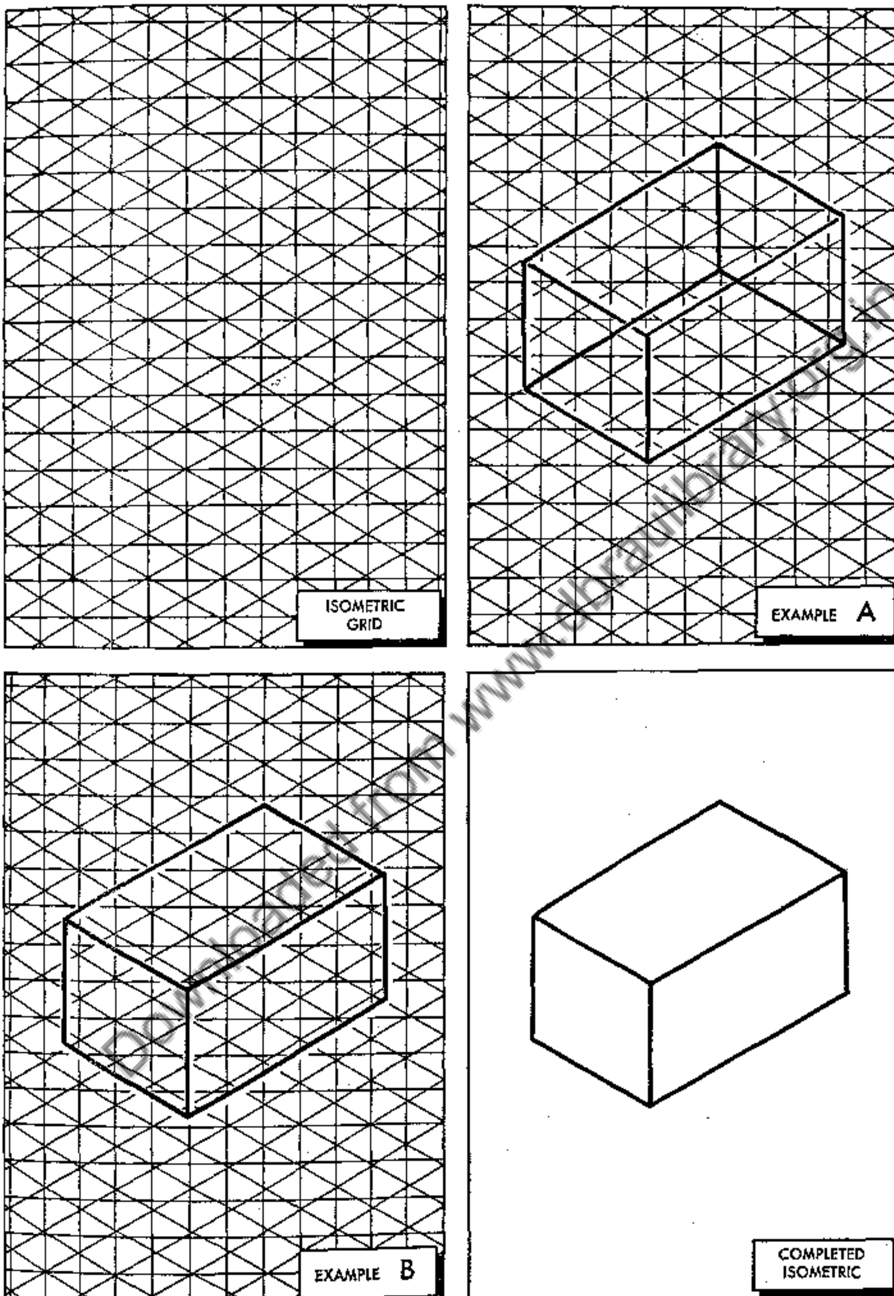
shortened in the ratio of 0.8165 : 1, or approximately 18.35 per cent less than their lengths.

When the illustrator has acquired a thorough understanding of the foregoing principles of isometric projection he should turn his attention to a practical method for making an isometric drawing, as illustrated by Fig. 12. By this method all dimensions given in the orthographic projections are drawn in true scale along their respective axes.

B. Isometric drawing

The isometric projection of Fig. 11, part A is a truer pictorial representation than the forthcoming practical method of making an isometric drawing, Fig. 12. The common intersection of the axes becomes the lowest corner of the object when the perpendicular is constructed above the horizontal line. From the orthographic drawing the true scale dimensions are set off along these lines. If the object lines are parallel in the orthographic drawing, the lines in the isometric drawing will be parallel.

To construct isometric circles approximately, the illustrator begins by establishing an isometric square with sides equal to the diameter of the circle, and then bisects each side of the rhombus to determine the tangent points of the ellipse as represented by points *O*, *R*, *S*, *T* in part A of Fig. 13. From point *A* a line is drawn to tangent points *O* and *T*. From point *B* a line is drawn to tangent points *R* and *S*. These lines intersect at points *C* and *D*, thereby establishing center points for the arcs *OR* and *ST*. Finally, by using points *A* and *B* as center points for the arcs *OT* and *RS*, the four-center oval is completed to represent a circle drawn in isometric projection. This method, of course, applies to the construction of circles which may appear on any regular isometric surface which may appear on the drawing. Fig. 13, part C illustrates the use of combinations of circles and straight lines. The same procedure would be used for any part of a circle on the isometric surface. Part D of Fig. 13 employs the "offset" method of plotting an irregular curve. Lines *a*, *b*, *c*, *d* are spaced any distances apart; distances may or may not be equal. However, *a′*, *b′*, *c′*, *d′*, must be spaced by the same respective distances. After these lines have been constructed the distances are set off on the isometric to correspond with the front view in


ISOMETRIC GRID
EXAMPLE A
EXAMPLE B
COMPLETED ISOMETRIC

this case. The "offset" method may be employed in several different types of drawings (see Fig. 20).

Figure 14 illustrates the application of a commercial isometric grid. These grids are very useful to the beginning illustrator in that they will help him to develop his depth perception and understanding, and acquaint him with the principles and techniques behind simple isometric drawing. These grids are available at engineering and art supply stores.

OBLIQUE DRAWINGS

The third or cross axis which represents distances perpendicular to the picture plane may be drawn at any angle to the horizontal, as shown in Fig. 15, though 30 degrees and 45 degrees are generally used. An oblique is more easily executed than an isometric drawing because one face of the object is placed parallel to the picture plane. Generally this face contains the larger portion of irregularities in their true size. Often in oblique surfaces an imaginary section must be used in order to describe the shape of the cross section of the object (Fig. 15A). This is used only on objects which have surfaces not parallel to the oblique plane of projection on the picture plane. All planes which are parallel to the face of the object represented on the picture plane are also drawn as in their orthographic projection. Therefore, lines which are parallel to the inclined axis are measured in their true length in cavalier projections (Fig. 17), and are parallel to each other. In cabinet projection the parallel projectors are measured at such an angle that the distances measured parallel to the third, or cross, axis are reduced to one-half that of cavalier projection.

To make an oblique drawing, study the dimensions of the orthographic drawing shown in step 1 of Fig. 16 which shows the top view and the front view of a rectangular block. Let the front view of the rectangular block lie in the picture plane which is represented by line R of step 2 (Fig. 16).

Project parallel rays in top view, making 45-degree angles with the picture plane. These lines could be parallel to any one of the elements formed by a 45-degree cone whose base is assumed to be on the picture plane. The two angles generally used are 30 degrees and 45 degrees. Then project the front view of the rectangular block and draw a refer-

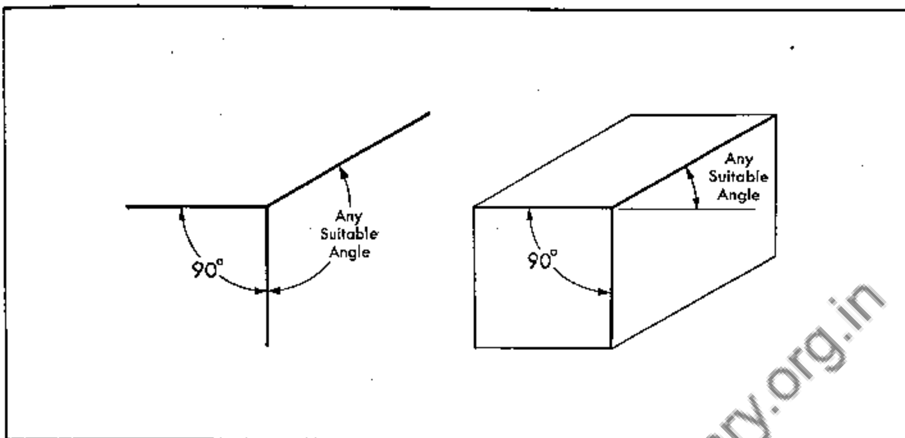
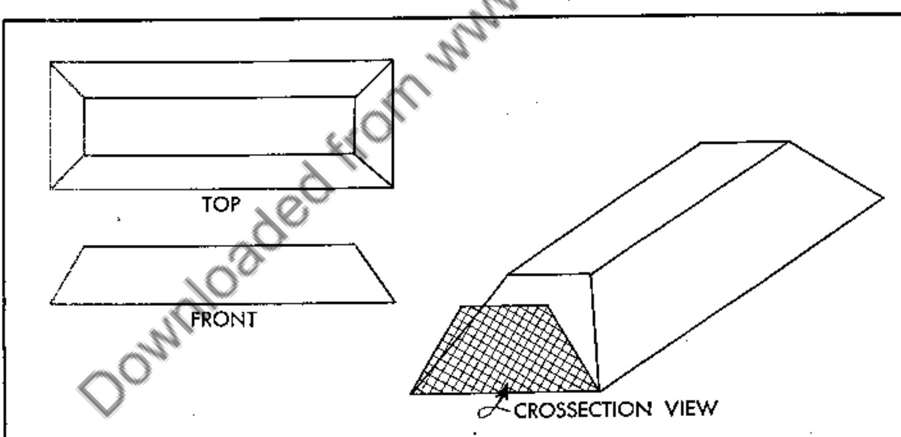


Fig. 15

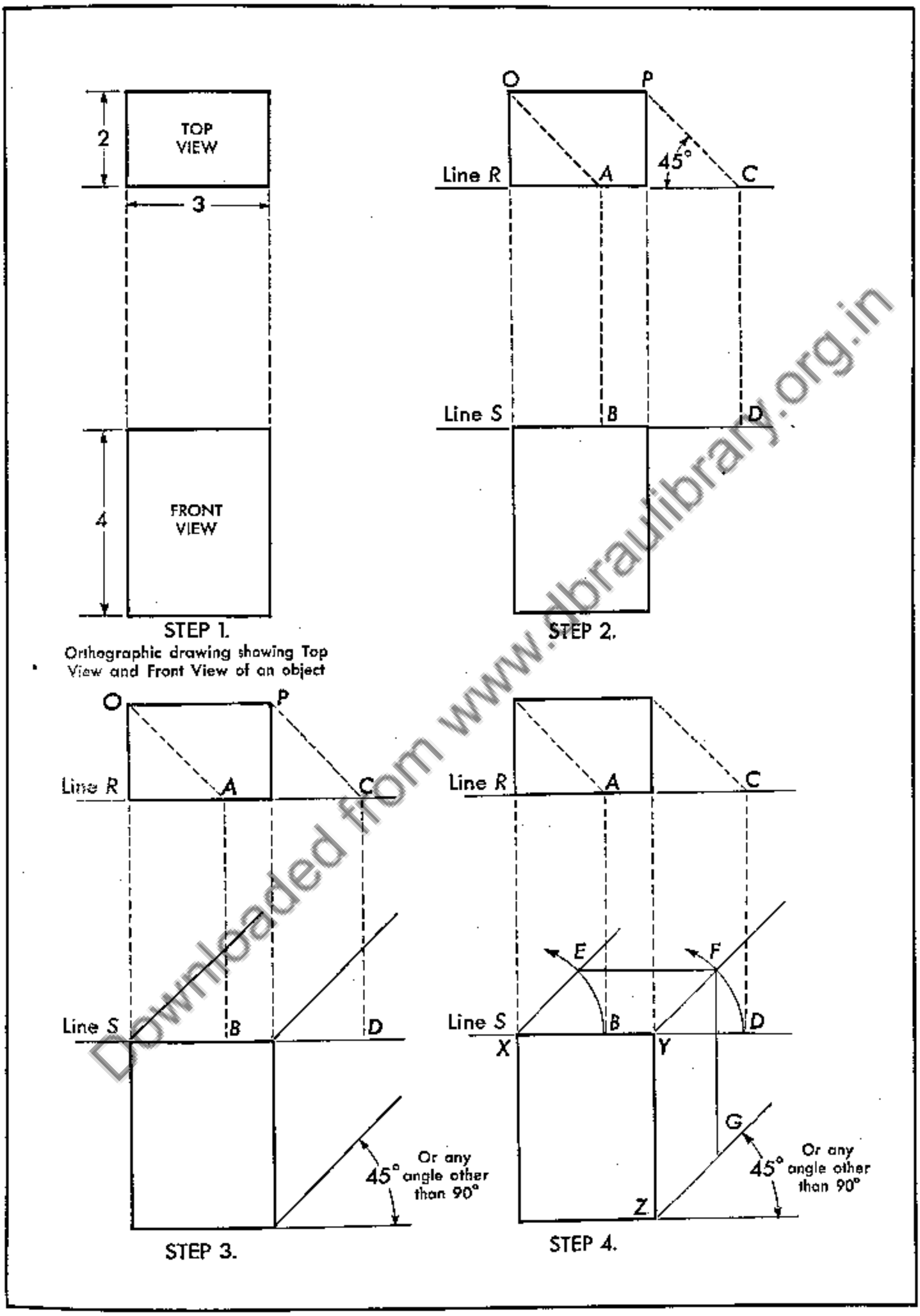
Fig. 15A



ence line across the top of this view, as indicated by line *S* of step 2 of Fig. 16. From the intersection points established by the top view projection of rays *OA* and *PC* project other parallel rays downward until they intersect with reference line *S* in front view at points *B* and *D*. Next decide upon the angle at which distances are to be represented with respect to the front view, and from each corner of the front view of the object project lines which are parallel to that angle, as illustrated by step 3 of Fig. 16. Finally, as indicated by step 4 of Fig. 16, using points *X* and *Y* as centers, *B* and *D* are revolved to establish points *E* and *F*, respectively. From point *F* draw, parallel to *YZ*, a line that intersects the angular projection at point *G*. Join points *E* and *F* which complete the application of the theory on oblique drawing.

Often illustrators who make oblique drawings merely draw the front view of the object taken from the orthographic projection, construct a suitable angle for the representation of depth, and scale off actual dimensions along the angle. If the illustrator chooses to represent distance in true scale the oblique pictorial which results is commonly termed a "cavalier" projection (see Fig. 17). Should one-half the actual measurements of the object be used to make an oblique pictorial, the result is known as a "cabinet" drawing. Other oblique pictorials using ¾ scale, ⅝ scale, or ⅛ scale are therefore called "¾ oblique," "⅝ oblique," "⅛ oblique," etc., depending upon the scale used as in Fig. 17.

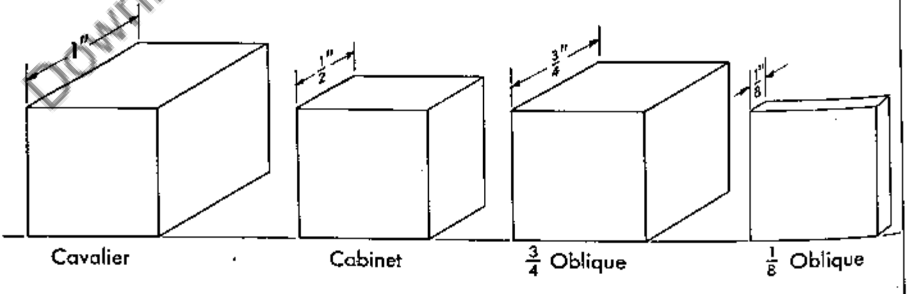
Lines which are not parallel to any of the three axes of an oblique drawing are referred to as "inclined lines." To construct an inclined line, it is therefore necessary to plot points for its construction. This may be done by drawing auxiliary lines which are parallel to the axes. For example, if an oblique drawing were to be made of the object shown in the orthographic projection of Fig. 18, the illustrator begins by making an over-all oblique box with a front reference plane and then constructs the orthographic view (front) on this plane, on which he will then project such points as are necessary along his inclined lines of projection. Next, he constructs the inclined plane of the object by plotting points as illustrated by step 2 of Fig. 18. Observe that the object shown in the orthographic projection has a slot which is cut into the surface of the inclined plane. A line is drawn through point G


2
TOP VIEW
3
FRONT VIEW
4
STEP 1.
Orthographic drawing showing Top View and Front View of an object
O
P
Line R
A
45°
C
Line S
B
D
STEP 2.
O
P
Line R
A
C
Line S
B
D
45°
Or any angle other than 90°
STEP 3.
Line R
A
C
E
F
Line S
B
D
X
Y
G
45°
Or any angle other than 90°
Z
STEP 4.

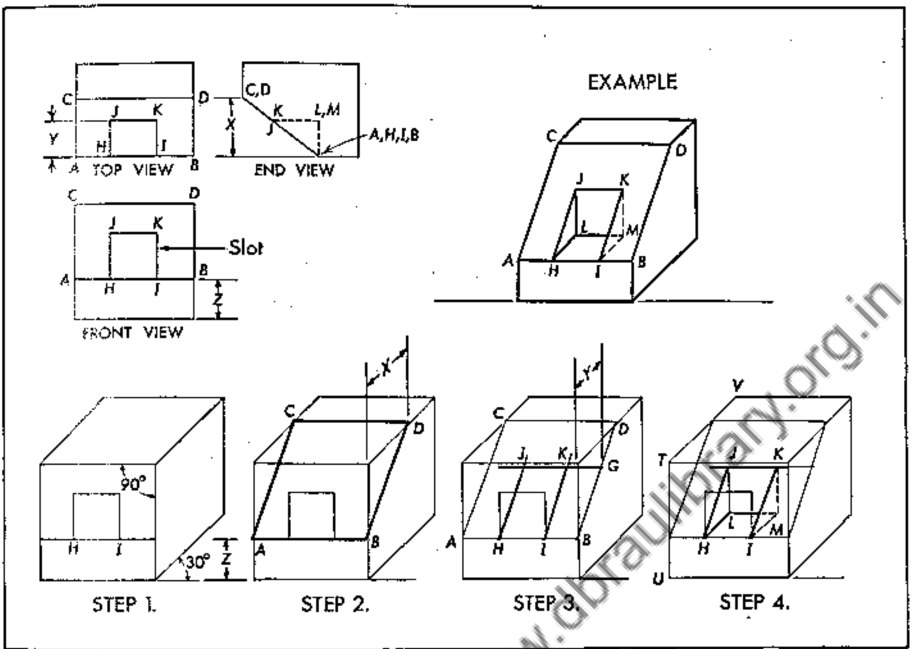
parallel to *CD*. From points *H* and *I* lines are projected parallel to *AC* and *BD*, respectively, and where these projections intersect the line drawn through point *G*, the extremities of the slot are established at points *J* and *K*. By projecting lines downward from points *J* and *K* parallel to *TU*, and by projecting lines from *H* and *I* parallel to *TV*, the intersections will establish points *L* and *M* to complete the oblique drawing of the slot when connected.

Circles which lie in the picture plane of an oblique drawing, or in any plane parallel to the picture plane, will appear as true circles and may be drawn with a compass, while all other circles will appear as ellipses; it is therefore necessary to plot points for their construction. For example, in cavalier projection, as shown in step 1 of Fig. 19, the circle which appears in front view is a true circle. Pass through the front view of the circle lines which are equal distances apart, and using the same spacing construct reference lines on the top and side of the object where circles are to appear, as in step 2 of Fig. 19. Where the vertical reference lines and the circle intersect in front view, the points formed by their intersection are projected to intersect with corresponding lines in the side and top view, thereby establishing points for the construction of ellipses on those respective surfaces as in step 3 of Fig. 19. These points are connected by the aid of a French curve or freehand.

FIGURE 17



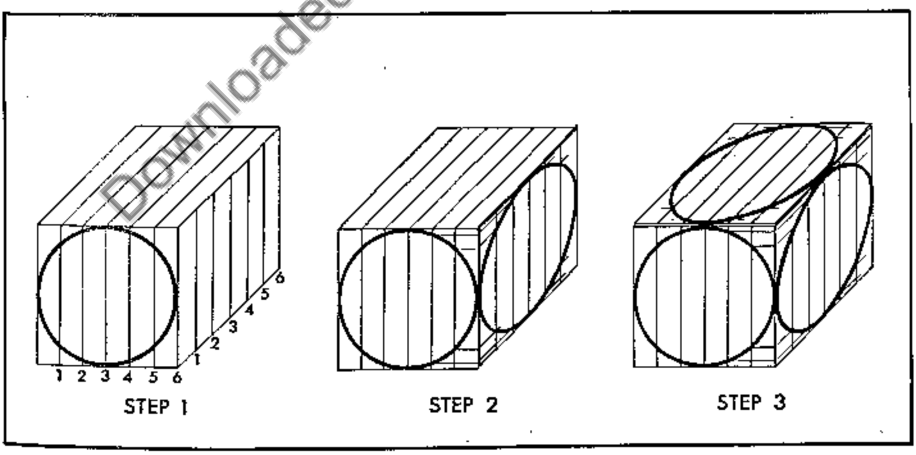
KINDS OF OBLIQUE PROJECTION



C
D
Y
A
TOP VIEW
B
J
K
H
I
C,D
X
K
L,M
J
A,H,I,B
END VIEW
EXAMPLE
C
D
J
K
L
M
A
H
I
B
C
D
J
K
Slot
A
H
I
B
Z
FRONT VIEW
90°
H
I
30°
Z
STEP 1.
X
C
D
A
B
STEP 2.
Y
C
D
J
K
G
A
H
I
B
STEP 3.
V
T
J
K
L
M
H
I
U
STEP 4.

Fig. 18

Fig. 19

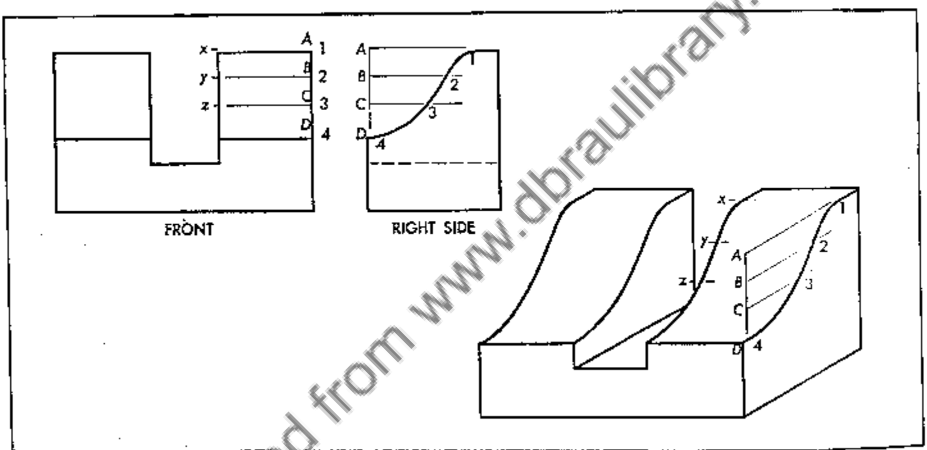


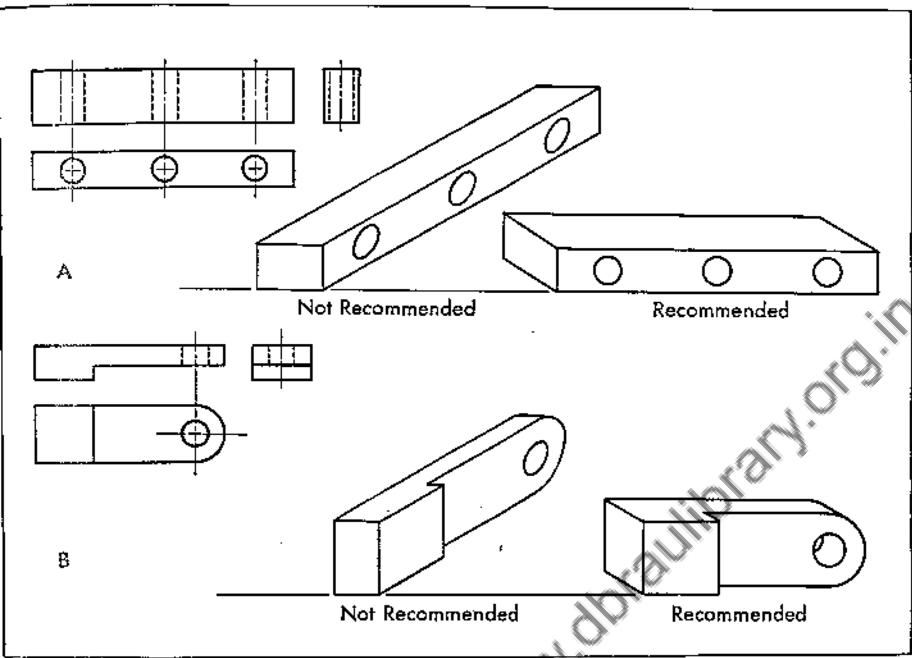
1 2 3 4 5 6
1 2 3 4 5 6
STEP 1
STEP 2
STEP 3

To construct irregular curves in oblique drawings the method is the same as for drawing circles in oblique. On the side view of the irregular curved line plot a sufficient number of points to form the curve and project the *A, B, C,* and *D* offsets, as shown in the orthographic projection of Fig. 20.

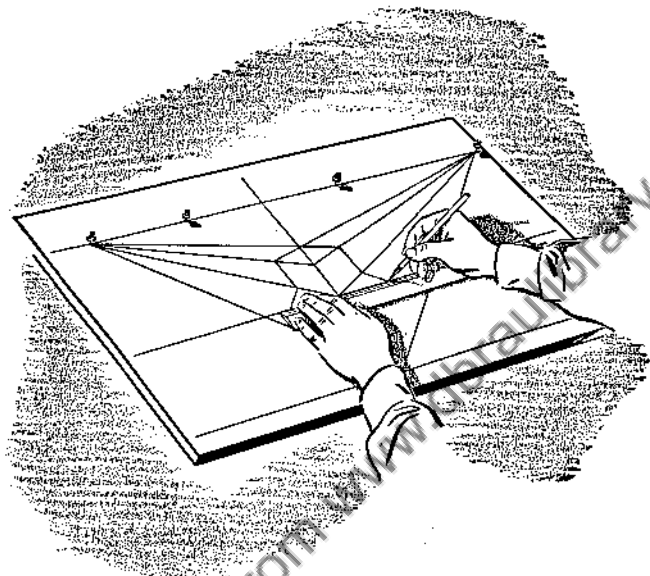
It is important that the illustrator bear in mind that the longest dimension of an object to be pictorially represented in oblique drawing should be placed parallel to the picture plane. For example, see parts A and B of Fig. 21.

FIGURE 20




A
Not Recommended
Recommended
B
Not Recommended
Recommended

Chapter 3 METHOD FOR MAKING TRUE-SCALE PERSPECTIVE DRAWINGS



PERSPECTIVE DRAWING is generally referred to as the representation of objects on a plane surface as they are seen by the eye at a particular point. It is a drawing which conveys to its viewer the same feeling of depth, distance, and atmosphere as are reflected by a photograph.

Numerous methods for making perspective drawings have been developed and advocated, almost all of which are feasible and applicable. However, a number of the methods are similar as well as complicated in that they make use of countless lines which tend to confuse the illustrator before his drawing is completed. Nevertheless, there are a few methods which are simple and easily applied to all perspective rendering without the difficulty of too many projected lines and points.

Perspective drawing is not difficult to understand or to do. The truth of the matter is that to draw in perspective is easy.[1] Some difficulties are to be expected, but if the illustrator is keenly aware of certain fundamental facts which must be taken into consideration before beginning each drawing, the difficulties will be eliminated.

To begin, let us consider the basic fundamentals involved in perspective drawing. Imagine a diamond-shaped object which stands in space some distance away from the observer's eye. The image of the object which the eye interprets for the observer is formed by visual rays which are reflected from the object's surfaces. If these rays are studied with the aid of a diagram, as presented in Fig. 22, the illustrator will notice that the rays form a pyramid as they are extended from the diamond shaped object to the observer's eye.

Now, suppose a sheet of glass is passed between the object in space and the observer's eye. It will intersect the visual rays and form a projection of the image upon the plane as shown in Fig. 23. This plane upon which the image appears is called the **picture plane.**

The location of the observer's eye, or the point from which any object is to be viewed, is called the **station point.** The station point, as illustrated by Fig. 24, is merely the point at which the observer's eye is assumed to be.

If a straight-line visual ray is drawn perpendicular to the picture plane from the station point, or observer's eye, as illustrated by Fig. 25, and if the line is drawn horizontally across the picture plane, this line will be called the **eye level,** or horizon line. Suppose, for example, the observer stands in the middle of a pair of long, straight railroad tracks and looks down the tracks as far as his vision will allow. Eventually the two tracks, between which the observer is standing, seem to converge into a single point at the eye level as shown by Fig. 26. This point on the horizon is called the **vanishing point.**

One of the easiest and most fundamental methods of making a perspective drawing as suggested by Fig. 26 is called **one point,** or **parallel perspective.** This is a method in which one face of the object is always parallel to the picture plane and yet has sides which appear to converge

[1] Ernest R. Norling, *Perspective Made Easy*, New York, The Macmillan Company, 1939.

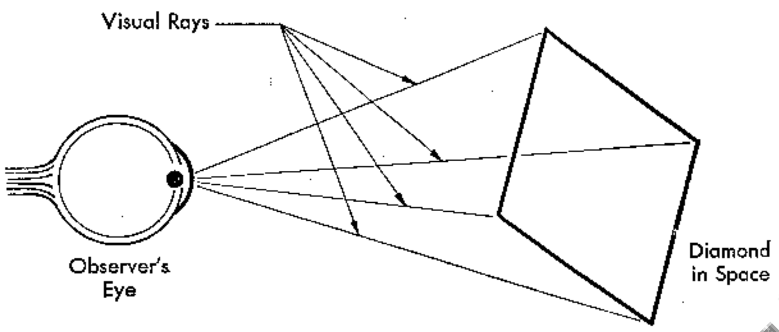


Fig. 22

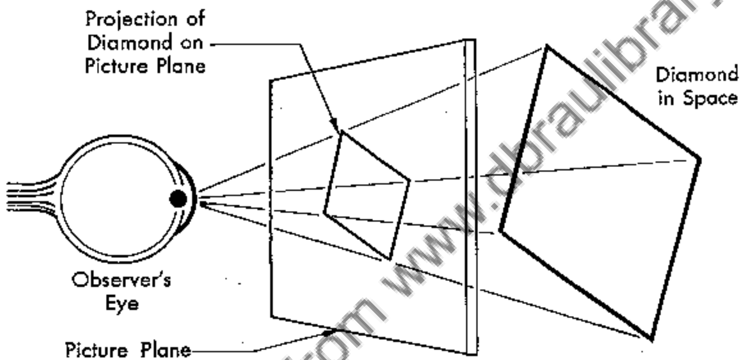


Fig. 23

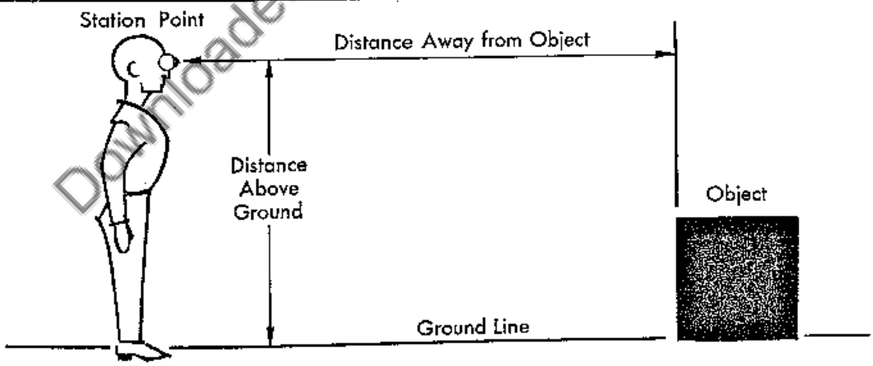


Fig. 24

into a single point. To use this method, two orthographic views, the plan view and the profile view, are required.

The mechanical steps involved in the one-point perspective method are simple and easy to follow: First, as illustrated by step 1 of Fig. 27, draw the top view of the object to be projected into perspective, and parallel to the front side draw a line which will represent the picture plane. This top view will give the width and depth of the object in its true-scale dimensions.

Next, at some arbitrary distance below the picture plane line draw a line parallel to the picture plane which, in front view, will be the ground line. Project the width of the object down from the top view until it meets the ground line, and scale the true height of the object in front view as shown by step 2 of Fig. 27. Let the picture plane line be common to the top view and the front view. When this is done the distance from the horizon line down to the ground line will represent the true distance of the horizon above the ground. Therefore the horizontal line will serve as the picture plane for the top view and the horizon, or eye level, for the front view.

The next step is to determine the location of the station point with respect to the top view as shown in step 3 of Fig. 27. Then, by projecting perpendiculars to the horizon line from the station point, establish the point of intersection which in front view will represent the vanishing point on the horizon. Now project the corners of the top view to the station point and the corners of the front view to the vanishing point.

Finally, where each projection line from the top view of the object to the station point intersects the picture plane, project lines downward at 90 degrees to the picture plane as illustrated by step 4 of Fig. 27. Then by connecting each point formed by the intersection of this projection the perspective outline of the object is clearly defined.

As the basis for developing the theory of one-point perspective, study Fig. 28. Notice that the vanishing point of the object always appears on the horizon, and that three sides are visible, with the exception of those which appear centered either above or below the vanishing point and those which are divided by the eye level either on the right or the left of the vanishing point. These are the most uninteresting of all

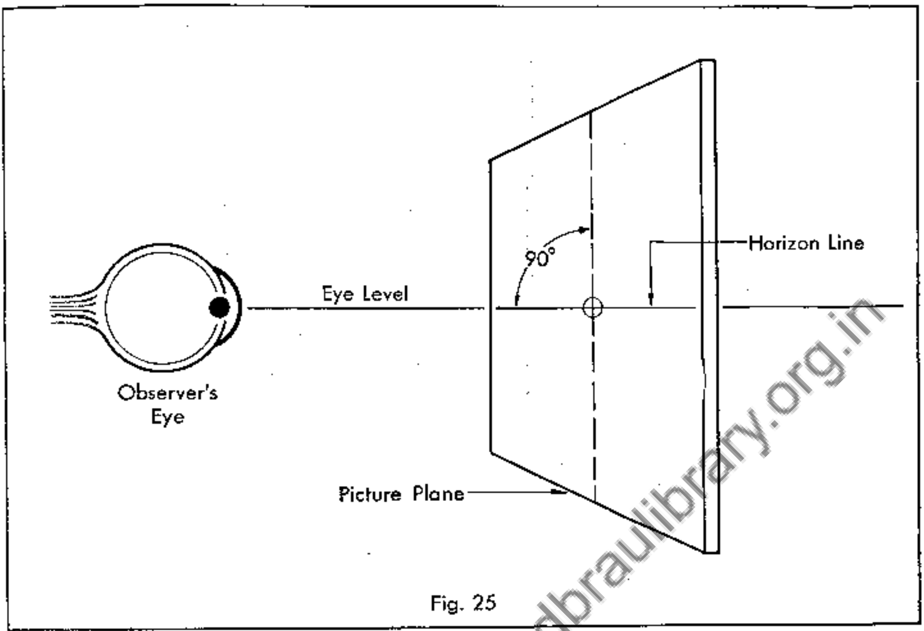

Horizon Line
90°
Eye Level
Observer's
Eye
Picture Plane

Fig. 25

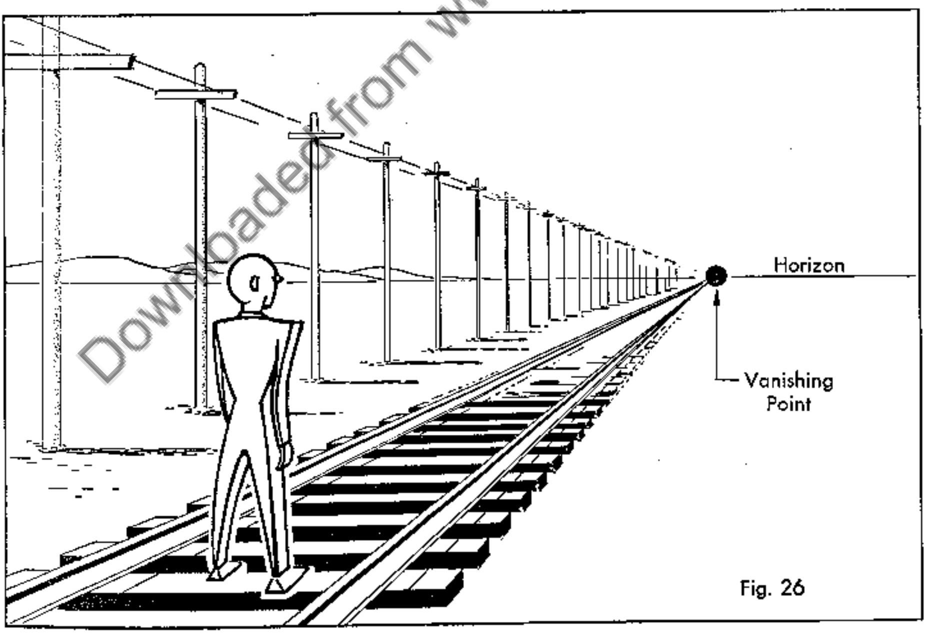

Horizon
Vanishing
Point

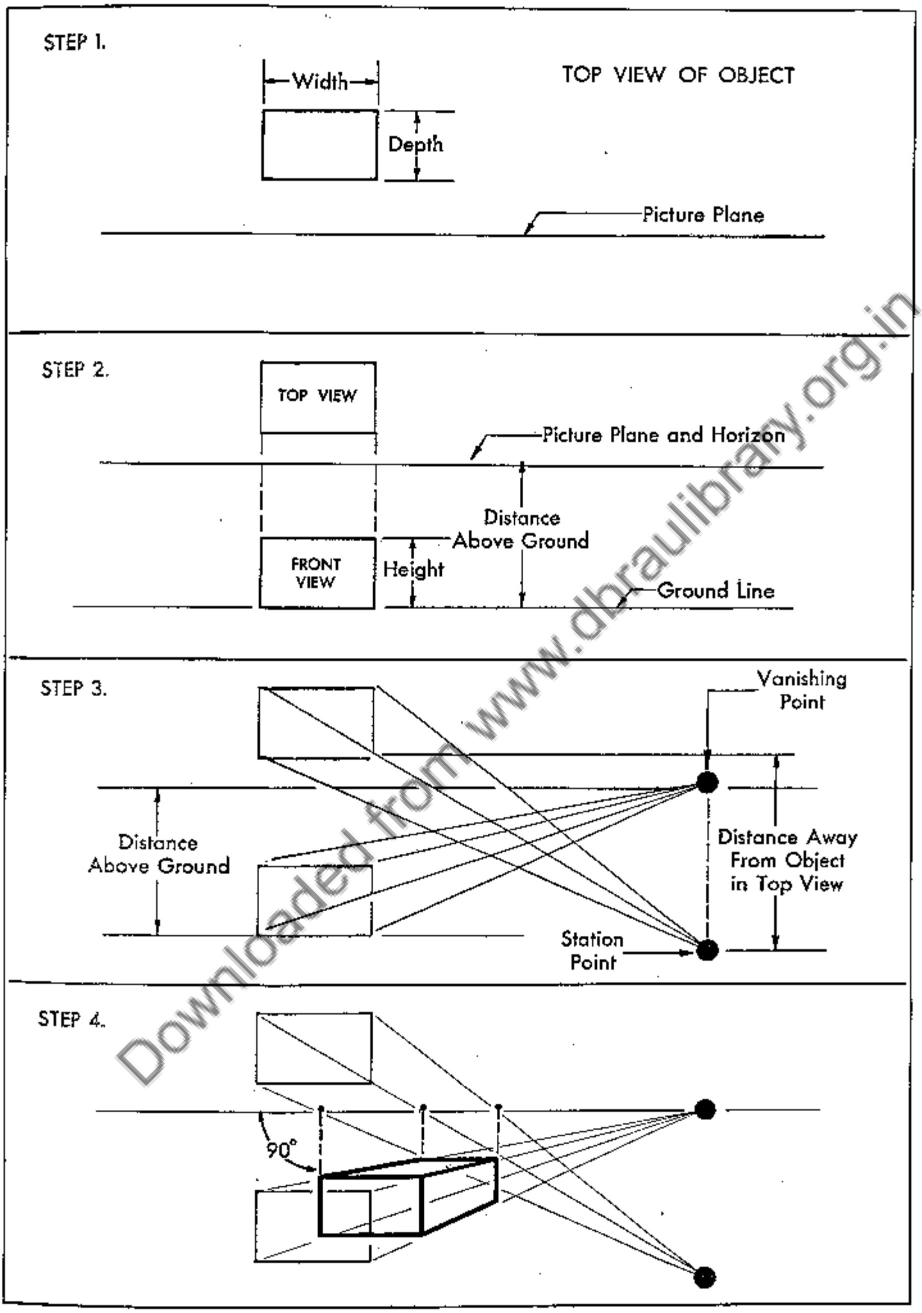
Fig. 26

perspective projections and should be avoided if possible. For further examples of the application of one point perspective, study parts A through F of Fig. 29 which present a series of projections having various, flat, curved, and inclined surfaces.

Most illustrators prefer to use the method known as **angular,** or **two-point** perspective. The method of construction for the angular perspective projection is the same as for the parallel, or one-point, perspective except that in this method the station point is located along a perpendicular line from the corner of the object which touches the picture plane, and the vanishing points are established by projecting, from the station point, lines which are parallel to the sides of the top view of the object and which intersect the horizon, as indicated by Fig. 30. The angle at which the object is placed with respect to the picture plane is arbitrarily established. It may be any number of degrees on either side of the object so long as the total is 90 degrees, as shown in A of Fig. 31; or it may have angles of 25 degrees and 65 degrees, or even 20 degrees and 70 degrees, as shown by B and C of Fig. 31

One of the more easily applied methods for making perspective drawings is explained in the following pages. The method explained here is one which is already in use by many well-known illustrators and has been proved very efficient as a timesaver. This method employs direct measurement to the object instead of the plan view and profile view which ordinarily are used in other methods. In other words, this method eliminates the extra work involved in drawing the plan and profile views of the object before projecting it into perspective.

In beginning a perspective drawing the most important things to remember are the distances **above** and **away** from the object which the illustrator is going to draw. A good standard which has proven very satisfactory is to assume a station point distance from the object of two and one-half or three times the height, or the longest dimension of the object. The location of the station point will have much to do with the final appearance of drawing, as illustrated by Fig. 32. Observe that A of Fig. 32 appears out of focus, or distorted, when it is viewed from a station point which is located close to the object, while B of Fig. 32 appears to be in good focus and is located a normal distance from the eye. For example, if the size of the object is 2 by 2 inches


STEP 1.
Width
TOP VIEW OF OBJECT
Depth
Picture Plane
STEP 2.
TOP VIEW
Picture Plane and Horizon
Distance
Above Ground
FRONT
VIEW
Height
Ground Line
STEP 3.
Vanishing
Point
Distance
Above Ground
Distance Away
From Object
in Top View
Station
Point
STEP 4.
90°

we would assume a station point distance which is three times the greatest length, or six inches from the object. This method for deciding upon a station point will show the object in a pleasing position without distortion. The method and explanation for locating the distance from the object are illustrated by Fig. 33.

In addition to locating the distance from the object, the distance above the object, as shown in step 2 of Fig. 34, is determined arbitrarily, depending upon how much of the top surface the illustrator desires to show. The next important step is the angle at which the object is to be viewed.

The most common and most satisfactory angle which has been used for years by architects, artists, and stylists, as illustrated by step 2 of Fig. 34, is 30 degrees for the side of the object having the greatest length, or the most detail.

In step 2 of Fig. 34, study the method for establishing the left-hand and right-hand measuring points. Now, study steps 4 and 5 of Fig. 35,

FIGURE 28

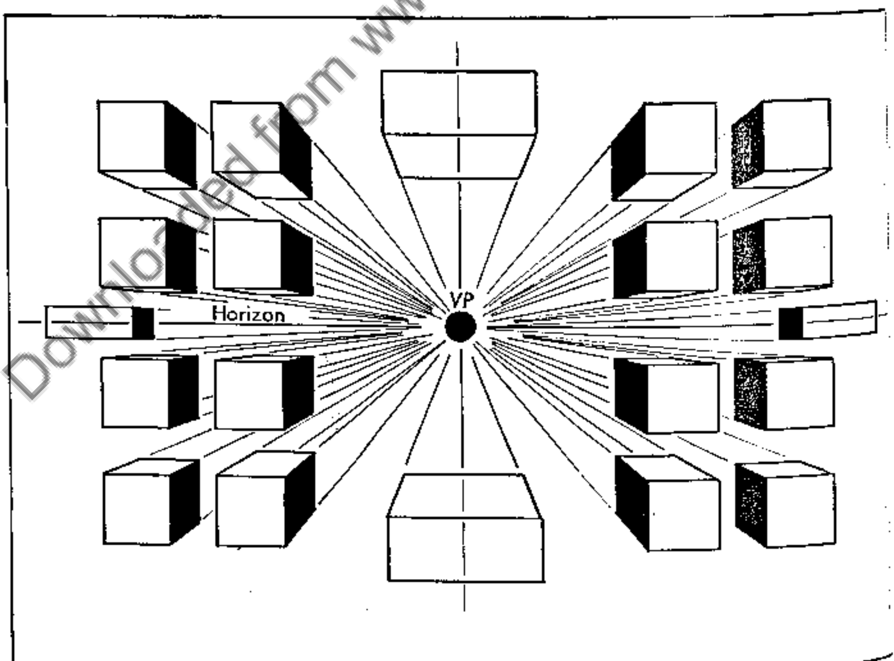
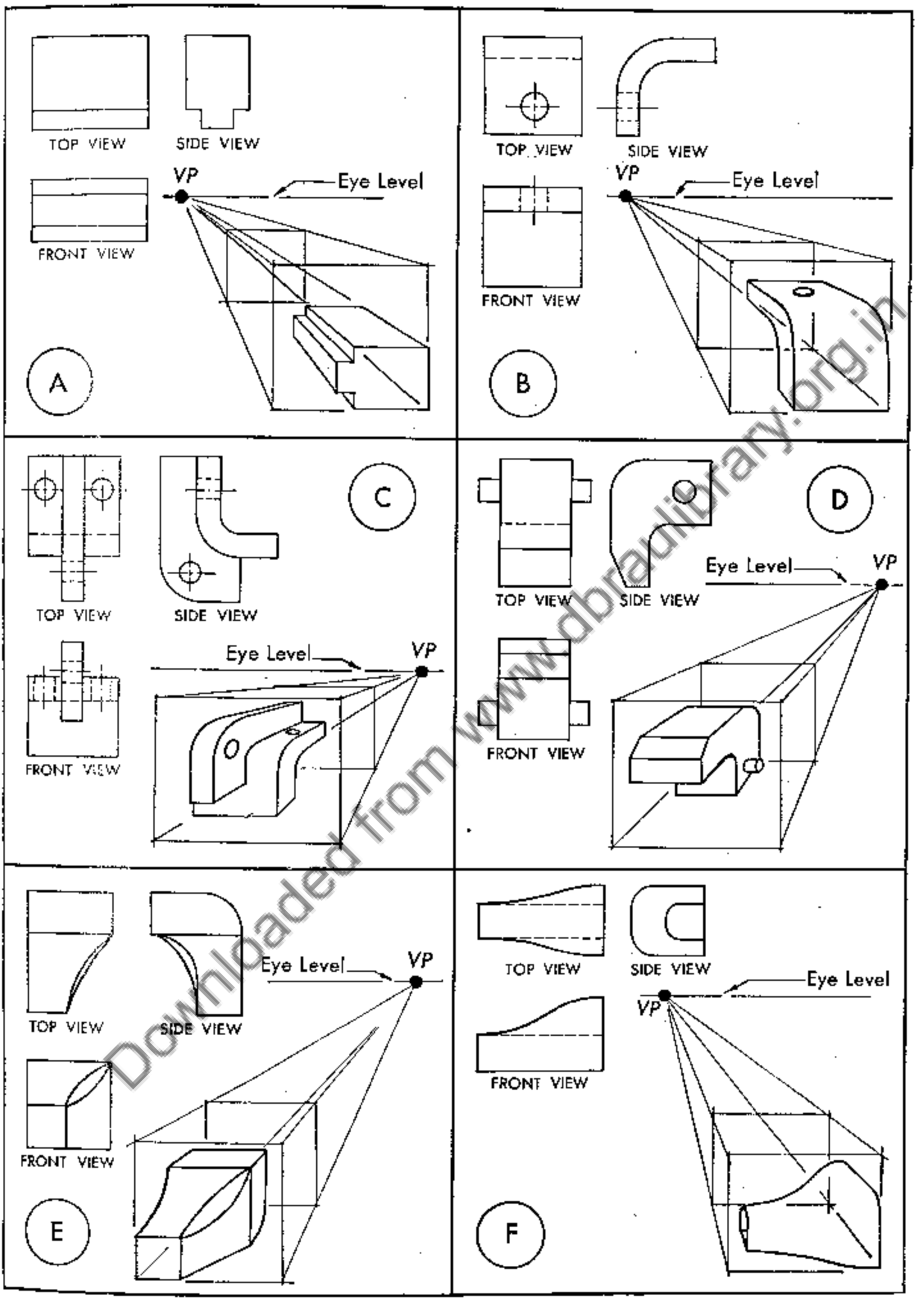


FIGURE 29



TOP VIEW
SIDE VIEW
FRONT VIEW
VP
Eye Level
A
TOP VIEW
SIDE VIEW
FRONT VIEW
VP
Eye Level
B
C
TOP VIEW
SIDE VIEW
FRONT VIEW
Eye Level
VP
D
Eye Level
VP
TOP VIEW
SIDE VIEW
FRONT VIEW
TOP VIEW
SIDE VIEW
Eye Level
VP
FRONT VIEW
E
TOP VIEW
SIDE VIEW
Eye Level
VP
FRONT VIEW
F

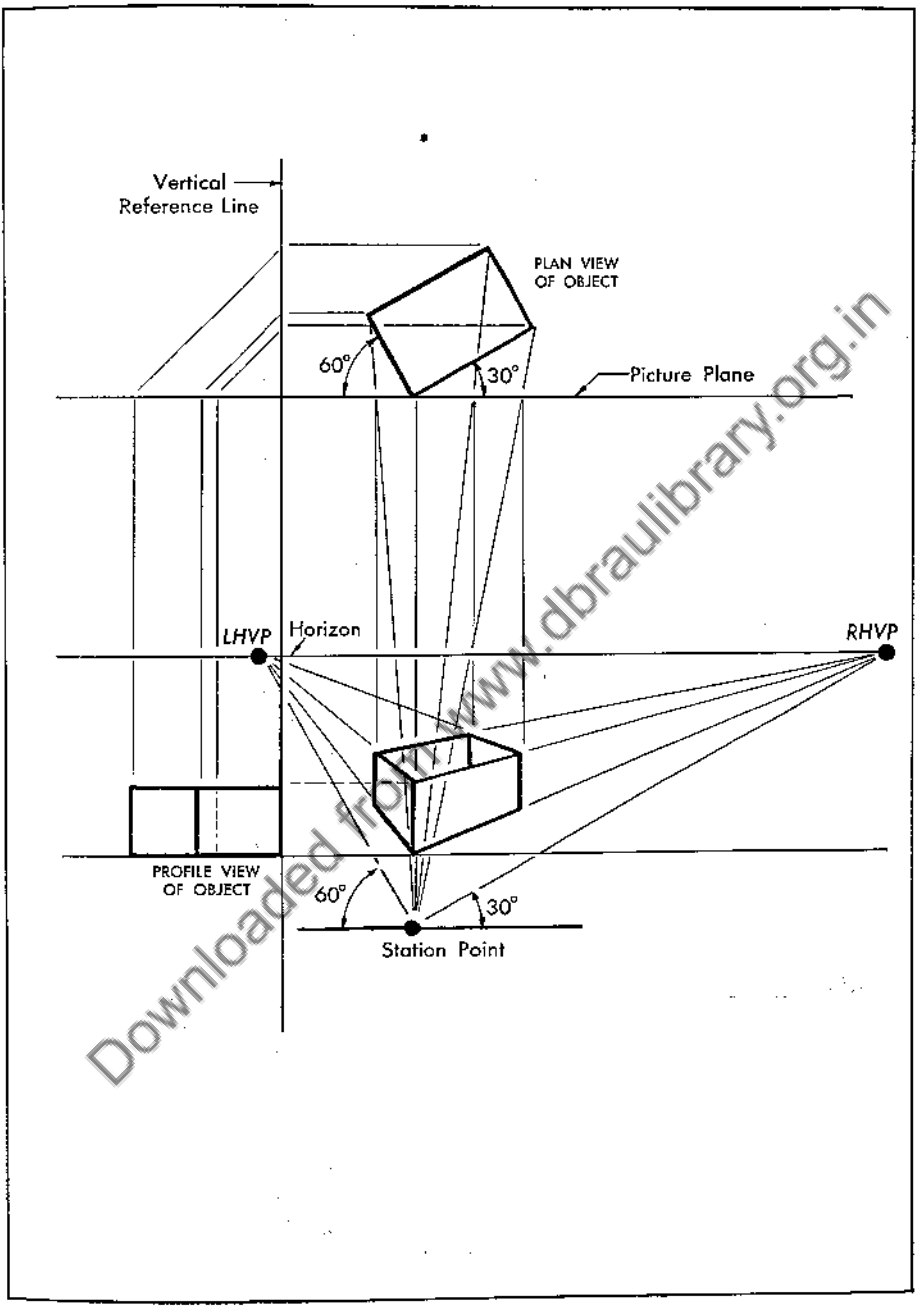
which explain the application of vertical and horizontal dimensions and the completion of a true-scale perspective layout.

The illustrator should bear in mind, however, that he may make the view angle as large or as small as he wishes so as to show the object in what he thinks will be the most interesting position. For example, if the object to be drawn in perspective is a new radio cabinet, as indicated in the orthographic drawings shown in A of Fig. 36, the illustrator might choose to make the view angle 22 degrees on the left side of the vertical measuring line. The angle forming the other side would therefore be 68 degrees. The logic back of selecting this view angle of 22 degrees on the left side of the vertical measuring line is based upon the study made of the orthographic drawings. The most details, and indeed the interesting ones, are at the right side of the cabinet in front view. The tuning knob, switch, and dial are on this side and would be too far back from the picture plane if the illustrator selected the right side of the vertical measuring line for the view angle, even though 22 degrees makes a pleasing view.

Other than the selection of the most appropriate view angle from which the object is to be viewed by the observer, the method for projecting and completing the perspective drawings of the radio cabinet is the same as described in the above steps for making a perspective drawing to scale. Study parts B, C, D, E, and F of Fig. 36 for a comprehensive understanding of the completion of a perspective drawing as set forth orthographically in A of the same figure.

Because it is important to represent circles correctly when drawn in perspective, there are specific fundamentals which the illustrator must bear in mind. All circles, as illustrated by Fig. 37, appear elliptical when drawn in perspective. A simple rule to remember is that all circles which appear on the right side of an object have a tendency to tilt towards the right. For example, see Fig. 37. By the same token, circles which appear on the left side of an object have a tendency to tilt towards the left. Circles which appear on the top surface of an object are constructed the same as for the left or right sides as in Fig. 37.

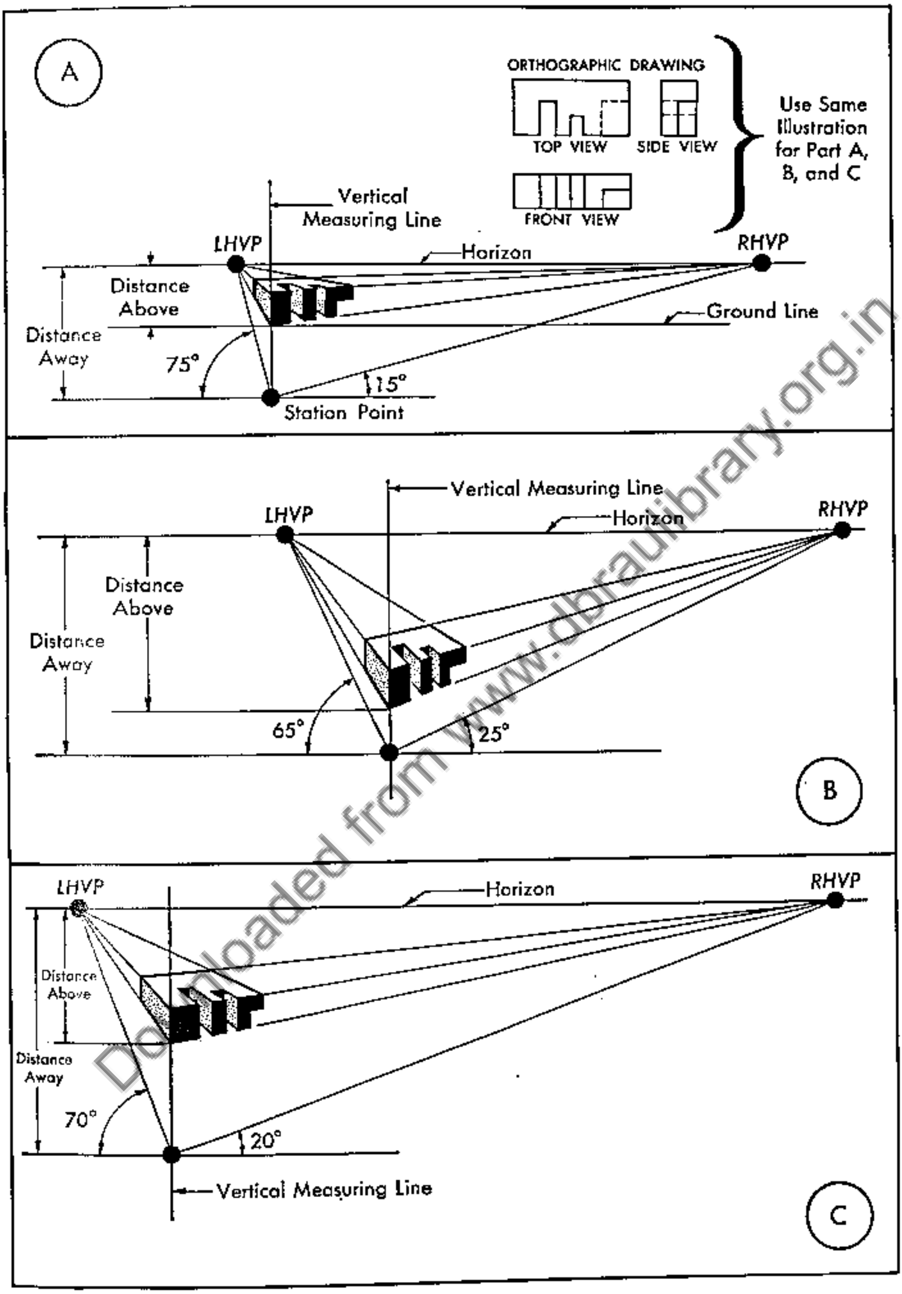
Having acquired a basic understanding of perspective projection it is important that the illustrator understand the principles of shading objects which have been drawn in perspective. To begin the projection

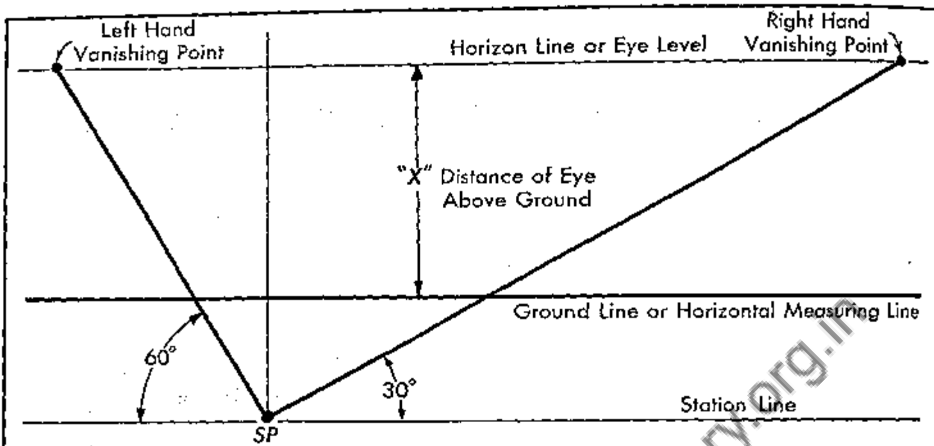

Vertical
Reference Line
PLAN VIEW
OF OBJECT
60°
30°
Picture Plane
LHVP
Horizon
RHVP
PROFILE VIEW
OF OBJECT
60°
30°
Station Point

of a shadow the illustrator must first decide whether the shadow is to appear at the front or rear of the object. For example, suppose he chooses to draw the shadow in front, as though the light came from the back of the object. A point is arbitrarily placed anywhere above the object representing the *light source*, as illustrated by the letter A in Fig. 38. Then directly beneath the light source the *base point*, as illustrated by the letter *B* in Fig. 38, is located arbitrarily in a vertical direction so long as it is behind the object and on the eye level. Now, from the light source extend lines, representing light rays, through points *C*, *D*, and *E* of the object. From point *B* as shown in Fig. 39 extend lines through points *F*, *G*, and *H*. When the base lines are extended to intersect the light-ray lines, points are established for outlining the shadow pattern as in Fig. 40, and shading is added within the shadow pattern.

Should the illustrator choose to draw the shadow at the rear, as though the light came from in front of the object, the light source is arbitrarily placed anywhere above the object, but the base point, which is always directly below the light source, is placed any distance in front of the object, as shown by the three examples in Fig. 41

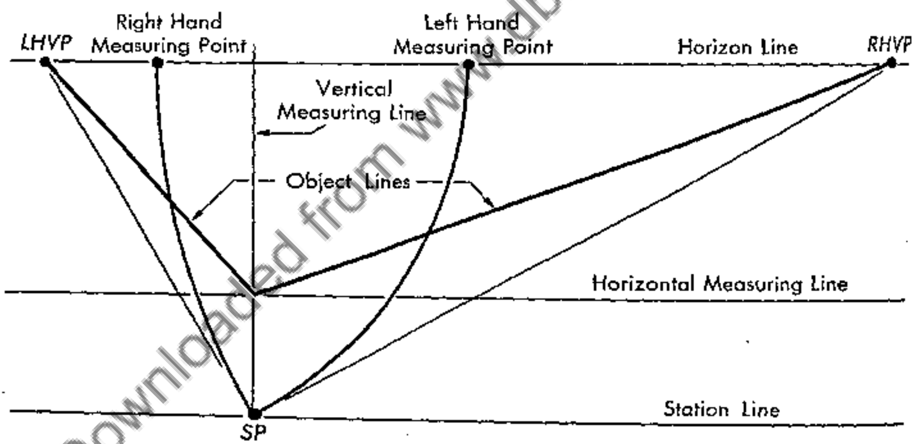
To illustrate the method of shadow projection as outlined in the preceding paragraphs, a shadow projection model has been prepared which uses actual geometric solids to determine the authentic shadow that each object casts when illuminated by an ordinary electric light bulb. Photograph A of Fig. 42 shows the geometric solids in position with the light switched off. Light-ray lines have been added to the photograph B of Fig. 42 in order to illustrate that they definitely form the extremities of the shadow pattern when intersected by the base lines.


A
ORTHOGRAPHIC DRAWING
TOP VIEW
SIDE VIEW
FRONT VIEW
Use Same Illustration for Part A, B, and C
Vertical Measuring Line
LHVP
RHVP
Horizon
Distance Above
Ground Line
Distance Away
75°
15°
Station Point
Vertical Measuring Line
LHVP
Horizon
RHVP
Distance Above
Distance Away
65°
25°
B
LHVP
Horizon
RHVP
Distance Above
Distance Away
70°
20°
Vertical Measuring Line
C



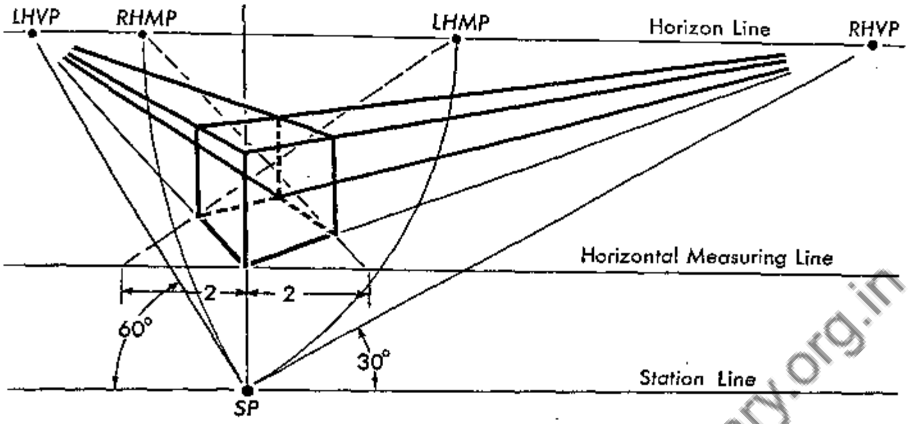
STEP 2

From the station point construct a "VIEW ANGLE" (30°) on one side of the vertical measuring line, and the complement of that angle on the other side of the vertical measuring line. The points at which the angle of projection intersects with the horizon are the "LEFT HAND VANISHING POINT," and "RIGHT HAND VANISHING POINT" respectively. Scale down the vertical measuring line, from horizon, the distance the object is to be viewed from above and draw a line parallel to the horizon. This is the "HORIZONTAL MEASURING LINE," or "GROUND LINE."



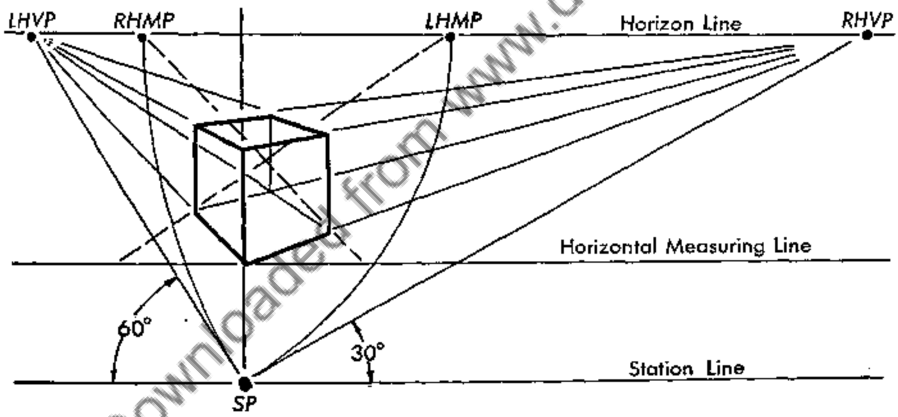
STEP 3

Now connect the point at which the horizontal measuring line and the vertical measuring line intersects with the left hand and right hand vanishing points thus forming the "OBJECT LINES." Construct "LEFT HAND AND RIGHT HAND MEASURING POINTS" on the horizon by swinging arcs with radius equal to distance from respective Vanishing Point to the Station Point.



STEP 4

Scale-off 2 inches along horizontal measuring line on both sides of the vertical measuring line. A line connecting these points with their respective left and right hand *measuring points on the opposite side of the vertical measuring line will give the true* scale perspective dimension at the intersection with the object line. Vertical measurements are placed on the vertical measuring line, scaled up from the ground line and then connected with the vanishing points.



STEP 5

Now connect all intersections which mark the boundary dimensions of the perspective projection. The result is the true scale perspective projection of the *2 inch cube* as given on the blue print. Erase the projection lines and there remains the basis for any true-to-scale perspective drawing.

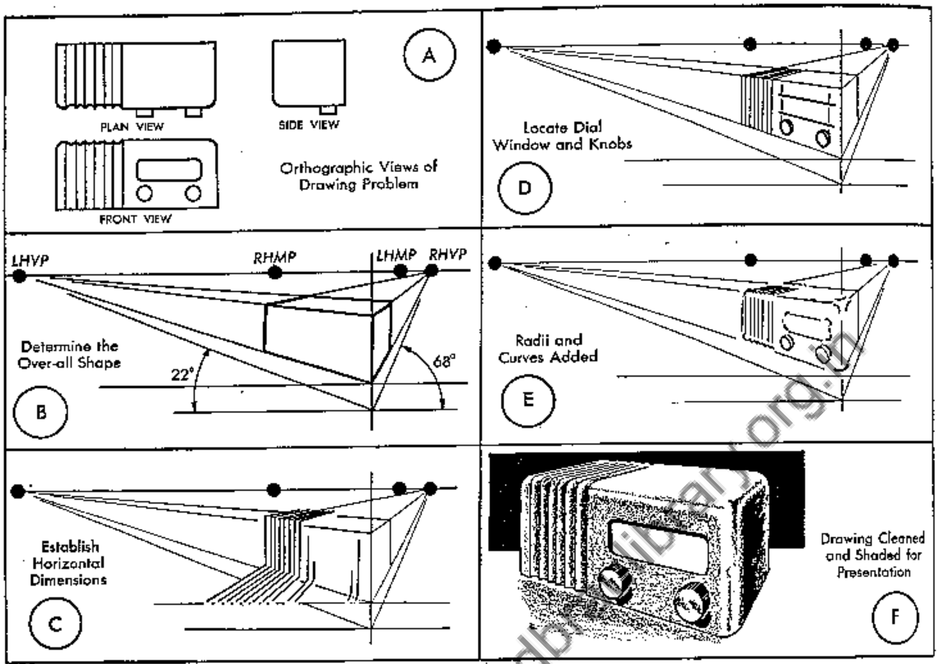
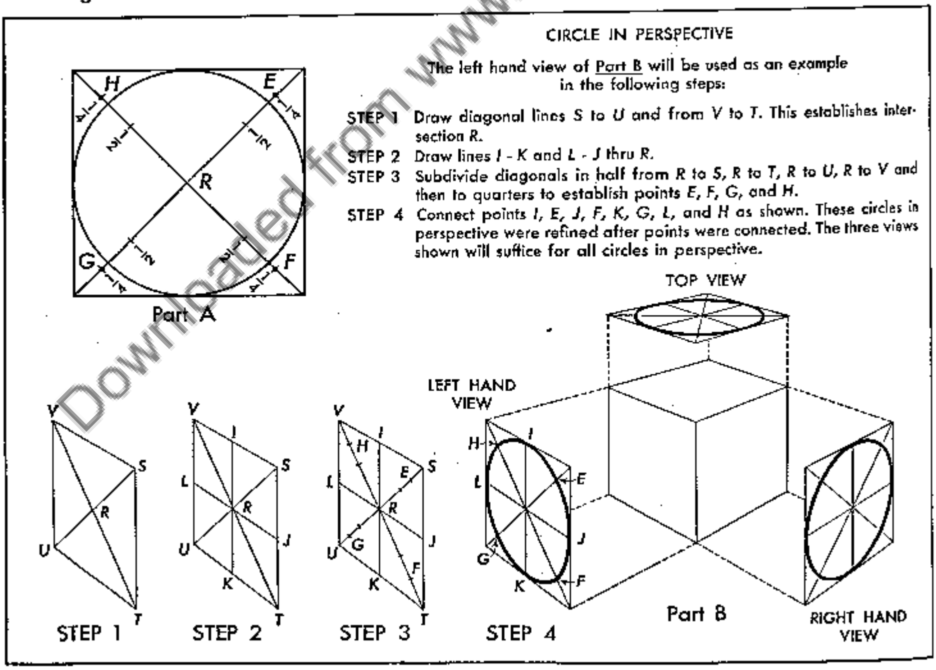


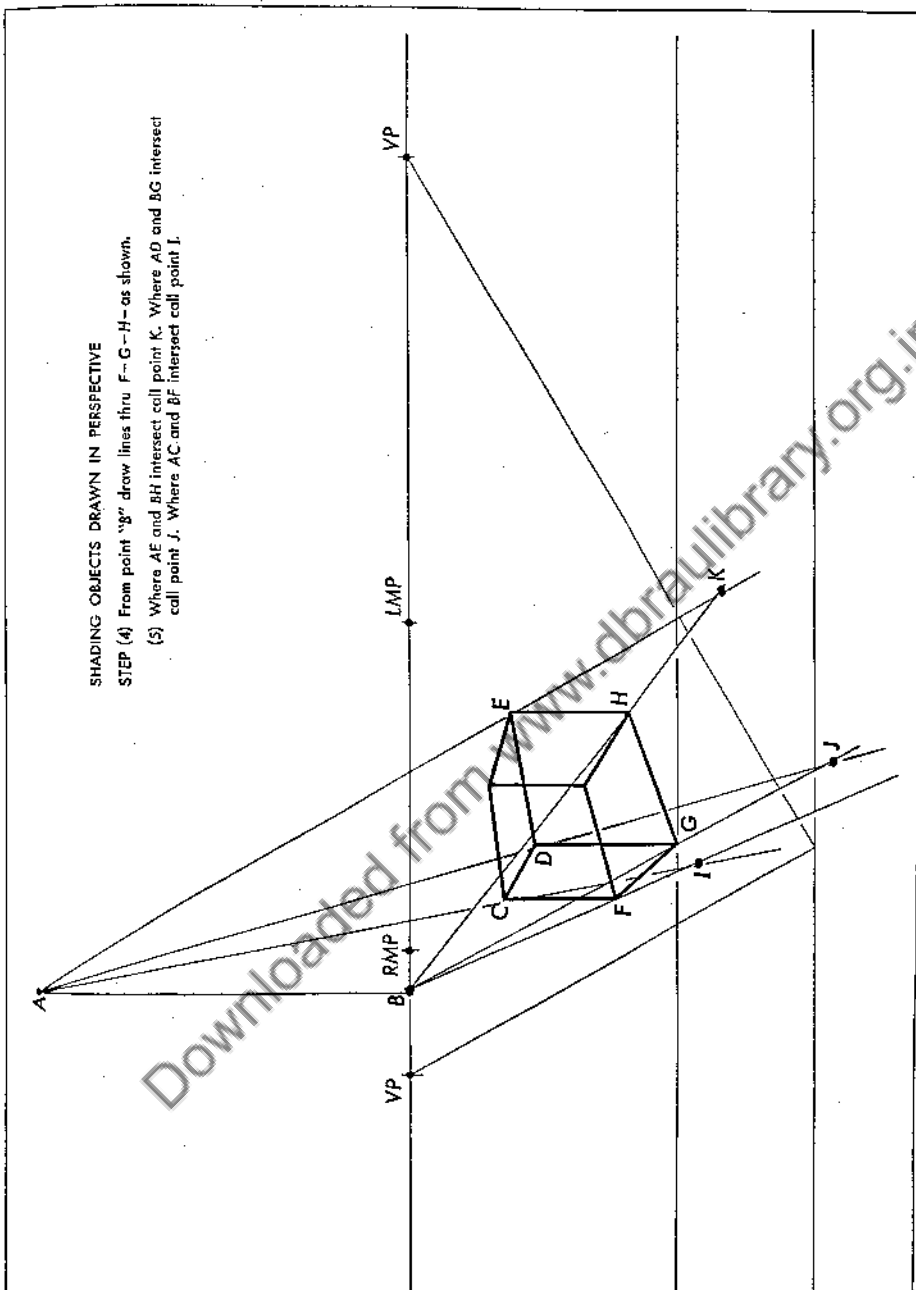
Fig. 36 Fig. 37

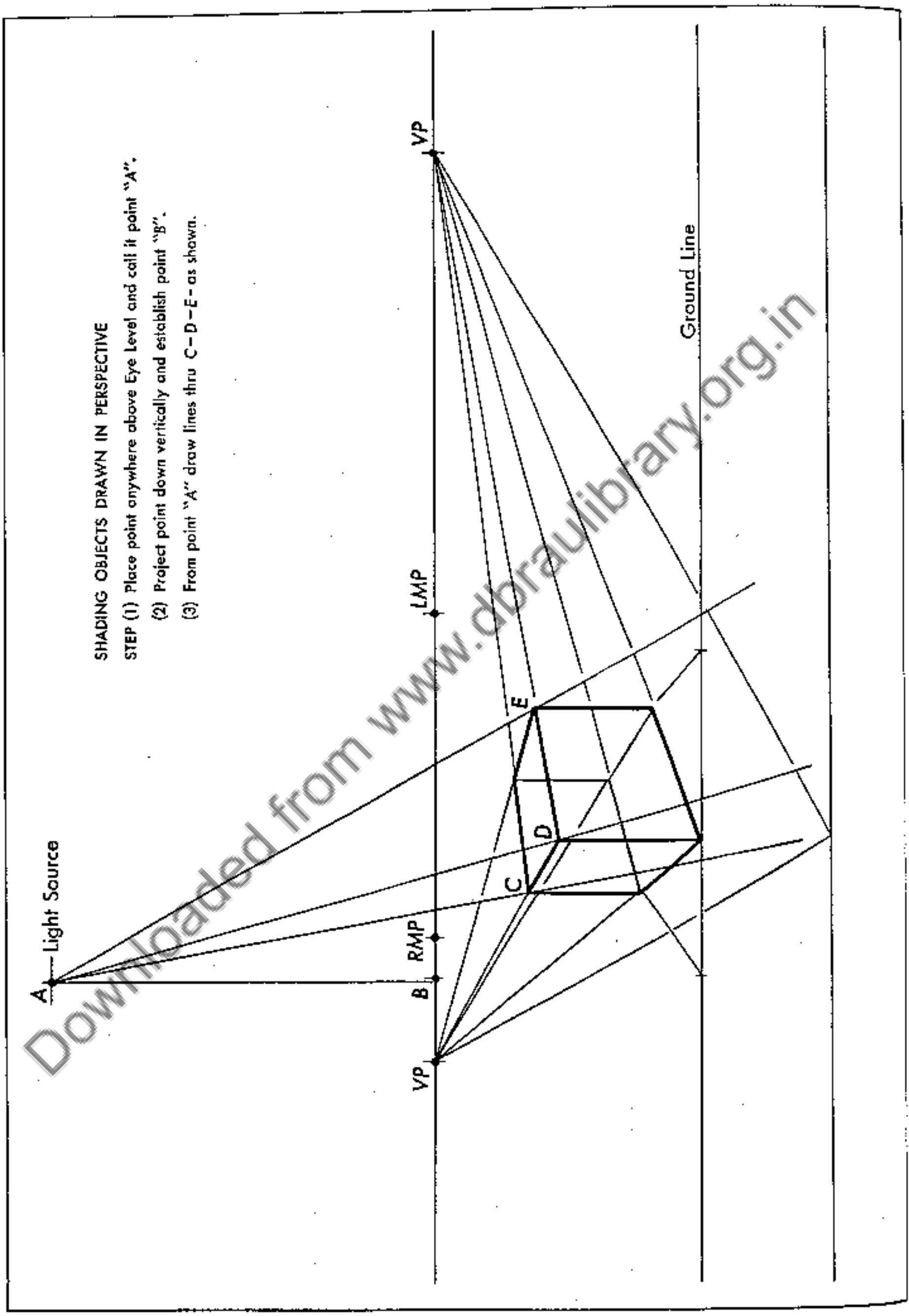


CIRCLE IN PERSPECTIVE

The left hand view of Part B will be used as an example in the following steps:

STEP 1 Draw diagonal lines *S* to *U* and from *V* to *T*. This establishes intersection *R*.
STEP 2 Draw lines *I* - *K* and *L* - *J* thru *R*.
STEP 3 Subdivide diagonals in half from *R* to *S*, *R* to *T*, *R* to *U*, *R* to *V* and then to quarters to establish points *E*, *F*, *G*, and *H*.
STEP 4 Connect points *I*, *E*, *J*, *F*, *K*, *G*, *L*, and *H* as shown. These circles in perspective were refined after points were connected. The three views shown will suffice for all circles in perspective.


SHADING OBJECTS DRAWN IN PERSPECTIVE
STEP (4) From point "B" draw lines thru F–G–H–as shown.
(5) Where AE and BH intersect call point K. Where AD and BG intersect call point J. Where AC and BF intersect call point I.
VP
LMP
RMP
VP
A
B
C
D
E
F
G
H
I
J
K


SHADING OBJECTS DRAWN IN PERSPECTIVE
STEP (1) Place point anywhere above Eye Level and call it point "A".
(2) Project point down vertically and establish point "B".
(3) From point "A" draw lines thru C—D—E—as shown.
Light Source
A
B
VP
RMP
LMP
VP
C
D
E
Ground Line

SHADING OBJECTS DRAWN IN PERSPECTIVE

STEP (6) Connect points F–I–J–K–H–and the result is a mechanically constructed shadow of the object.

(7) Remove lines and shade.
Example shaded shown below.

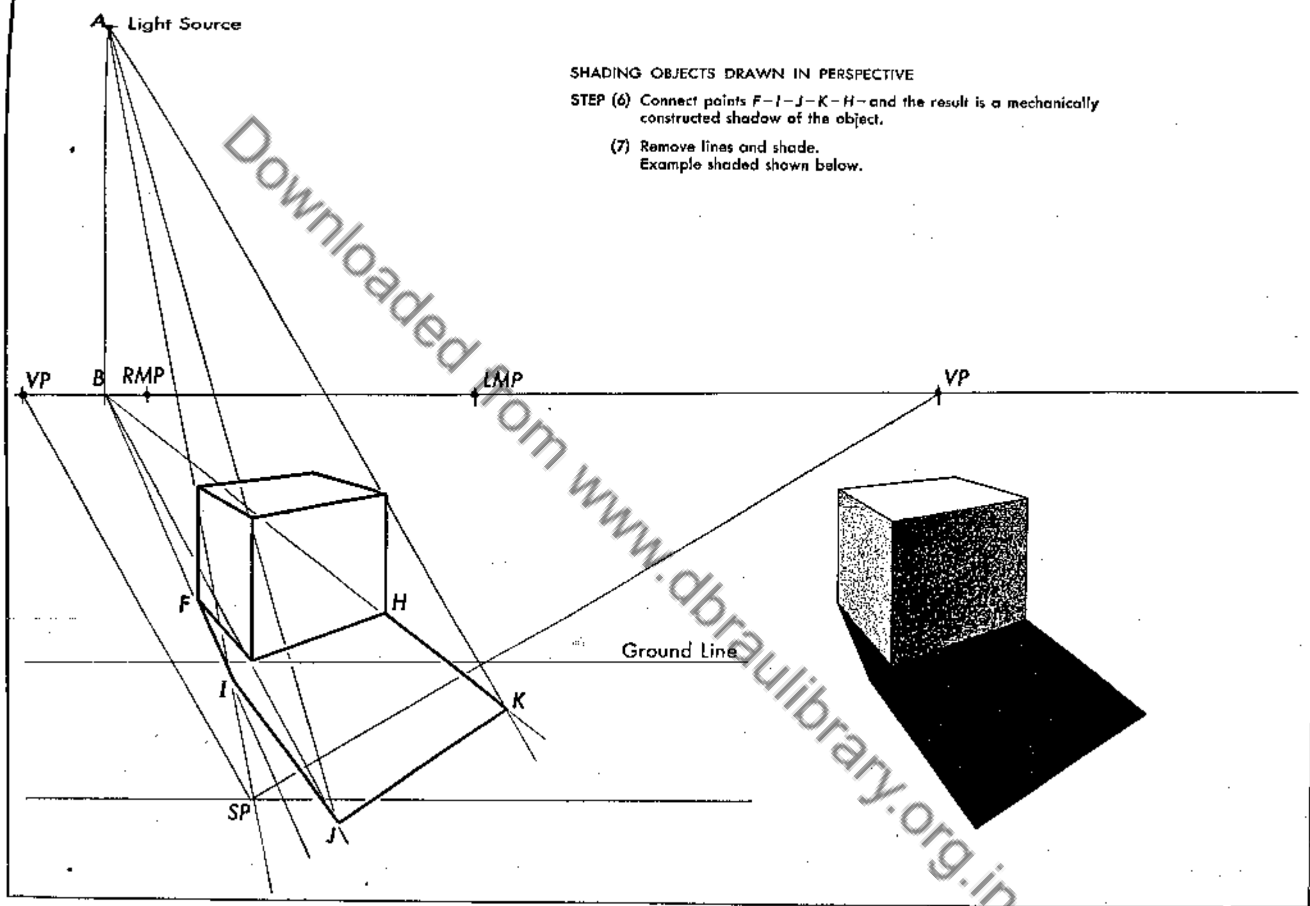
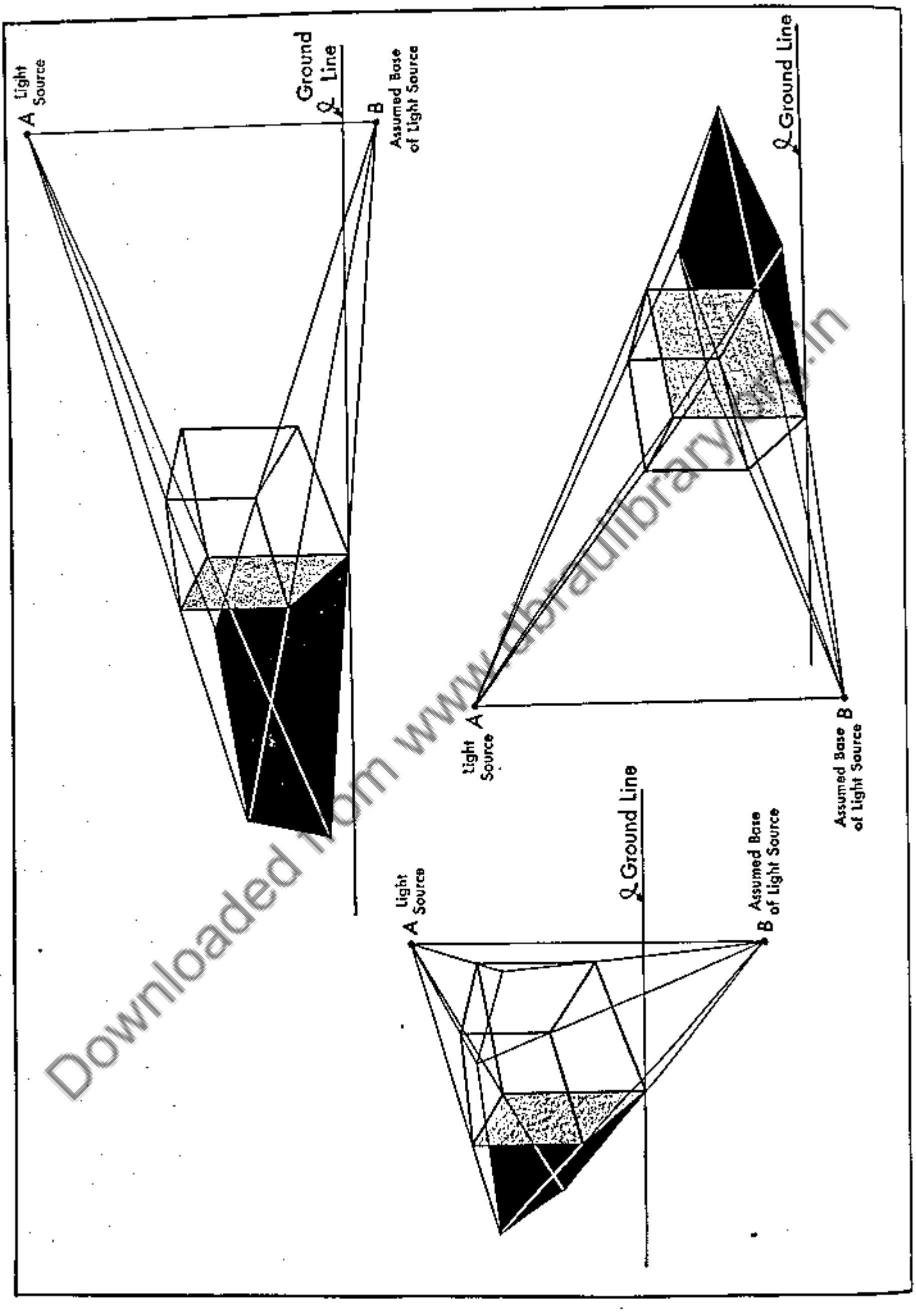
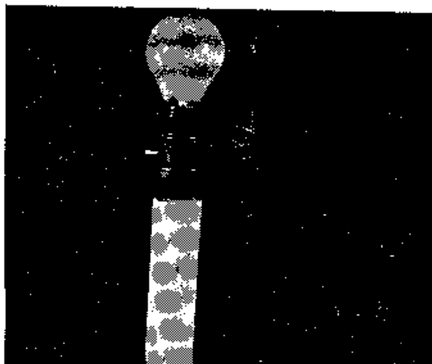


FIGURE 40

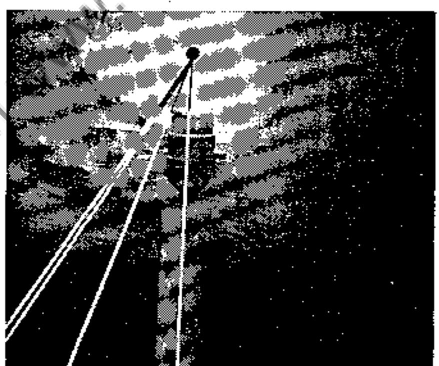

A
Light Source
Ground Line
B
Assumed Base of Light Source
A
Light Source
Ground Line
B
Assumed Base of Light Source
A
Light Source
Ground Line
B
Assumed Base of Light Source

A SHADOW PROJECTION BOARD



A

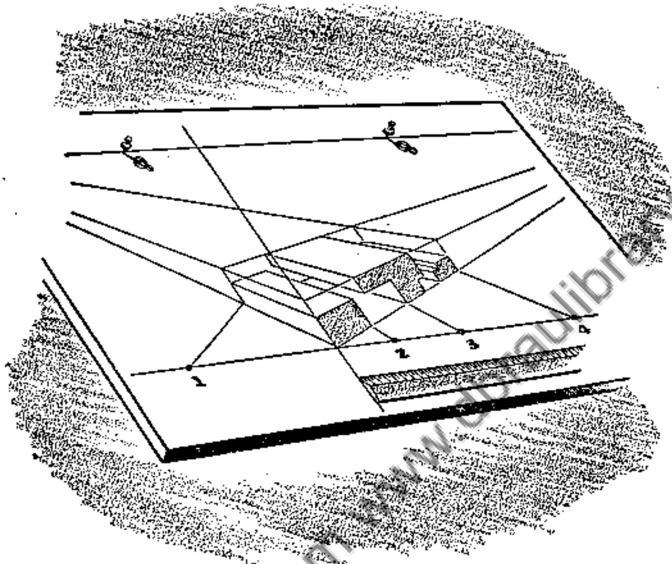
Showing a photo of an unlighted shadow projection model with the geometric figures placed at a desired location in order to assist the illustrator to visualize the light principle.



B

Showing the shadow projection model lighted. This shows the shadows cast by the geometric figures on the base plane. Lines on base plane indicate the angle of the shadow cast on the base plane.

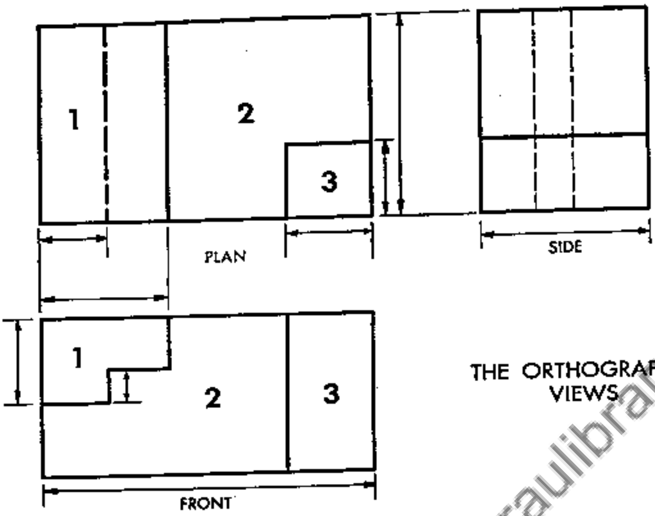
Chapter 4 MECHANICAL METHOD FOR EXPLODING VIEWS



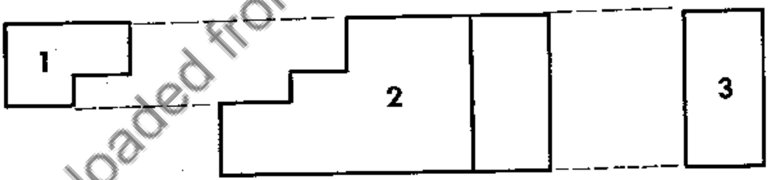
IN THE PRECEDING chapter the method of making a perspective drawing has been thoroughly explained. Those steps are essential and important, because they are the basis for each true-scale perspective rendering and also because they apply to the drawing of an exploded view of an assembly which is designed to expedite tomorrow's production.

The method which is discussed and explained in the following pages applies to exploded drawings which must be done accurately in scale. As a rule, freehand renderings are acceptable; however, the following will provide the necessary background for doing a drawing accurately if the occasion calls for such a drawing.

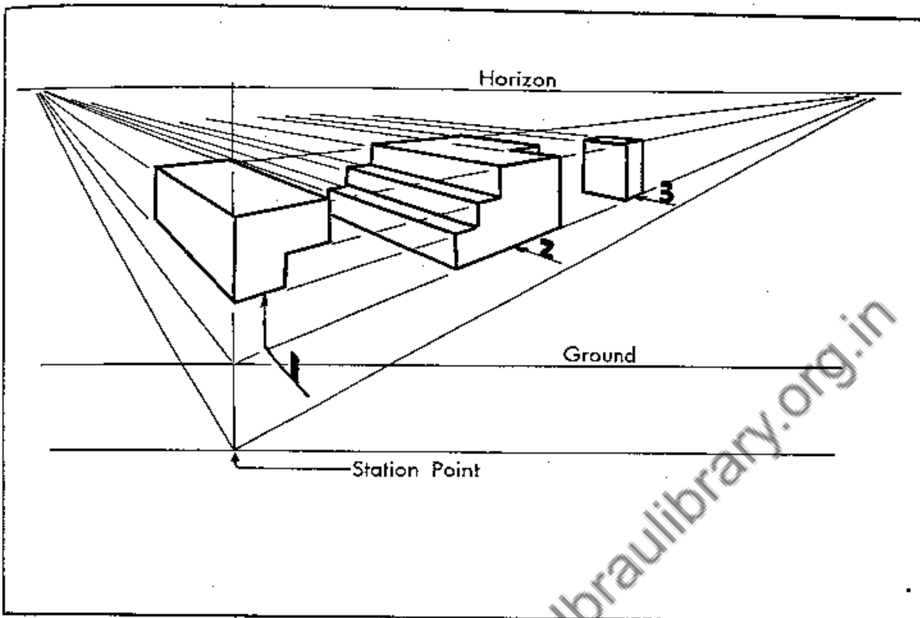
The examples shown in Figs. 43 through 47 will appear to be very simple and elementary; nevertheless, they are representative of various conditions with which the illustrator is confronted in drawing more



THE ORTHOGRAPHIC VIEWS



THE ORTHOGRAPHIC EXPLOSION



complicated objects. Bear in mind, however, that no matter how complicated and varied the object may be, the approach is always the same, as illustrated by these primary examples.

First, study the orthographic drawing as indicated by the upper half of Fig. 43 and then separate, or explode into individual units, as also indicated by the numbers 1, 2, 3 of Fig. 43, allowing space between the units. Now, enclose the units within an imaginary box. This indicates the over-all dimensions of the units to be exploded.

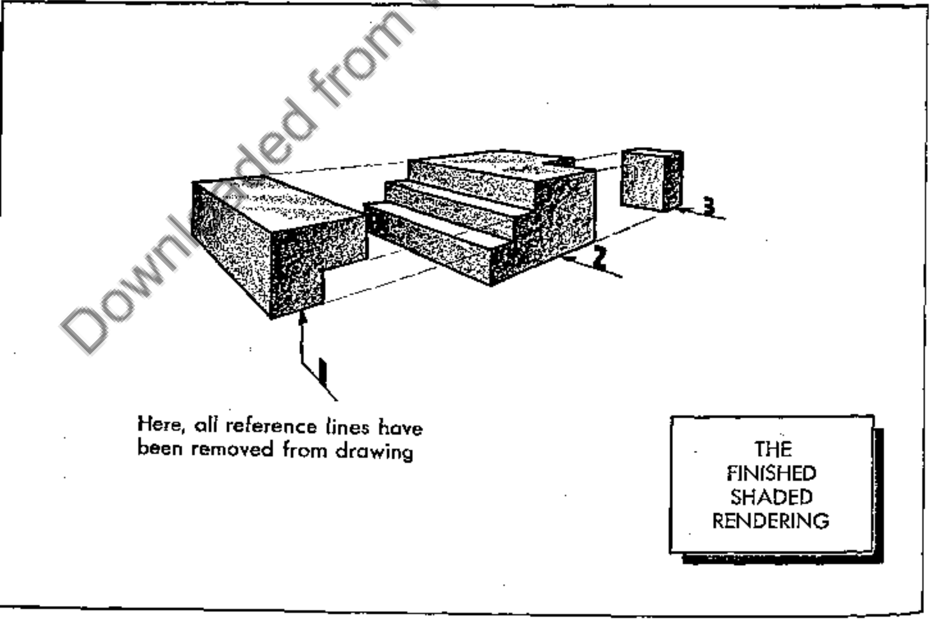
Second, set up the layout in accordance with the basic fundamentals for making a perspective drawing and proceed by drawing unit 1, which is stationary, as shown in Fig. 44. Place unit 2 a short distance from unit 1, but if the view appears crowded, increase the space between unit 1 and unit 2. The same rule applies also to the placement of unit 3.

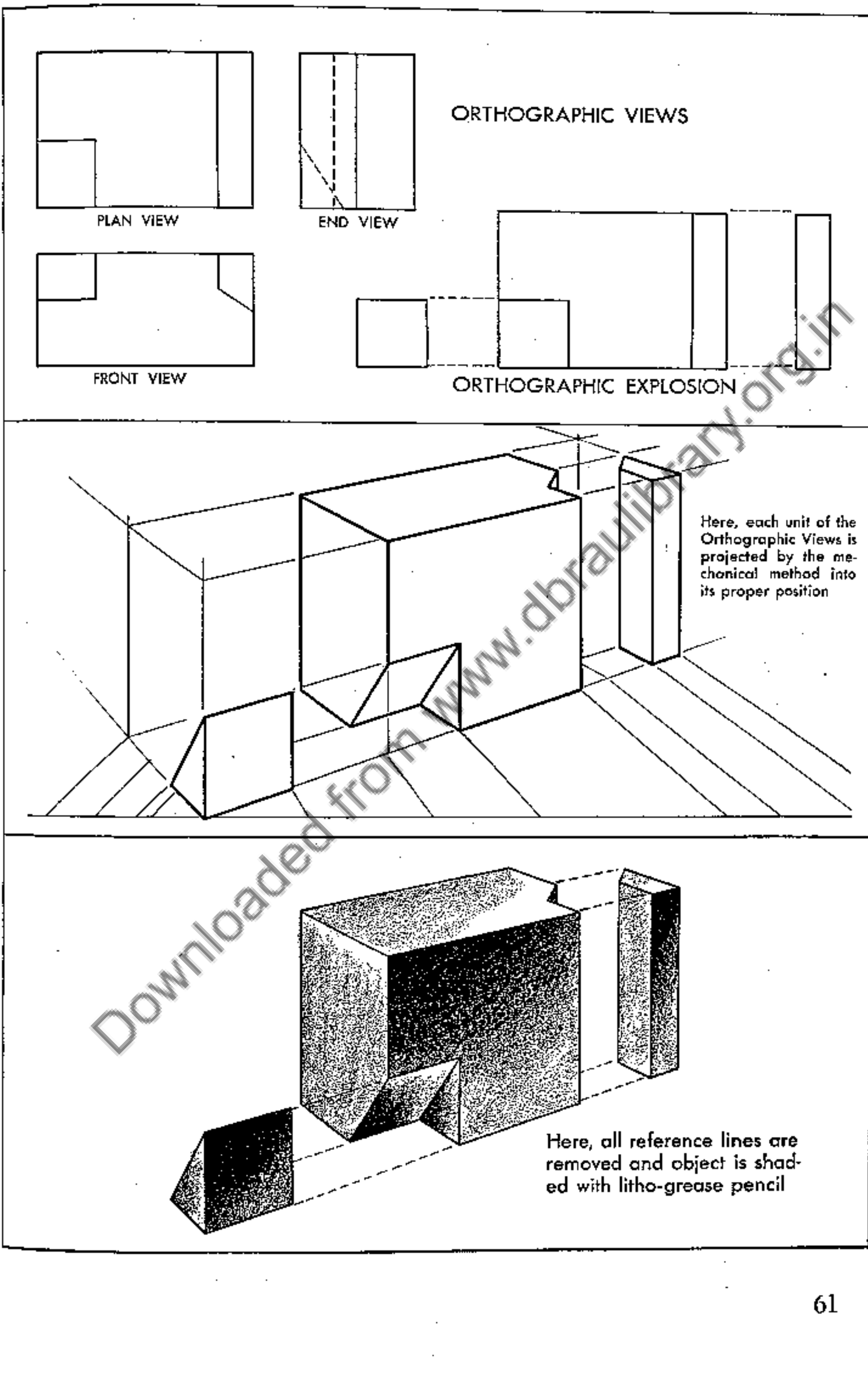
Third, place tracing paper over the projected and exploded units and copy, omitting all reference lines. Then ink in the lines with a draftsman's ruling pen and shade if desired with a litho-grease pencil (see Fig. 45). Of course other mediums can be used for shading besides a litho-grease pencil, depending upon the shading effect desired (see

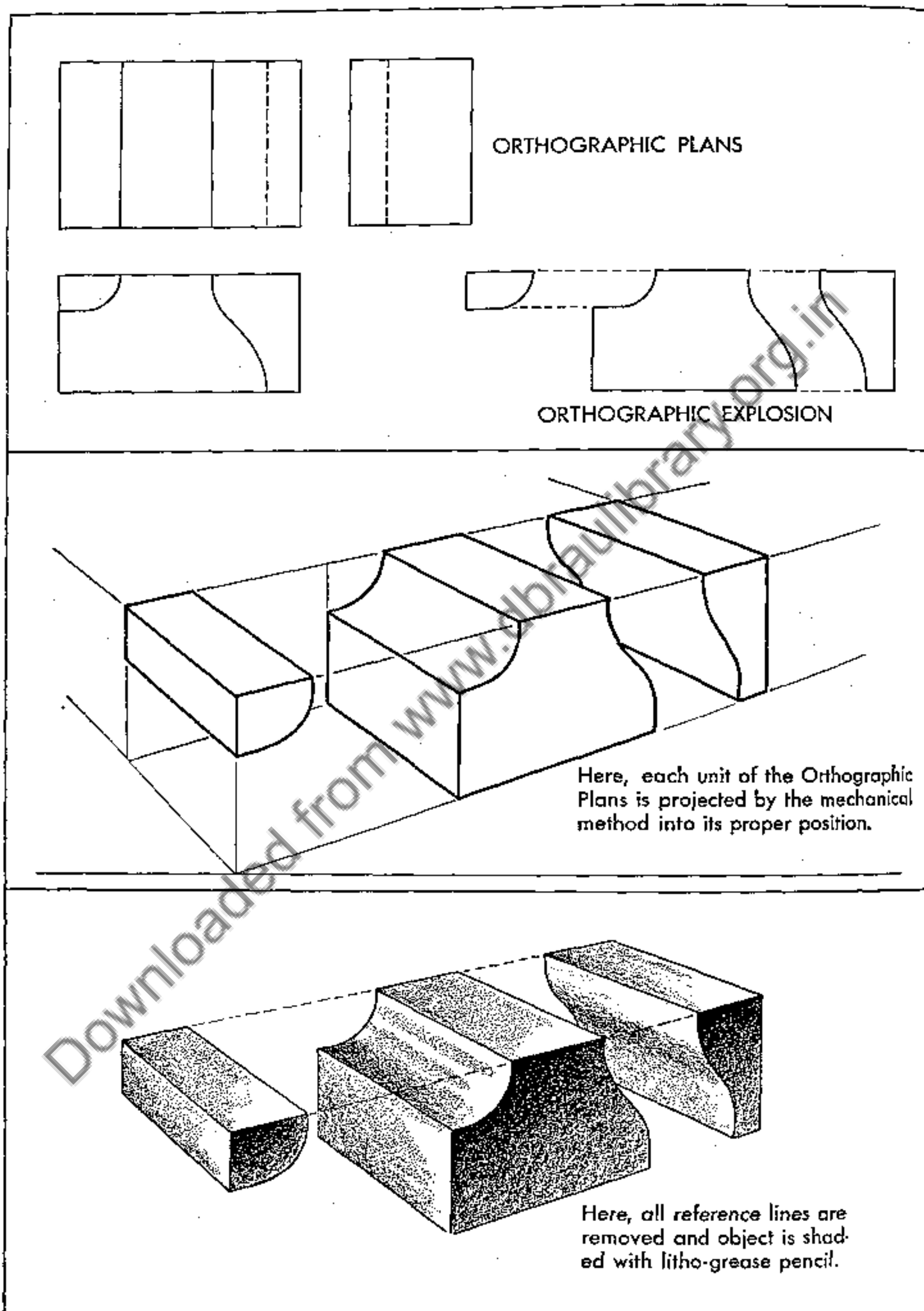
Chapter 9 on Rendering). Grease pencil is popular however, because it reproduces well. For other examples of exploded drawings see Figs. 46 and 47. It should be remembered, however, that the illustrator does not necessarily project into true scale every exploded drawing he may be required to make. For example, Fig. 48 shows an exploded drawing which was made freehand by estimating the separations between parts. An exploded drawing of this nature is usually done with the aid of a perspective reference line chart, as discussed in Chapter 6.

Instead of an illustrator's drawing, it may sometimes be desirable to use exploded-view photographs as illustrated by Fig. 49. An exploded-view photograph is made after the product has been manufactured, while a drawing may be made at any time, before or after manufacture. In some cases photographs are objectionable since much of the detail is lost in reproduction. For example, notice part number 8 in the top photograph of Fig. 49. It is hard to tell exactly what this part looks like; but had this exploded view been drawn, the details could have been exaggerated slightly so that the part would not appear vague, dull, or hard to visualize in reproduction.

FIGURE 45

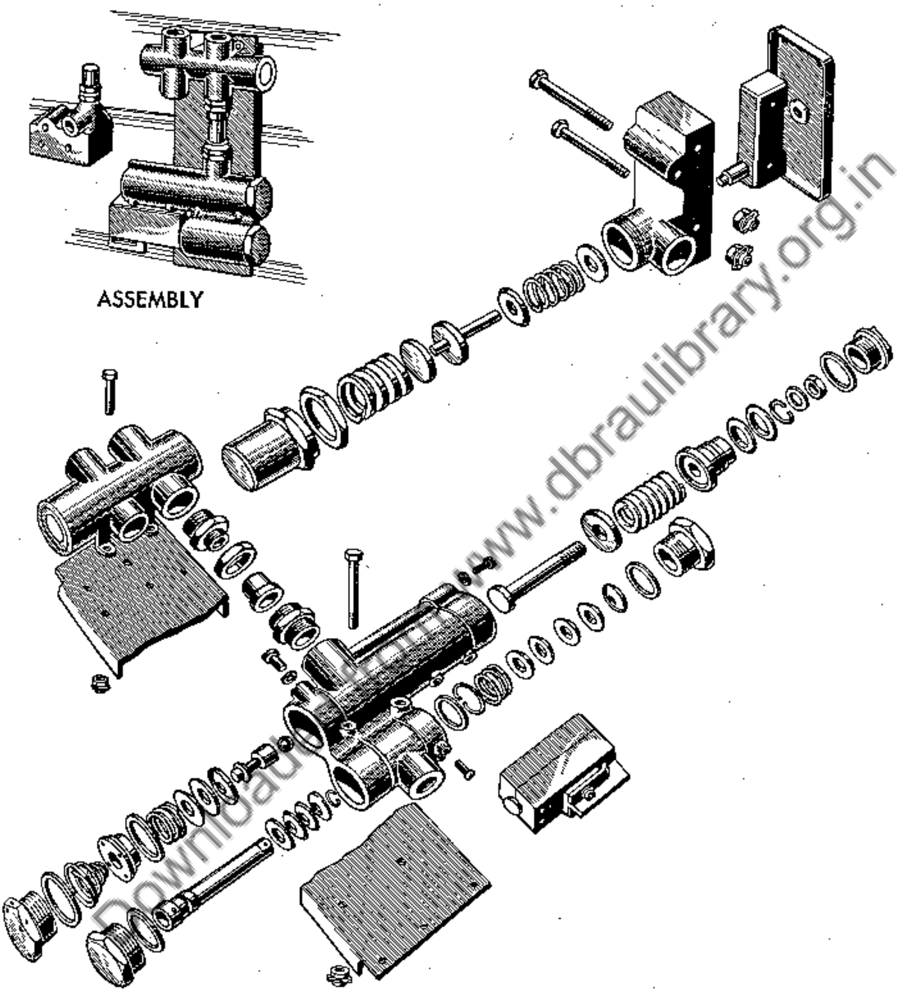



ORTHOGRAPHIC VIEWS
PLAN VIEW
END VIEW
FRONT VIEW
ORTHOGRAPHIC EXPLOSION
Here, each unit of the Orthographic Views is projected by the mechanical method into its proper position
Here, all reference lines are removed and object is shaded with litho-grease pencil



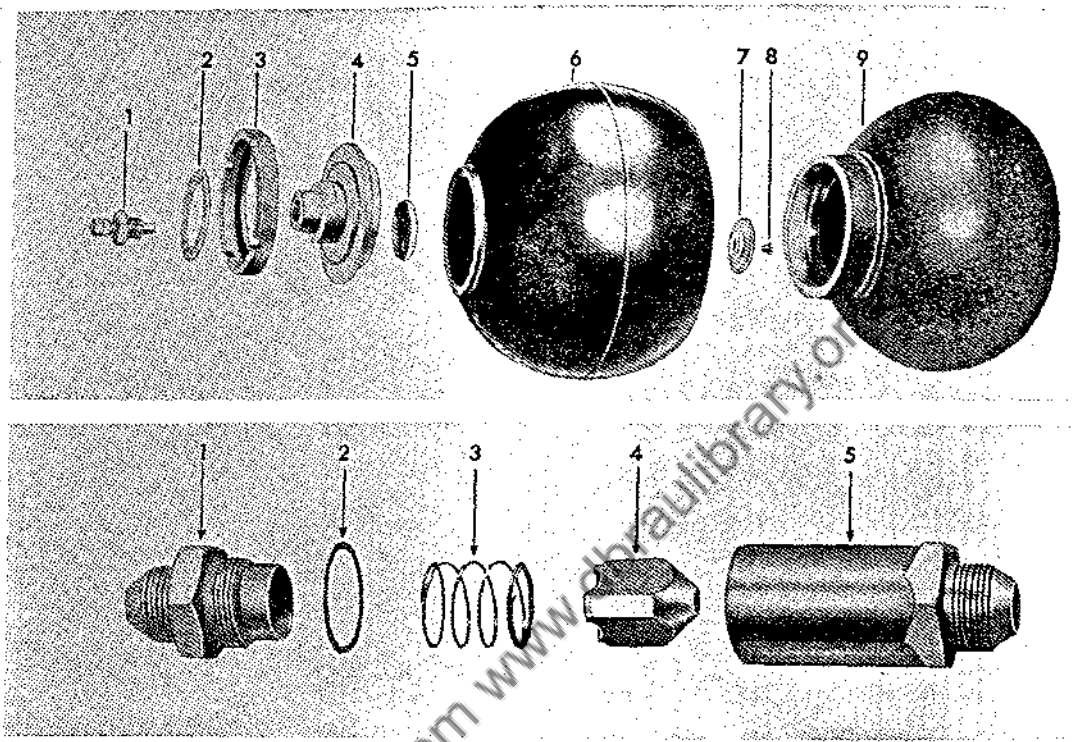
Here, each unit of the Orthographic Plans is projected by the mechanical method into its proper position.

Here, all reference lines are removed and object is shaded with litho-grease pencil.



Illutsration of an exploded unit which has been drawn in free-hand with the aid of a perspective reference line chart

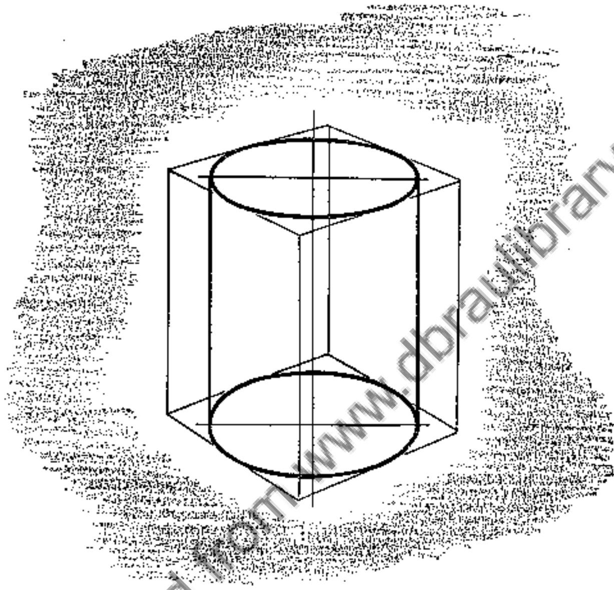
FIGURE 49



Examples showing the use of photographs for making exploded views of units which have already been manufactured and disassembled.

Chapter 5

FUNDAMENTALS FOR ILLUSTRATIVE DRAWING



EVERY ILLUSTRATOR is constantly confronted with many problems involving the construction of particular shapes, intersections, and irregular lines. To determine the construction of some specific problem is of special importance when the illustrator is working in freehand with the use of a **perspective reference line chart.** (See Chapter 6 for an explanation of the use of the reference line chart.) The illustrator should have some specific method for laying out his dimensions in perspective when there are no vanishing points within the limits of the table. One of the most practical methods for determining dimensions in perspective is to *bisect areas.* For example, as illustrated by Fig. 50, to find a dimension of 2 inches from the front corner of the object A, the side on which the dimension is to be located is first bisected diagonally from each corner. If a vertical line is drawn through the intersection of the diagonal lines it will represent 2 inches along the side of the object from the front corner. Then if this area, formed by the first bisection, is also bisected diagonally, the resulting intersection will be 1 inch along the side of the object from the front corner. Objects *B*, *C*, and *D* of Fig. 50 will show additional bisections for determining fractional parts of an object.

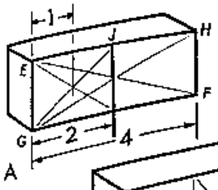
This same method of bisecting may be used to locate **centers**, as illustrated by the lower part of Fig. 50.

For a step-by-step instruction on how to determine the major and minor axes of concentric ellipses, refer to Fig. 51. Other fundamentals for bisecting to locate dimensions are shown in Figs. 52, 53, 54, and 55.

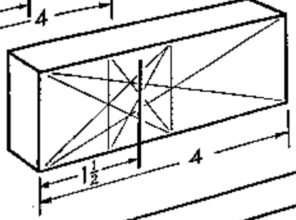
In addition to the fundamentals already discussed it is important that the illustrator have a basic understanding of what happens to the circle in perspective. To help visualize the function of the circle in perspective, Figs. 56, 57, and 58 show three photographs of a visual-aid model in various positions. For instruction in how to draw circles in perspective see Chapter 3, Fig. 37.

DIMENSIONING BY BISECTING

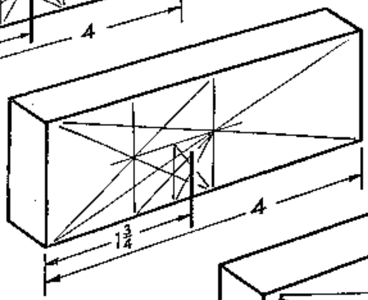
Draw a diagonal line through *E* and *F*, and *G* and *H*. Then draw line *J* parallel to *E*, *G*, or *H*, and *F*. The result will be dividing a four-inch rectangle into two parts, or getting the dimension of two-inches. Knowing the principal of bisecting is of great importance, it eliminates minute dimensions.
B, C, and D, are approached in the same manner except for adding necessary bisectors for required dimensions.



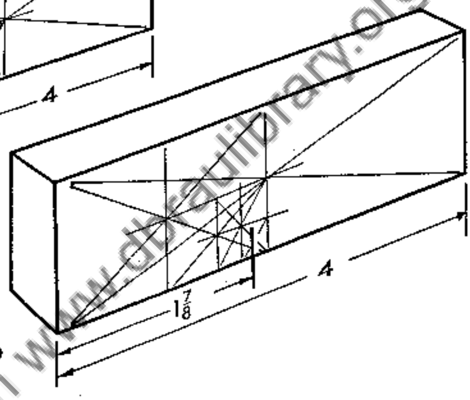
A



B

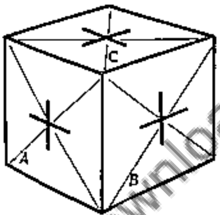


C

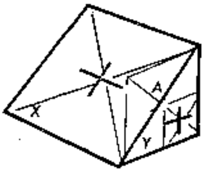


D

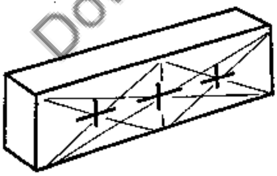
LOCATING BY BISECTING



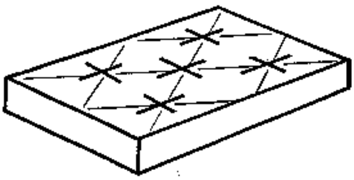
Centers for holes were located on this cube by bisecting sides *A*, *B*, and C.



Center on an oblique plane *X* was located the same as on the cube. To locate hole on plane Y, construct a vertical through intersection A, then draw in square and bisect.

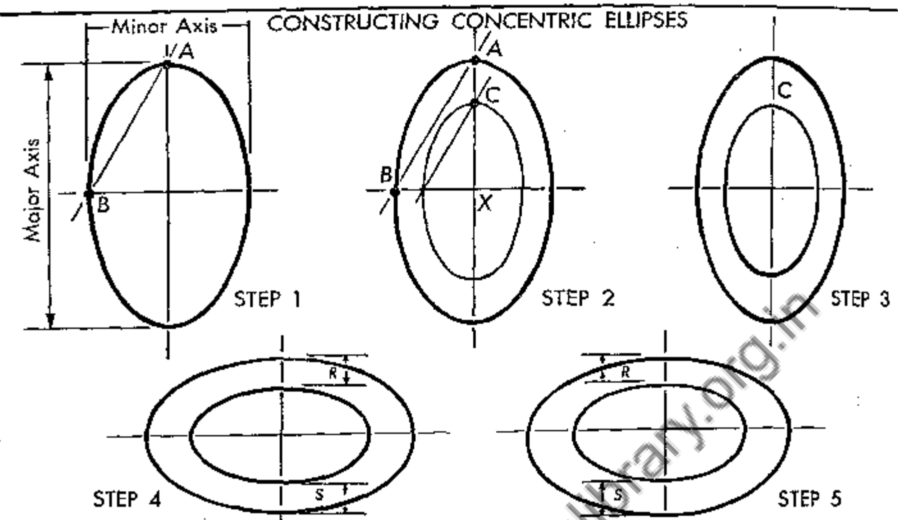


Locating centers on a rectangular plane is the same principal, only adding two more bisectors to get the three centers



To locate the five centers on this object, make one larger and four small bisectors.

CONSTRUCTING CONCENTRIC ELLIPSES



METHOD

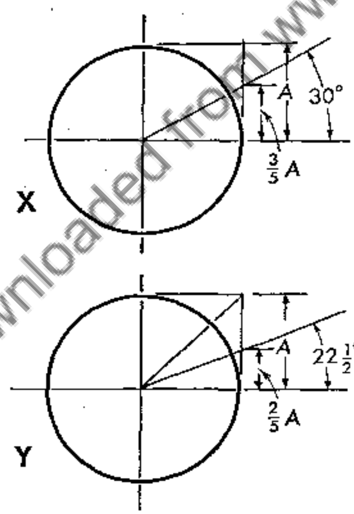
STEP 1 Draw a line through *A* and *B*.

STEP 2 Locate point C anywhere between *A* and *X*, then draw a parallel line to line *AB*, the result will give necessary points to construct a concentric ellipse.

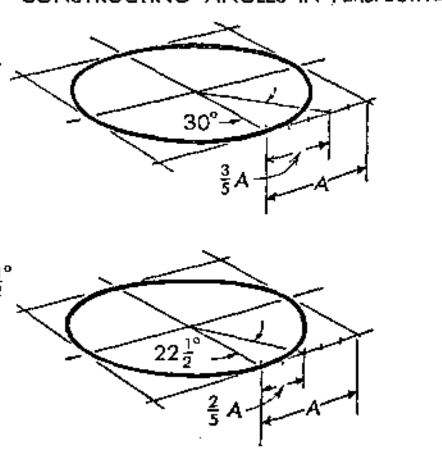
STEP 3 This step shows the concentric ellipse completed.

STEP 4 This example gives no allowance for diminishing as would occur in true perspective, however it is practical for average work. Note that *R* and *S* are equal.

STEP 5 This example shows the allowance as would occur in true perspective and where greater accuracy is needed. Note that *R* is less than *S*. This allowance is usually judged by eye.

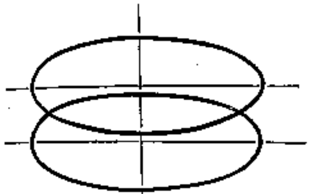


PROPORTIONAL METHOD FOR CONSTRUCTING ANGLES IN PERSPECTIVE

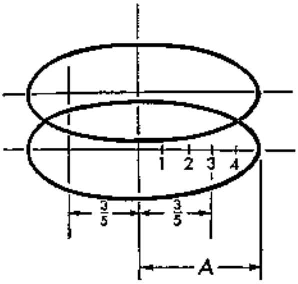


The above examples showing the proportional method for constructing angles, are within a half degree. This method will coincide with the free hand drawing in perspective which is approached in the same manner, by bisecting and proportioning. Other angles can be acquired by using the same method.

THE CONSTRUCTION AND DRAWING OF A NUT



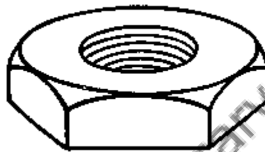
STEP 1



STEP 2

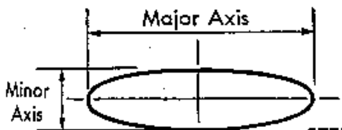
METHOD

STEP 1 First draw two ellipses as shown.
STEP 2 Draw two lines parallel to the center line, three-fifths of the distance *A* as shown.
STEP 3 Draw in arcs, hole, threads and accent the lines that make up the nut.

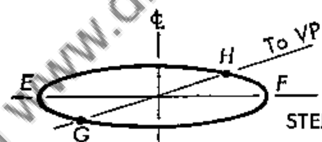


STEP 3

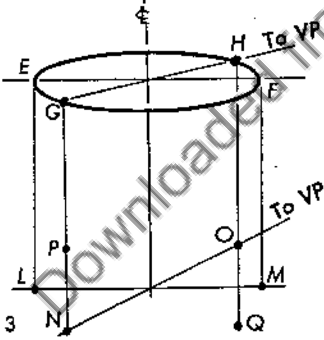
THE CONSTRUCTION AND DRAWING OF A CYLINDER



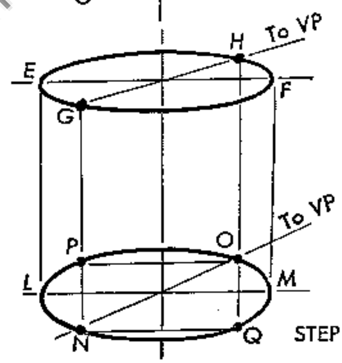
STEP 1



STEP 2



STEP 3

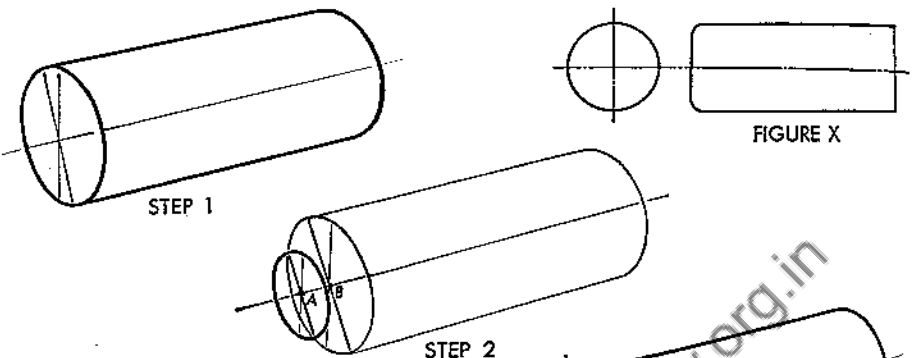


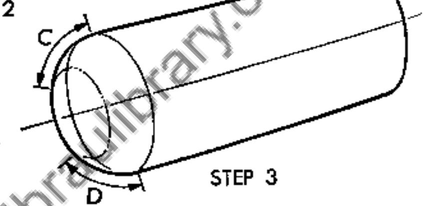
STEP 4

METHOD

STEP 1 Draw an ellipse with the major and minor axes as shown.
STEP 2 Draw line through center of ellipse going to vanishing point. The intersections will be *G* and *H*. *E* and *F* are intersections of the major axis.
STEP 3 Draw parallel lines to center line down at points *E, F, G,* and *H,* then draw another line to vanishing point, allowing enough taper so that the distance between G and *N* will be greater than between *H* and O. Draw parallel lines *P, O, - L, M, - N,* Q.
STEP 4 Draw ellipse through points *P, L, N, Q, M,* and O. The result will be a well constructed cylinder.

CONSTRUCTION OF A ROUNDED EDGE OF A CYLINDER





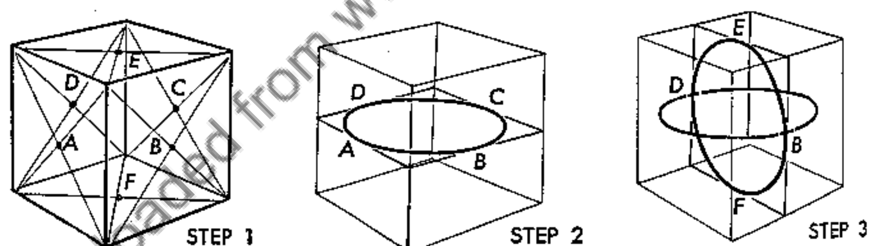
METHOD

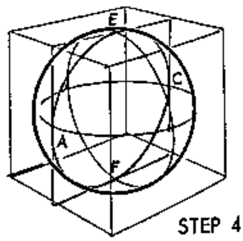
STEP 1 Figure X shows type of problem that will be constructed. First draw a cylinder as shown.

STEP 2 Measure off approximate distance between *A* and *B*. Then draw an ellipse as shown.

STEP 3 Draw in arcs *C* and *D* connecting at tangent points. Then accent lines to complete.

CONSTRUCTING A SPHERE WITHIN A CUBE





METHOD

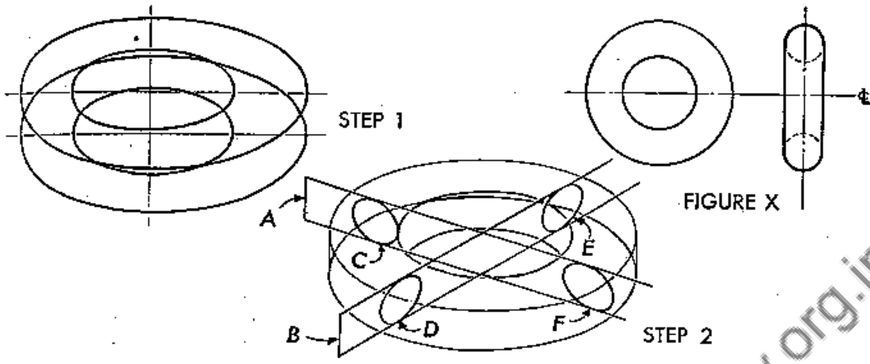
STEP 1 First draw a cube and bisect all sides, as shown.

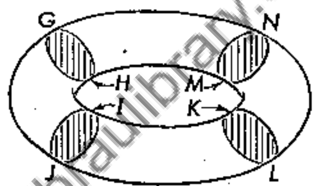
STEP 2 Draw lines through *A*, *B*, *C*, and *D*, and construct an ellipse using points *A*, *B*, *C*, and *D* as tangent points.

STEP 3 Draw lines through *E*, *D*, *F*, and *B*, and construct an ellipse using points *E*, *D*, *F*, and *B* as tangent points.

STEP 4 Draw lines through *E*, *A*, *F*, and *C*, and construct an ellipse using points *E*, *A*, *F*, and *C* as tangent points. The last step after completing the three ellipses, the arcs are drawn to complete the sphere, as shown.

CONSTRUCTING A TORUS





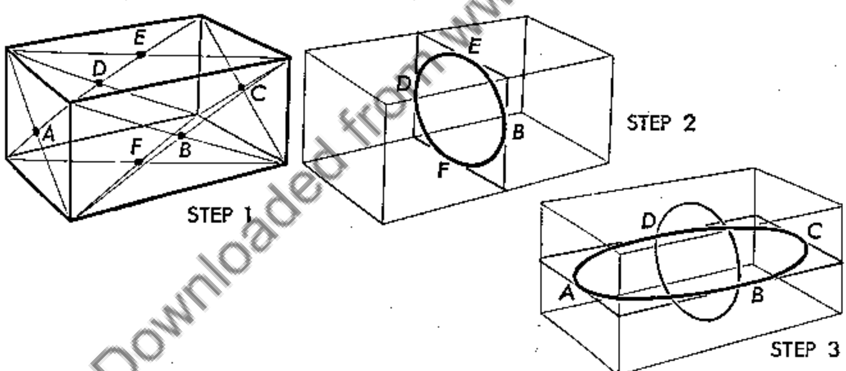
EXAMPLE

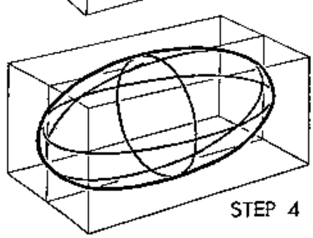
STEP 1 Draw two large ellipses, and two smaller ones to represent hole.

STEP 2 Draw two planes A and B, then construct ellipses C, D, E, and F.

STEP 3 The final stage connecting tangent points at G, H, I, J, K, L, M, and N, and accenting lines that compose the torus.

CONSTRUCTING AN ELLIPSOID





EXAMPLE

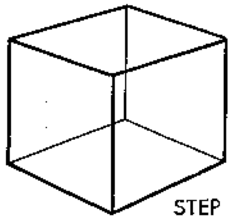
STEP 1 First draw a rectangular solid and bisect all sides as shown.

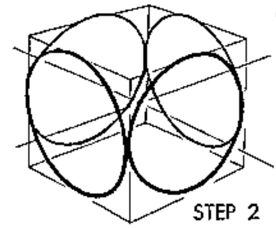
STEP 2 Draw lines through E, D, F, and B, and construct an ellipse using points E, D, F, and B as tangent points.

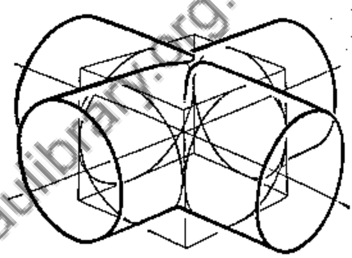
STEP 3 Draw lines through A, B, C, and D, and construct an ellipse using points A, B, C, and D as tangent points.

STEP 4 Draw lines through A, E, C, and F, and construct an ellipse using points A, E, C, and F as tangent points, the last step after completing the three ellipses, the arcs are drawn to complete the ellipsoid as shown.

CUBE METHOD FOR DRAWING INTERSECTIONS


STEP 1

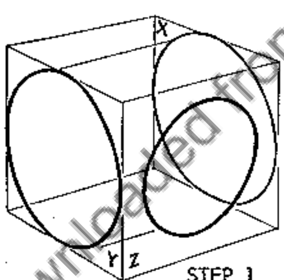

STEP 2


STEP 3

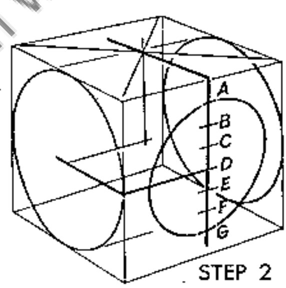
METHOD

STEP 1 Draw a cube in perspective.
STEP 2 Construct ellipses on all four sides of cube as shown.
STEP 3 Shows a completed intersection.

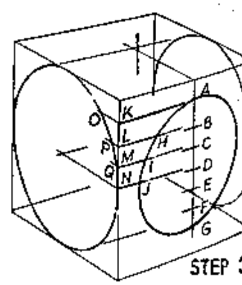
CONSTRUCTING INTERSECTING POINTS OF CYLINDERS



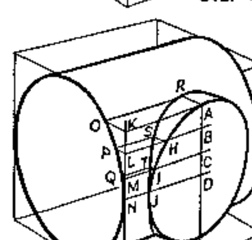
STEP 1



STEP 2



STEP 3

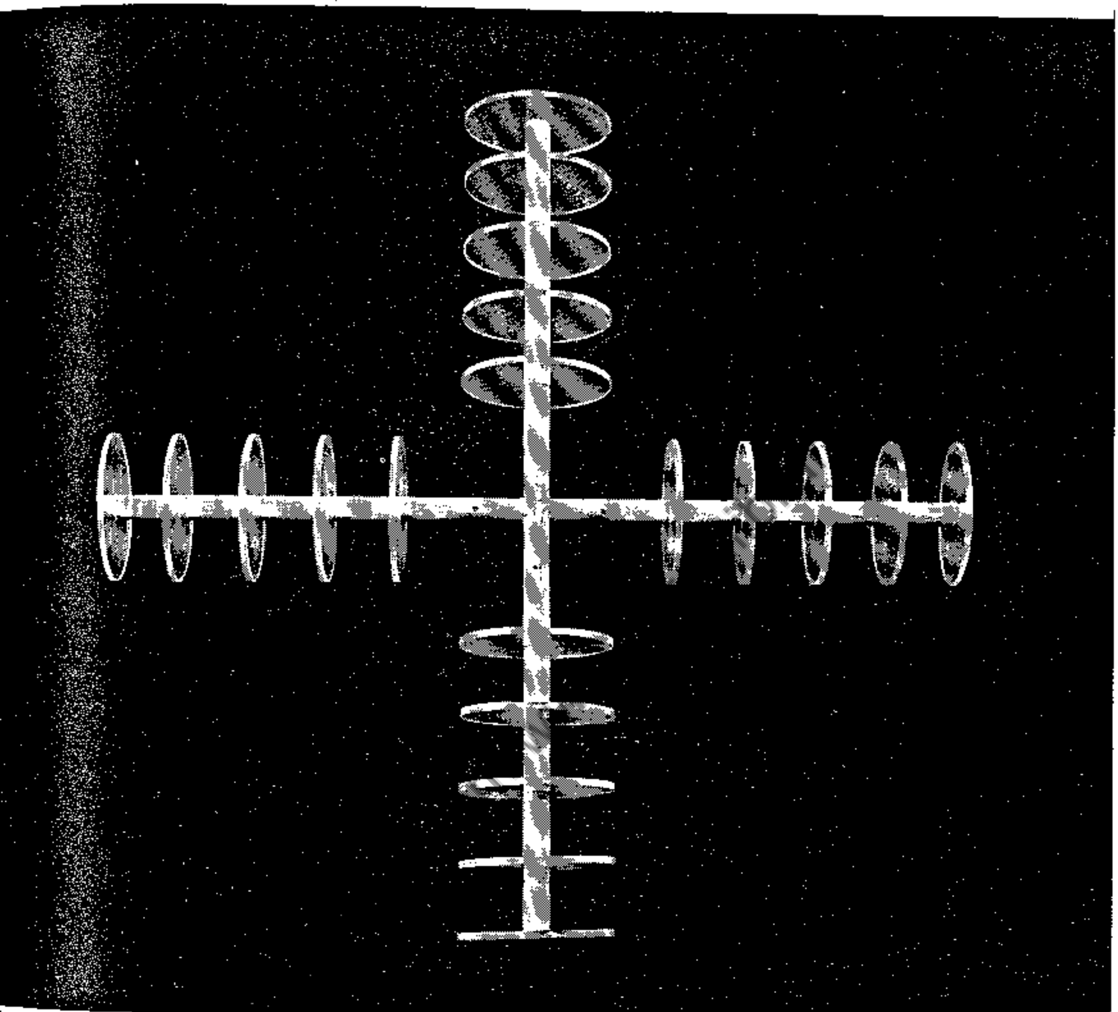


STEP 4

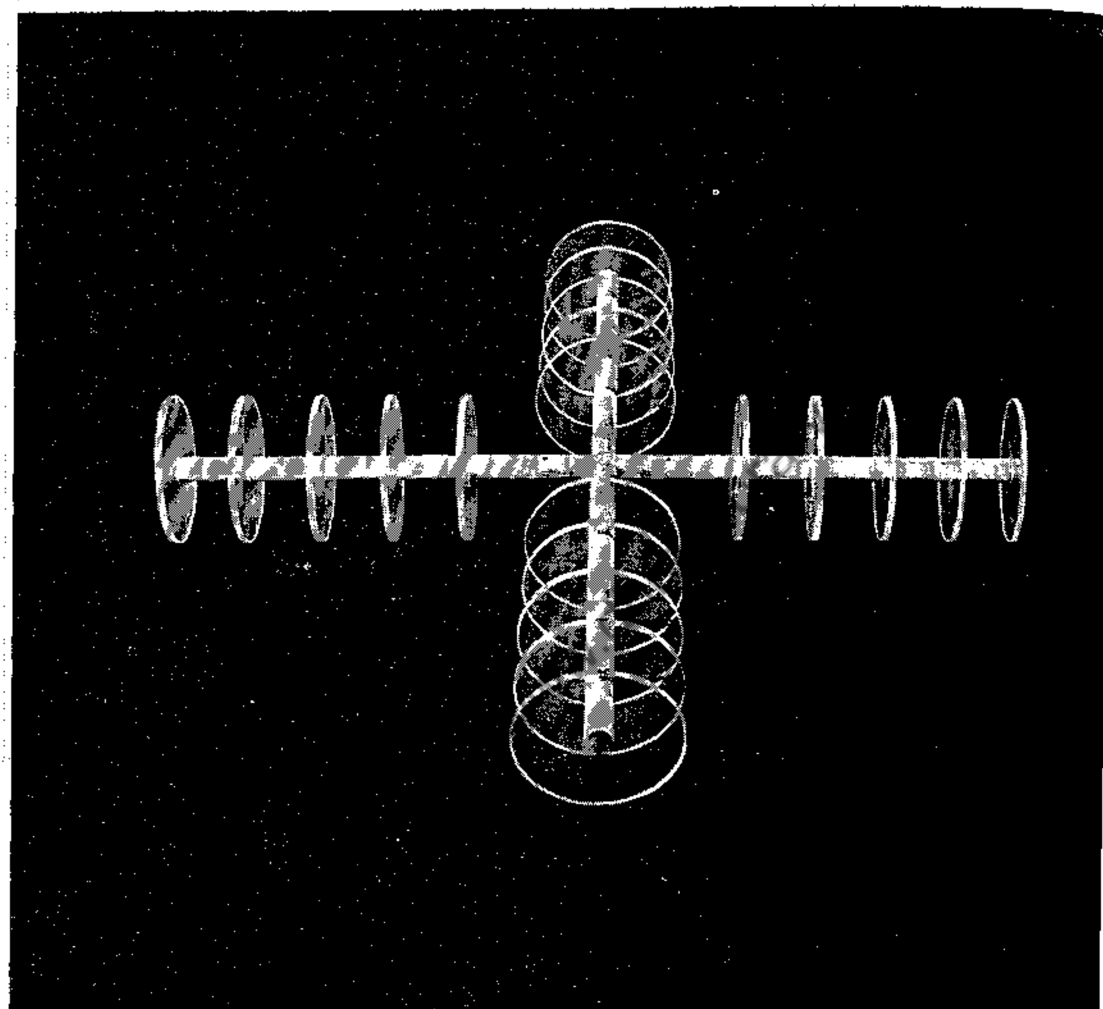
METHOD

STEP 1 Construct ellipses on sides *X, Y,* and *Z,* of a cube as shown.
STEP 2 Divide ellipses on *Z* side into six spaces, mark off as shown, *A, B, C, D, E, F,* and *G.*
STEP 3 Draw lines to intersect small ellipse, corner of cube, and intersection of larger ellipse, and mark as shown *H, I,* and *J.* For intersection points of small ellipse *K, L, M,* and *N,* at corner of cube intersection, and *O, P, Q,* for intersections of larger ellipse.
STEP 4 Draw a line from *A* to *R* and from O to *R,* this will give one intersection point. Next, *B* to *H* and *P* to *S* for the next intersection. Then *I* to *T* and Q to *T.* For the last point of intersection, connect points *R, S, T,* and *J.* This will give the principle of intersections.

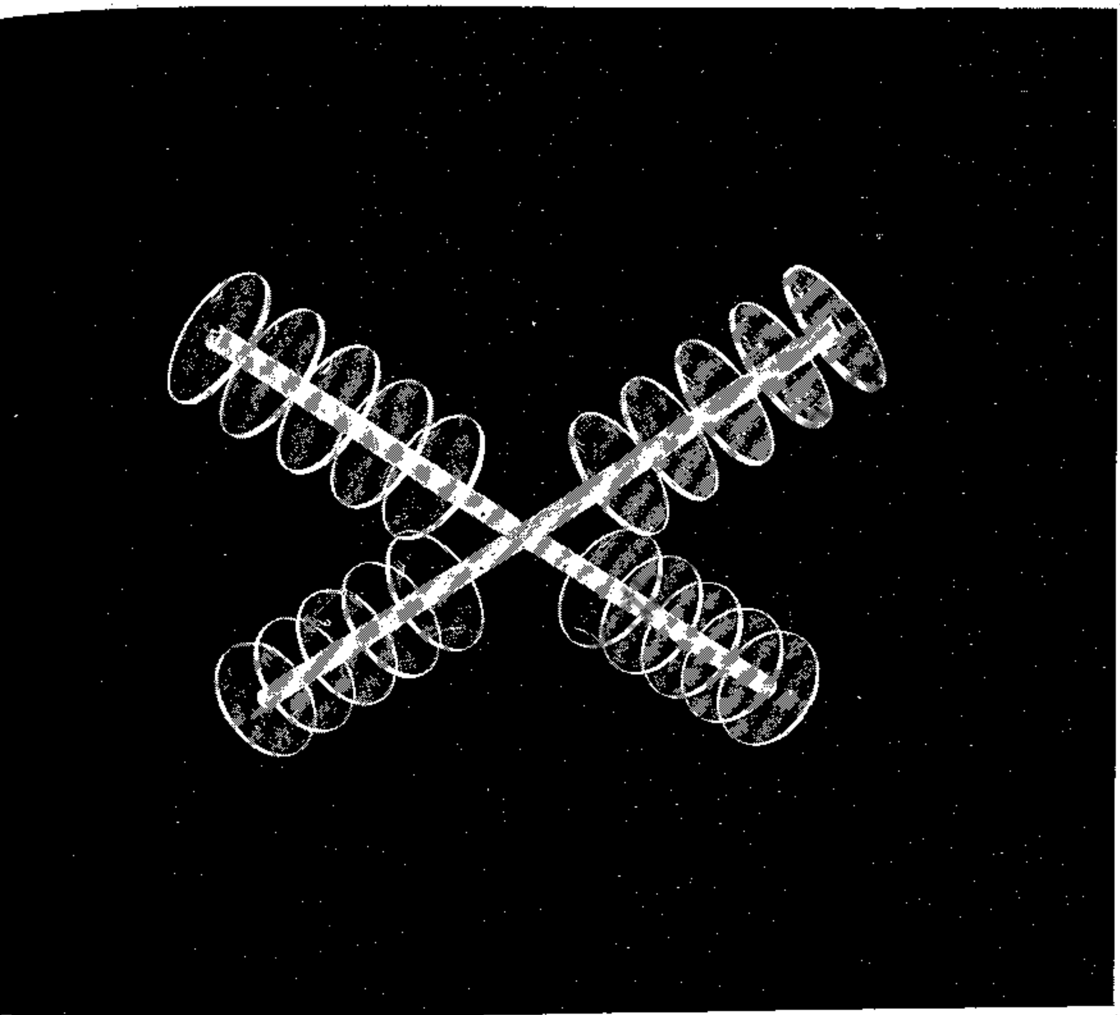
FIGURE 56



Photograph of a model designed to help visualize the principle of circles in perspective. Notice that the circle at the bottom of the illustration appears at eye level and appears to have no minor axis, while those above the eye level have minor axes. As the eye moves up, the minor axis of each circle increases. Notice also that the minor axes of circles which appear on the horizontal line increase when they are spaced at greater distances from the vertical center line, either to the left or to the right.

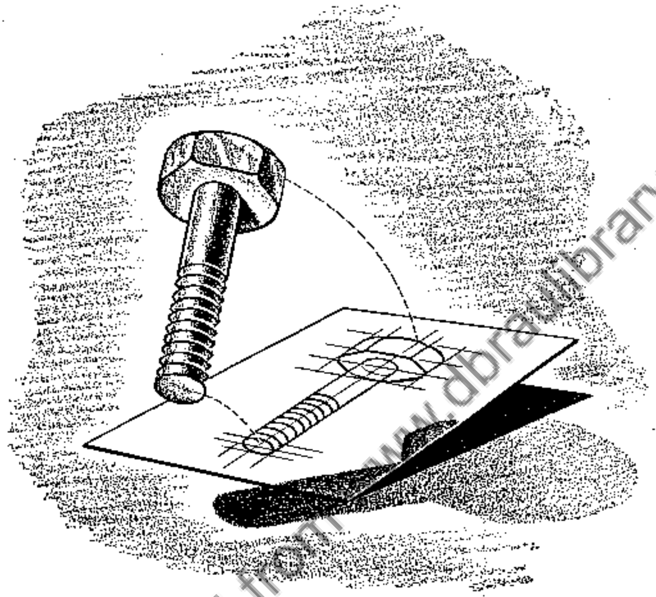


Using the same model as shown in Figure 56, notice that circles on the vertical-center line, when revolved at the horizontal line, greatly increase their minor axes when they appear at greater distances above the eye level.



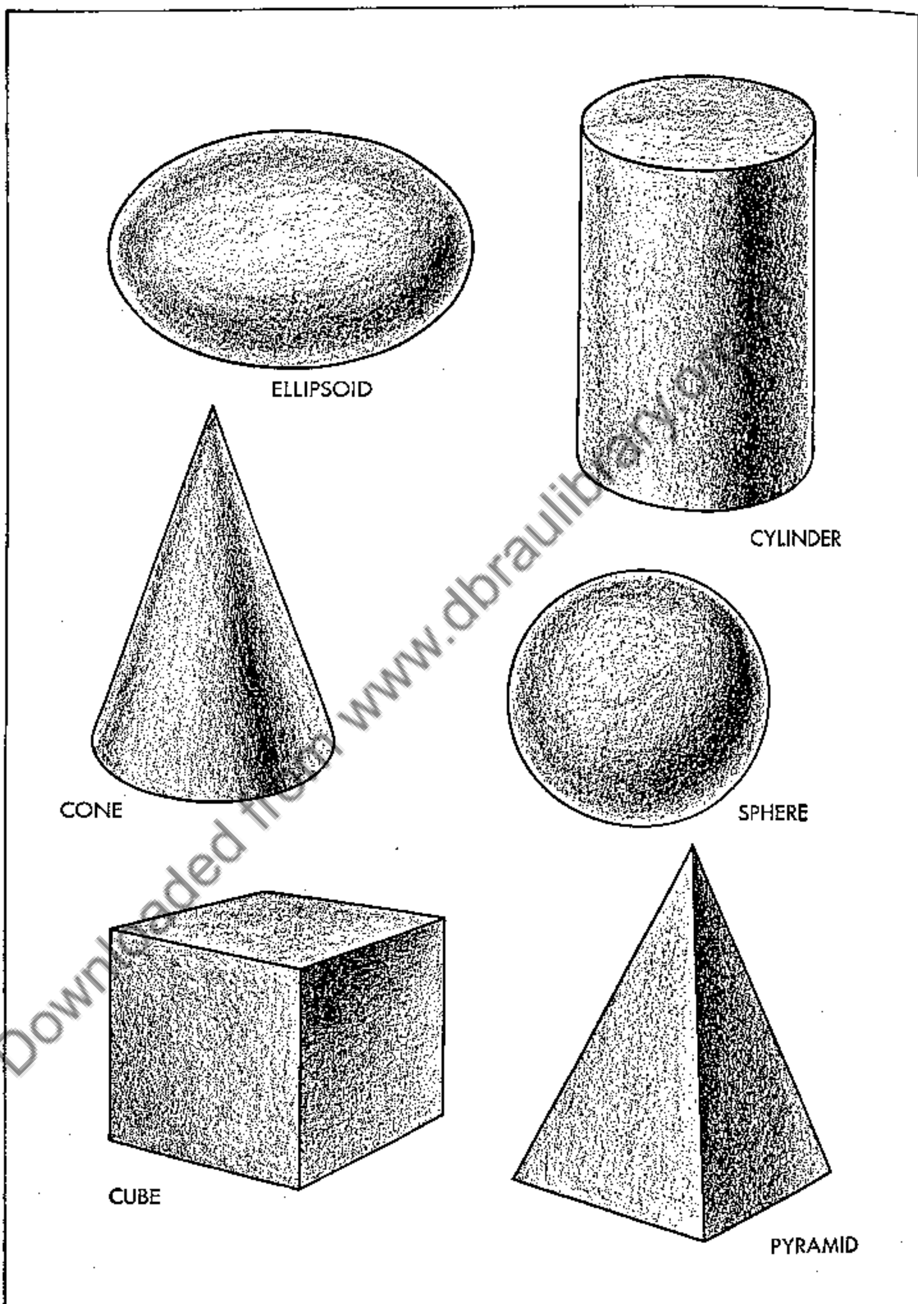
Using the same model as shown in Figure 56, the vertical and horizontal axes have been set at an angle which shows circles in perspective above the eye level. By turning the illustration upside down the circles will appear to be below the eye level.

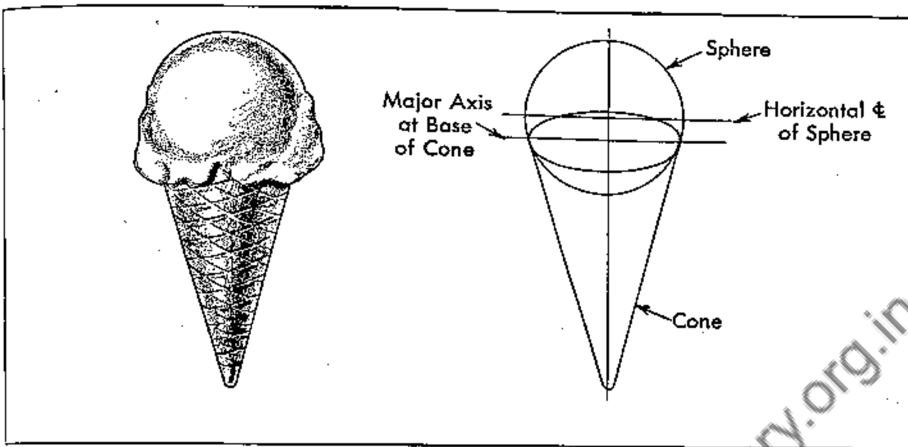
Chapter 6 FREEHAND DRAWING BASED ON THE MECHANICAL CONSTRUCTION PRINCIPLE



TO MOST PEOPLE the term *freehand*, as applied to drawing, means drawing for fun, entertainment, or even copying what one may see, such as a picture from a magazine or newspaper, a landscape sketch, a portrait, or some specific design. This is not necessarily true, however, for the professional artist and illustrator, especially if he is at work in industry. Freehand drawing is a means by which the illustrator expresses construction, form, and size. It is true that a drawing, which later in its entirety will appear perfect, usually begins in a very sketchy manner. This preliminary sketching is usually referred to as a *rough* and will be discussed in the following chapter. From this sketchy beginning the size and form of the object is actually determined.

To begin with, the illustrator must relate the object being rendered to one of the geometric shapes shown in Fig. 59. For example, let us


ELLIPSOID
CYLINDER
CONE
SPHERE
CUBE
PYRAMID



consider a drawing of an ice cream cone. Notice that in Fig. 60 the cone is, of course, a definite geometric shape and the scoop of ice cream stuck into the open cone is a sphere, or ball. Therefore, the illustrator arrives at a definite geometric relationship which in the final analysis amounts to reducing the object being drawn to its most simple shape.

It is important to consider the basic method for making a perspective drawing to scale because the correct view is determined by the method as described in a previous chapter. To illustrate this point consider Figs. 61 and 62. The illustrations show A as a poor view because it does not show third dimension. Sketch B is not satisfactory because it is in the extreme of the third dimension and does not show the object in its true shape. Sketch C is a correct view because it shows clearly the general shape as well as the third dimension.

Of course the illustrator could easily make his drawing a *project* by overdoing this method of using geometric construction lines. But the underlying principle presented in this chapter is that the basic construction of all objects must be carefully considered in order to give a feeling of solidness, or third dimension.

Now, with an understanding of the importance of applying appropriate geometric shapes to the object being drawn, the illustrator should consider the application of geometric shapes to some of the more commonly used objects in industry such as the bolt, the rivet, the flathead screw, the setscrew, the washer, the roundhead screw, and the nut as illustrated by Fig. 63. First, consider the bolt. To begin with, decide on the view which will best illustrate the bolt in third dimension and draw in the center line, or axis, around which is drawn a cylinder representing the stem, or grip, of the bolt. At one end of the small cylinder draw another cylinder of a size which is in proportion to the

FIGURES 61, 62

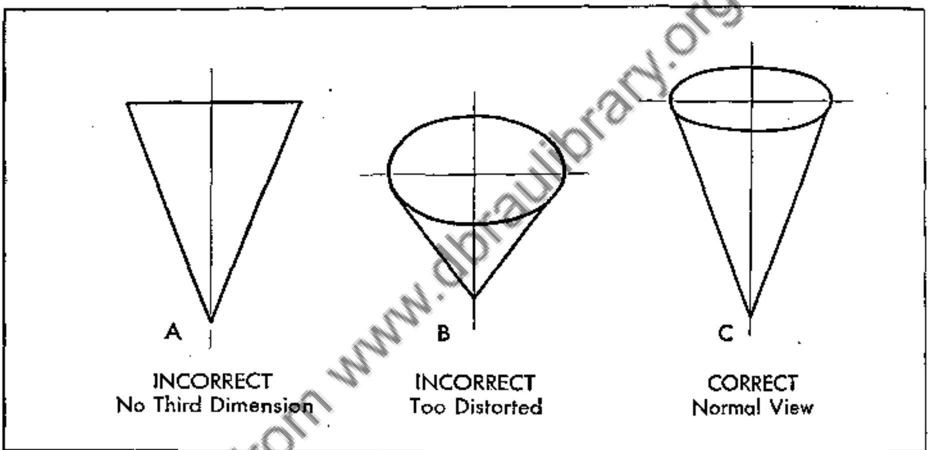
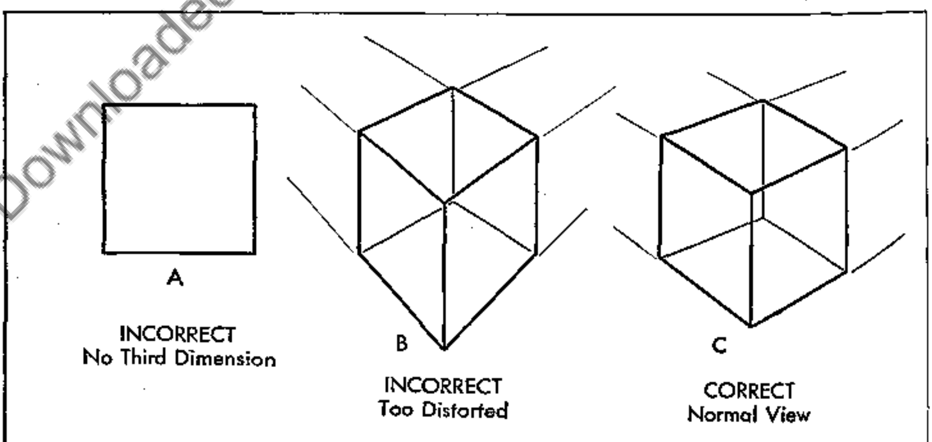
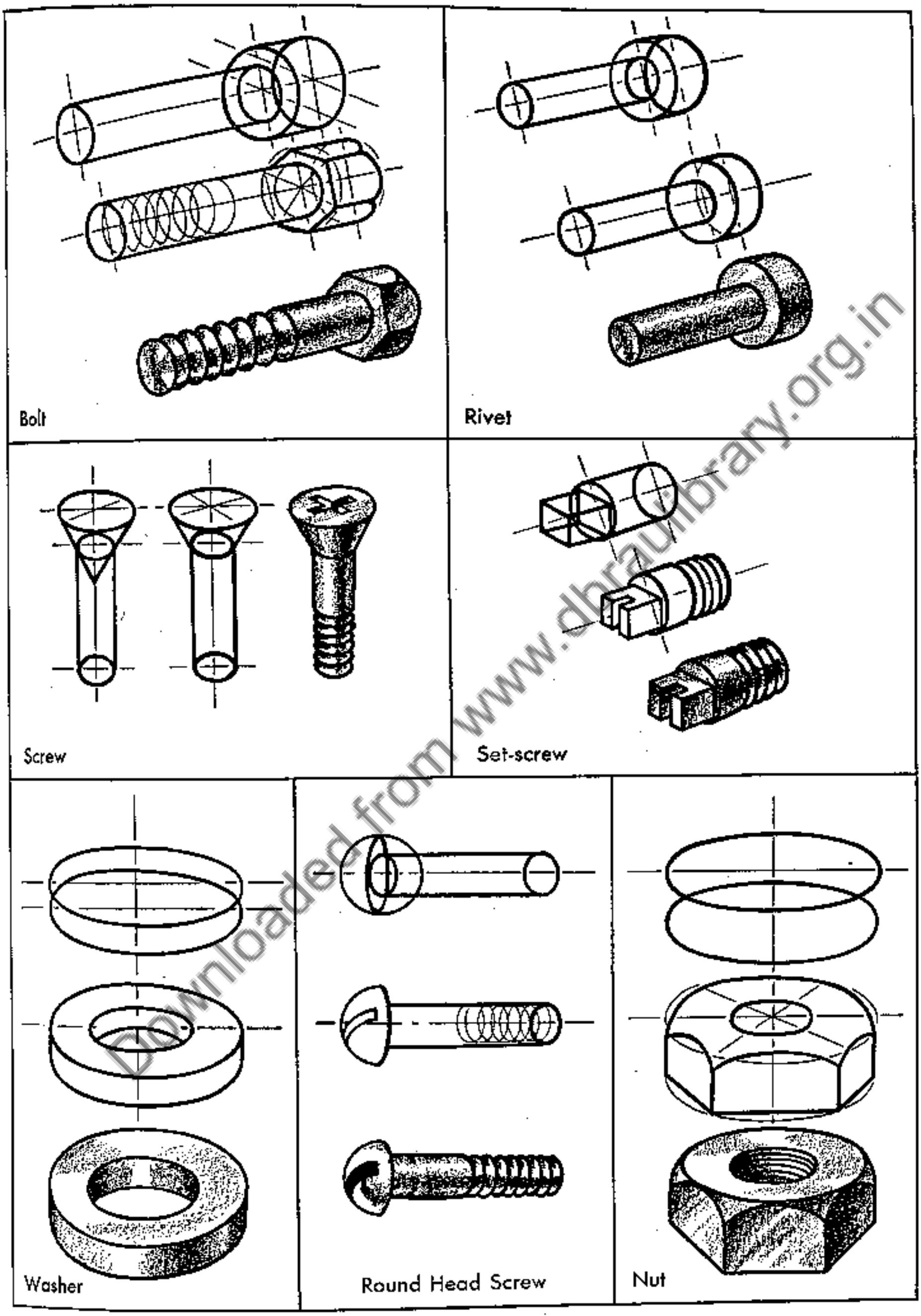


Fig. 61

Fig. 62




Bolt
Rivet
Screw
Set-screw
Washer
Round Head Screw
Nut

head of the bolt. Now sketch the hexagon shape of the head of the bolt. Then, at the end of the small cylinder, opposite the head of the bolt, draw a series of ellipses to form the threads of the bolt. Finally, add refinement and render.

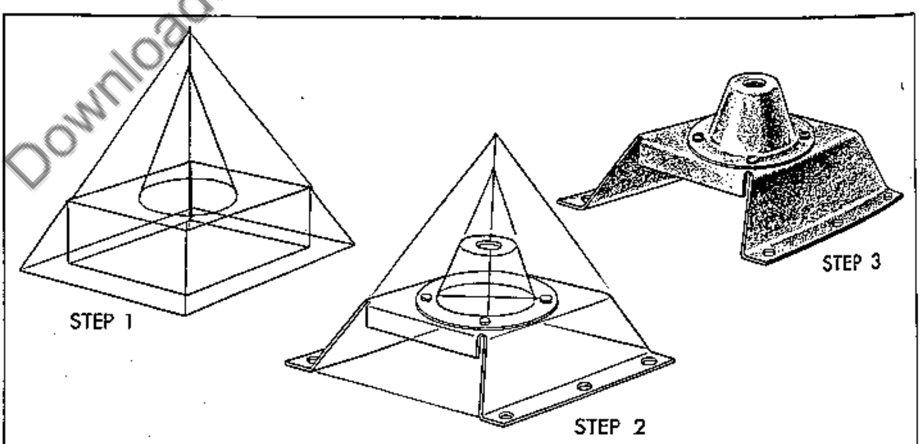
To illustrate the rivet, the same procedure described for the rendering of the bolt is applied. However, a new proportion between the cylinders must be considered. After that it is merely a matter of shaping the two cylinders so as to express the form of the rivet.

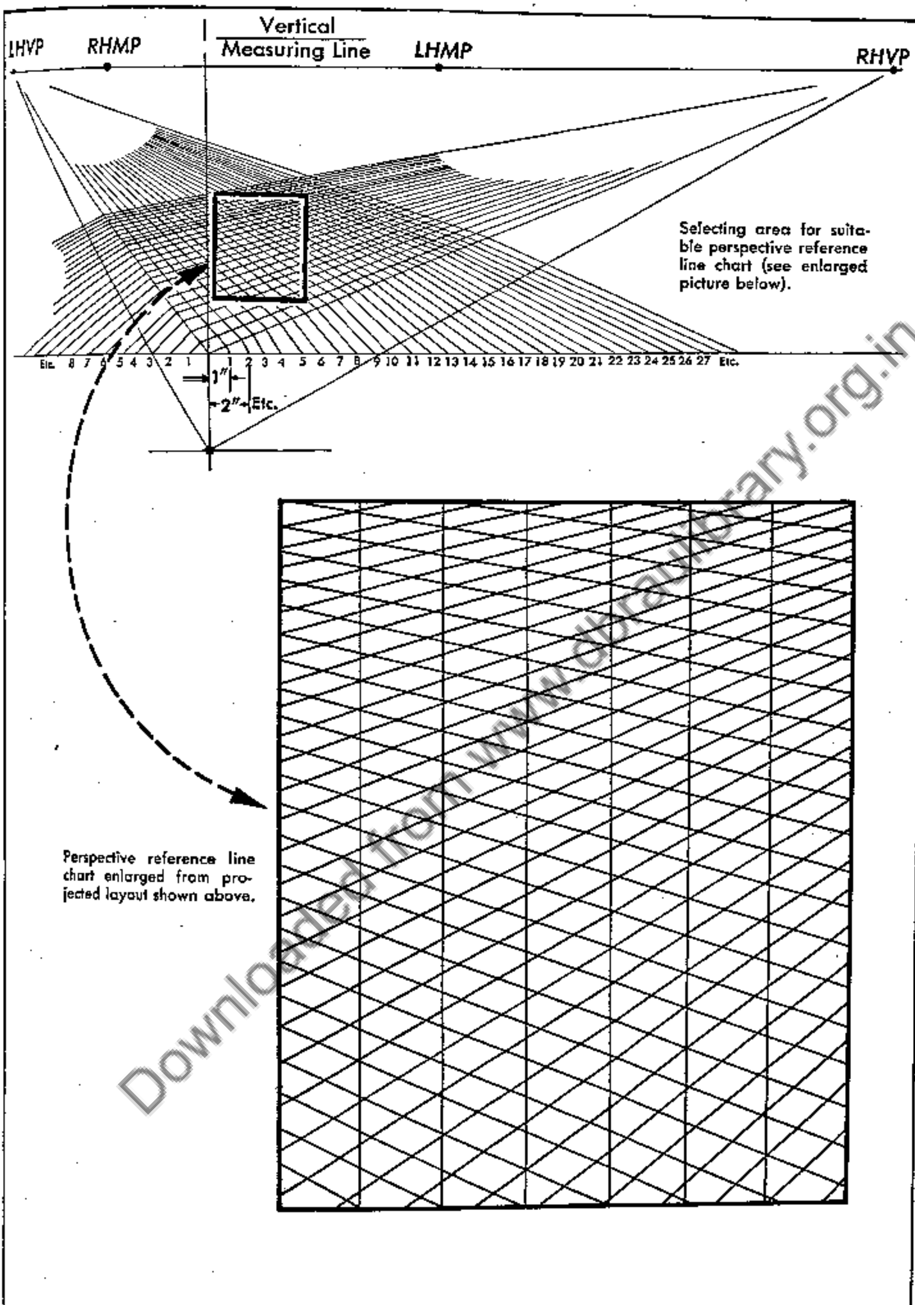
To render a flat, countersunk Phillips-head screw, another geometric shape is added to the cylinder. This time a cone is placed so that it intersects one end of the cylinder, as illustrated in Fig. 63. The remainder of the process of rendering is the same described in the previous examples.

In the case of a setscrew as shown in Fig. 63, a small cube is placed next to one end of the cylinder, but in the case of the roundhead screw a semisphere is attached to the cylinder so that it intersects one end. Otherwise the rendering is the same as already described.

The application of geometric shapes to various objects used in industry has been discussed in a very basic way. The same principles are used in the rendering of any assembly or manufactured part. For example, see Fig. 64, which indicates the relationship of several geomet-

FIGURE 64



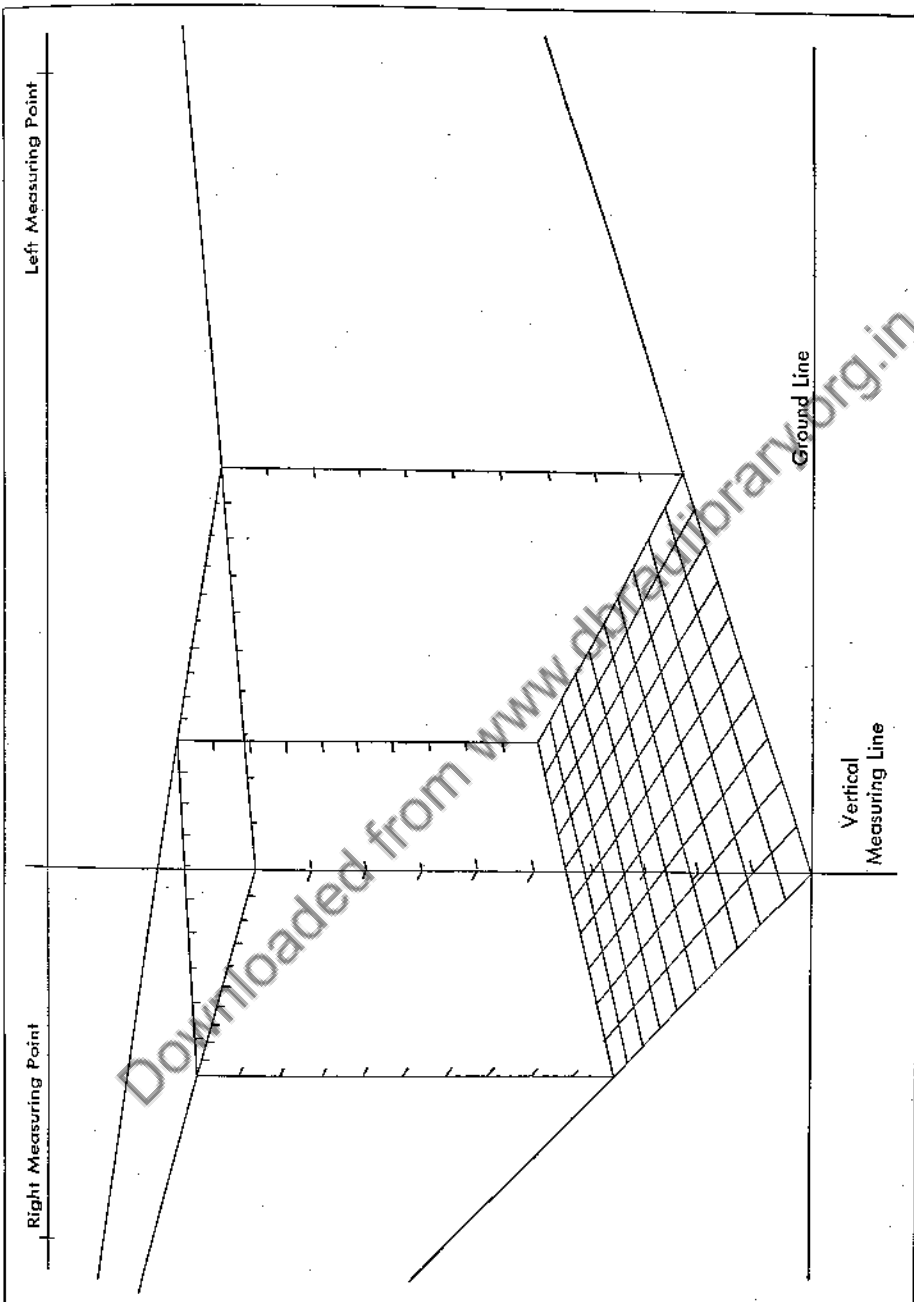

LHVP
RHMP
Vertical
Measuring Line
LHMP
RHVP
Selecting area for suitable perspective reference line chart (see enlarged picture below).
Etc. 8 7 6 5 4 3 2 1 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 Etc.
1"
2"
Etc.
Perspective reference line chart enlarged from projected layout shown above.

ric shapes to each other and to the entire assembly. In the first step of Fig. 64 the basic geometric shapes are indicated so that one may visualize immediately the relationship of the cube to the pyramid. Then, in step 2 it will be noted that the relationship of the cone to one of the parts has been added. Finally, the minor parts, which one might say play a supporting role to the complete assembly, are indicated. These minor parts, and the screws, washers, bolts, and nuts are shown with the cylinder as the fundamental geometric shape, as explained by Fig. 63. When the geometric constructions have been completed, the finished rendering is all that remains.

Numerous short-cut methods have been devised to assist the illustrator in the preparation of freehand perspective drawings and renderings. The one which is of particular significance however is the **perspective reference line chart.** This chart enables the illustrator to begin work immediately when he is drawing an object in perspective without first having to set up his vanishing points. Such a reference line chart is easily prepared by the illustrator and should be kept handy for ready use at any time. This chart, which is based on the method explained in Chapter 3, should be set up in various sizes and with various view angles. However, a good standard would be to use a 1-inch horizontal grid with a 30-degree view angle, as shown in Fig. 65. In this figure the fundamentals have been set up and a 1-inch grid has been laid out on both sides of the vertical measuring line and the lines projected to their respective measuring points and then to the vanishing points as illustrated. When this grid has been completed the illustrator should select the portion of the projected grid which will be suitable to the type of work he intends to do.

To select the grid which is best adaptable for the illustrator's use, first draw a rectangle on a sheet of tracing paper and place it over the projected lines as indicated by the small rectangle at the top of Fig. 65. When a suitable grid is viewed through the tracing paper, the illustrator traces the lines within the rectangular area. The result will be a miniature reference line chart which may then be enlarged to the desired size as shown at the bottom of Fig. 65. Finally, the illustrator, if he desires, may rule in vertical lines of equal distances apart and parallel to the sides, as also illustrated in Fig. 65. These vertical lines

FIGURE 66


Left Measuring Point
Right Measuring Point
Ground Line
Vertical
Measuring Line

will serve as a guide for drawing all vertical or upright lines, without fear of those lines tilting from one side to the other.

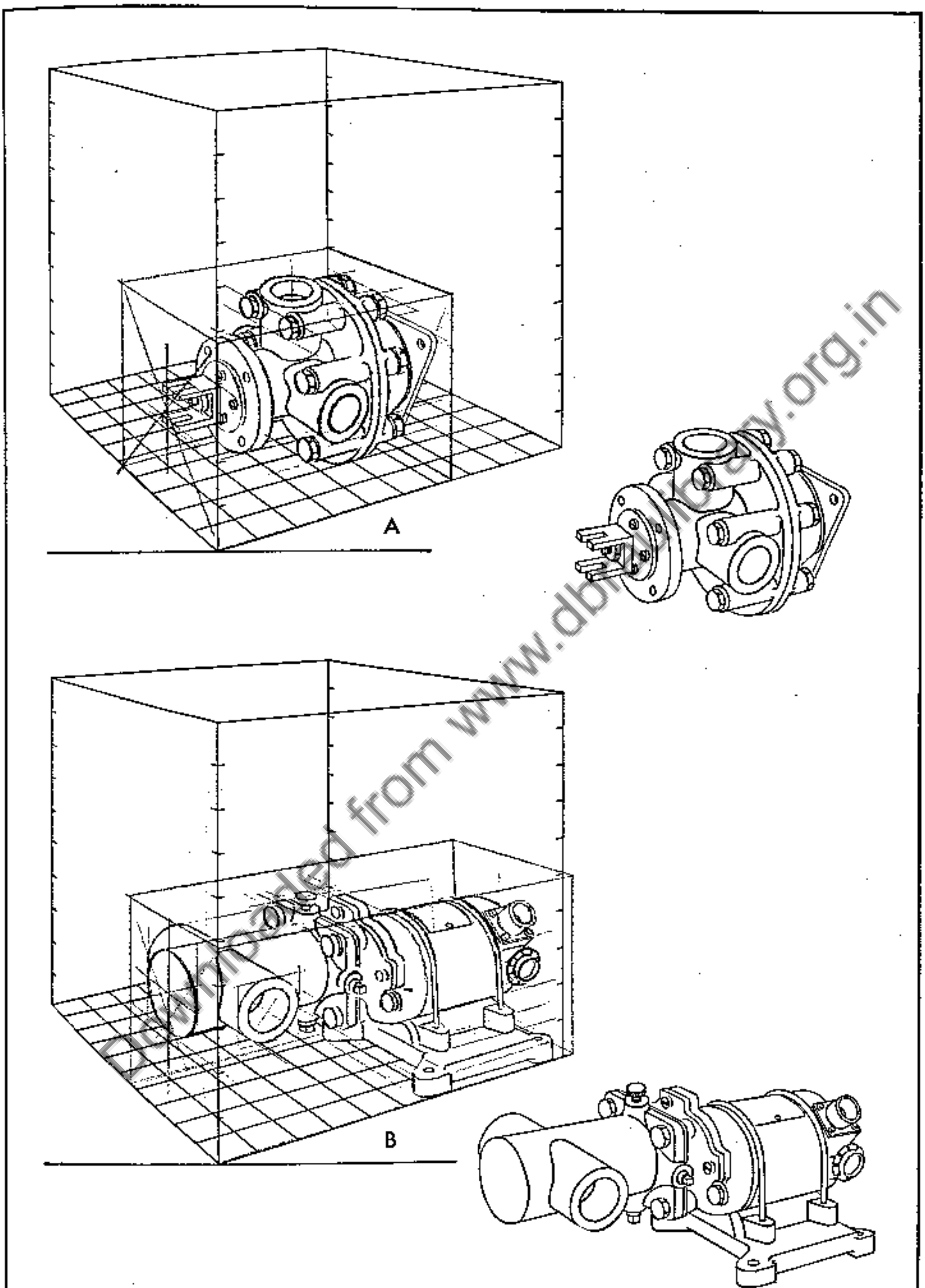
Using the same method as described above and shown in Fig. 65, the illustrator may also prepare a grid similar to the one shown in Fig. 66. This grid is one which has 1-inch horizontal and vertical dimensions projected and indicated so that actual measurements given on blueprints may be approximated more accurately when drawn in perspective. For an example of the application of the use of this grid see A and B of Fig. 67. Observe that the objects drawn have been boxed in. The boxing-in of objects is determined by the over-all dimensions and helps to determine whether the view is suitable for the object. By boxing in the object, the procedure is simplified; the illustrator eliminates working haphazardly and assures himself of determining correct proportions.

After the proper reference line chart, as shown in Figs. 65 and 66, has been prepared, the illustrator is ready to put it to use, as illustrated in Fig. 68. If, for example, he is required to make several freehand illustrations as shown in Fig. 68, he will find the reference line chart to be a convenient timesaver. Since this is to be a freehand illustration, all dimensions and proportions will be approximated by eye. The first stage of making such an illustration would be to place the perspective reference line chart, as prepared, under the layout tracing paper, and using the indicated vanishing lines as a guide, begin to outline the rough construction lines of the various objects. Should the illustrator be required to sketch objects of a more detailed nature, the type of grid as shown in Fig. 67 would be more practical. When the sketch is complete the reference line chart is removed and refinement is added.

The method explained above is one of the short-cut methods which is already being used to expedite production. Instead of preparing a reference line chart as suggested, the illustrator may choose to purchase a commercially prepared perspective grid which may be secured from any engineering and artist supply house. There are a number of these grids now on the market, and by following directions set forth on the grids they will undoubtedly produce approximately the same results as any the illustrator may prepare.

To make a drawing which has one or both of its vanishing points

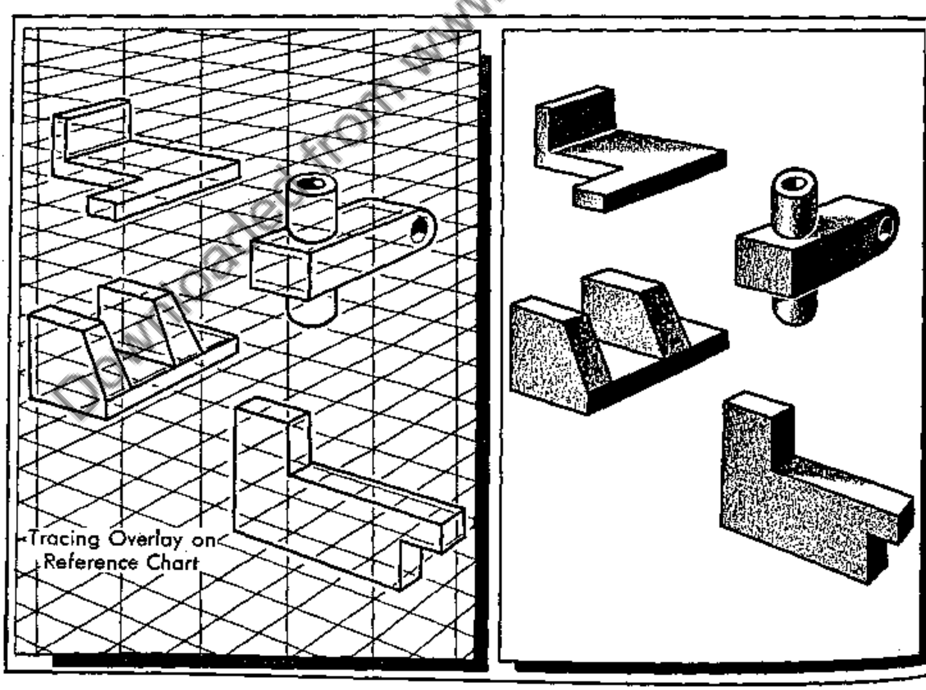
FIGURE 67

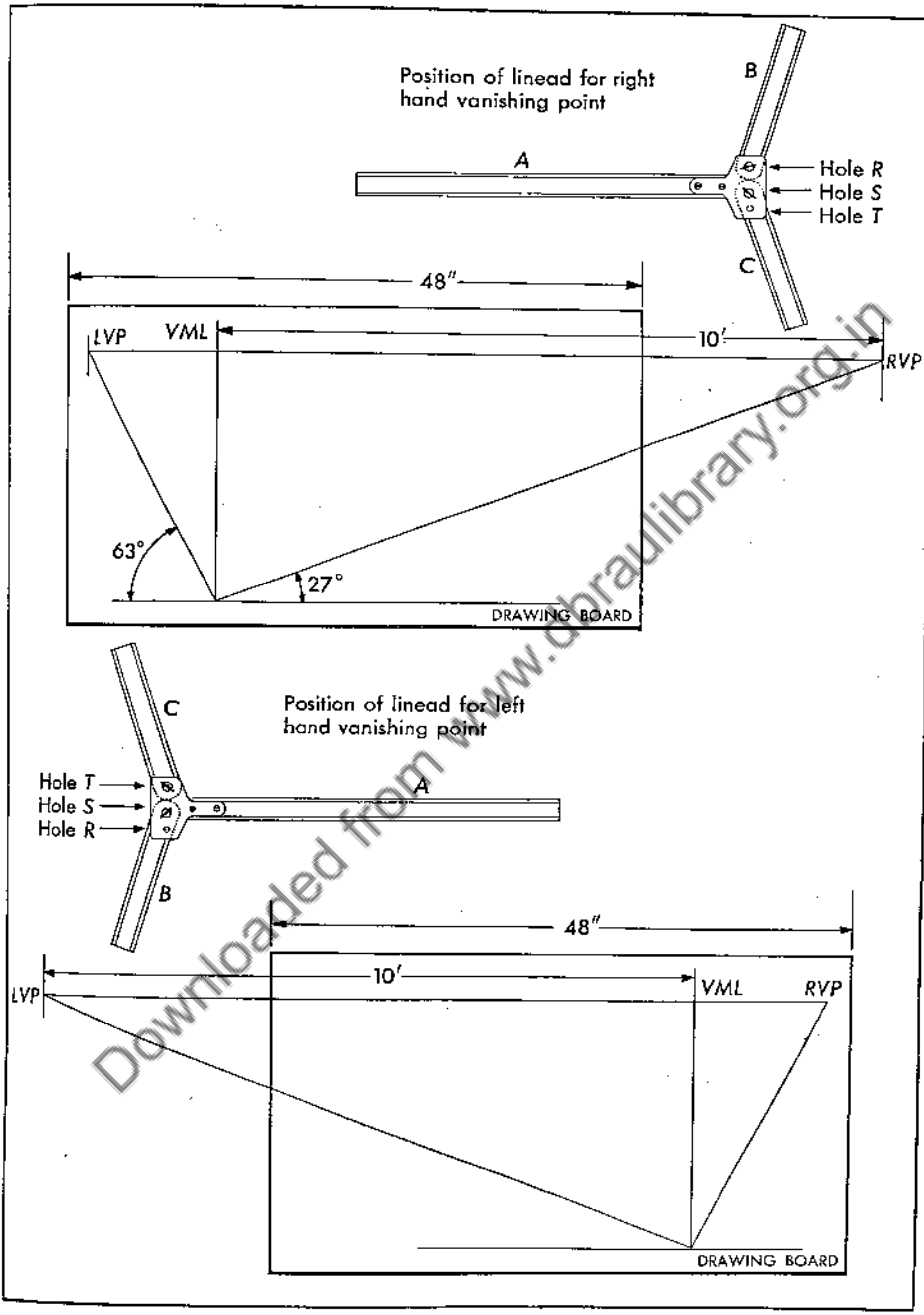


outside the boundaries of the drawing board, the approximate distances from the center line to the respective vanishing points must be calculated. However, in most cases, unless the drawing is extremely large, the vanishing point of the side having the greater number of degrees will remain on the drawing board, and only the vanishing point of the side with a lesser number of degrees will have to be calculated. In this case the illustrator must use what is known as a perspective centrolinead, or Y stick, in order to determine the angular projections of lines to the vanishing point which is outside the boundaries of the drawing board.

The centrolinead consists of a long ruler on one end of which are two adjustable arms fastened to the ruler by wing nuts as illustrated in the top part of Fig. 69. The ruler is referred to as *A*, the arm above the horizon as *B*, and the arm below the horizon as *C*. The arm *B* is charged from hole *R* to hole *S* and arm *C* on the crosshead when the stick is used for left-hand vanishing lines, as shown in Fig. 69. The rea-

FIGURE 68




Position of linead for right
hand vanishing point
B
A
Hole R
Hole S
Hole T
C
48″
LVP
VML
10′
RVP
63°
27°
DRAWING BOARD
C
Position of linead for left
hand vanishing point
Hole T
Hole S
Hole R
A
B
48″
10′
LVP
VML
RVP
DRAWING BOARD

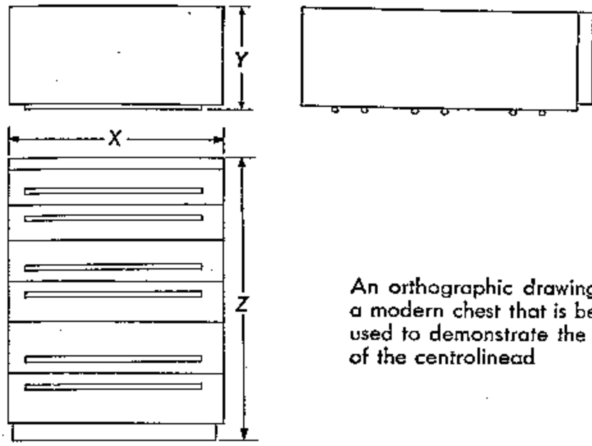
son for changing *B* to the opposite hole when projecting to the left, or to the right, is that the spacing of holes *R*, *S*, and *T* is offset with respect to the ruler arm A.

Suppose, for example, the illustrator were making a perspective drawing of a modern chest, as shown in A of Fig. 70, with the aid of the centrolinead. He would adjust the **Y** stick, as given in the directions which follow, and place it into position as shown in B of Fig. 70. By sliding arms *B* and *C* of the linead against the pushpins at points *A* and *B*, any angular projection may be drawn above or below the horizon line from the vanishing point, as in C of Fig. 70.

With the linead in position the over-all dimensions of the chest are drawn in as in the top of Fig. 71. Each detail is projected into the drawing. Then the linead is removed and the projection lines are straightened out before the shading is added to complete the rendering of the chest.

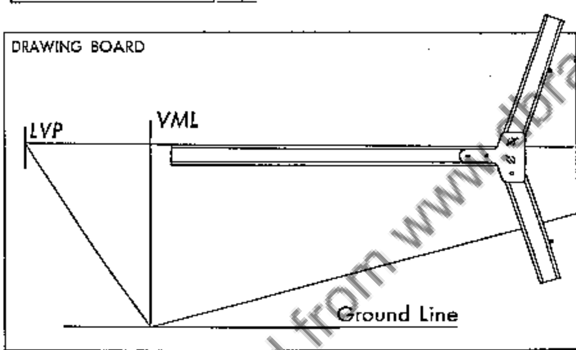
With the help of Fig. 72 as an aid to understanding the function of the linead, the following step-by-step description will enable the illustrator to use the linead to an advantage:

1. Establish the right-hand vanishing point as shown at the top of Fig. 72.
2. Draw a horizontal line across the board representing the horizon, or eye level.
3. Draw the vertical line *AB* perpendicular to the horizon line near the right-hand edge of the board.
4. Place pushpins on the vertical line at points *A* and *B* which are equal distances above and below the horizon line, as illustrated by the detail X of Fig. 72.
5. The angle at which the two movable arms of the linead is to be set will be determined as follows: Multiply the distance between the horizontal line and either one of the pushpins by itself. Divide the product by the distance of the right-hand vanishing point from the vertical line *AB* and measure the quotient found by the above division along the horizontal line toward the drawing to establish point *D*. This point designates the place at which the lines of the inner edges of the arms intersect the horizon line.
6. Draw a diagram of these lines on the drawing and set the arms of the linead so that the inner edges of the arms coincide with the lines of the diagram, as shown in detail X of Fig. 72.



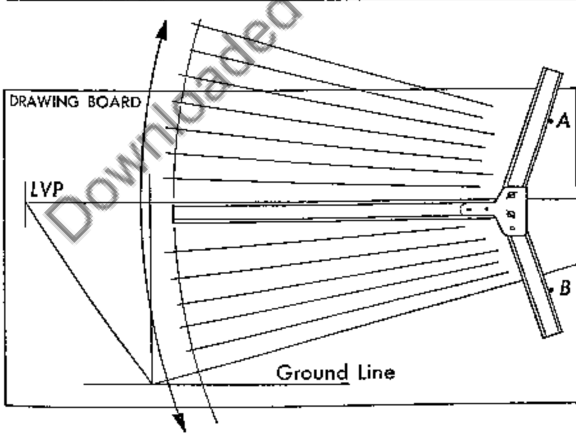
(A)

An orthographic drawing of a modern chest that is being used to demonstrate the use of the centrolinead



(B)

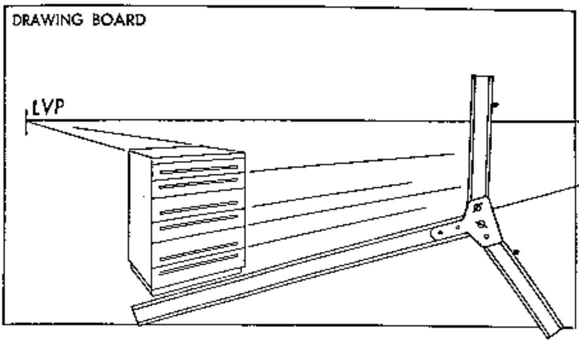
Here the "linead" is in position for right hand projections



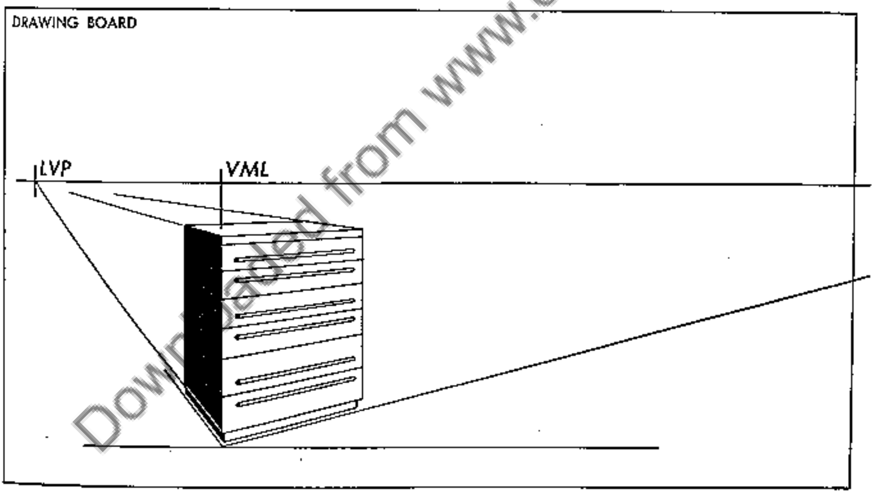
(C)

Radiation of angular projections caused by moving linead about points A and B

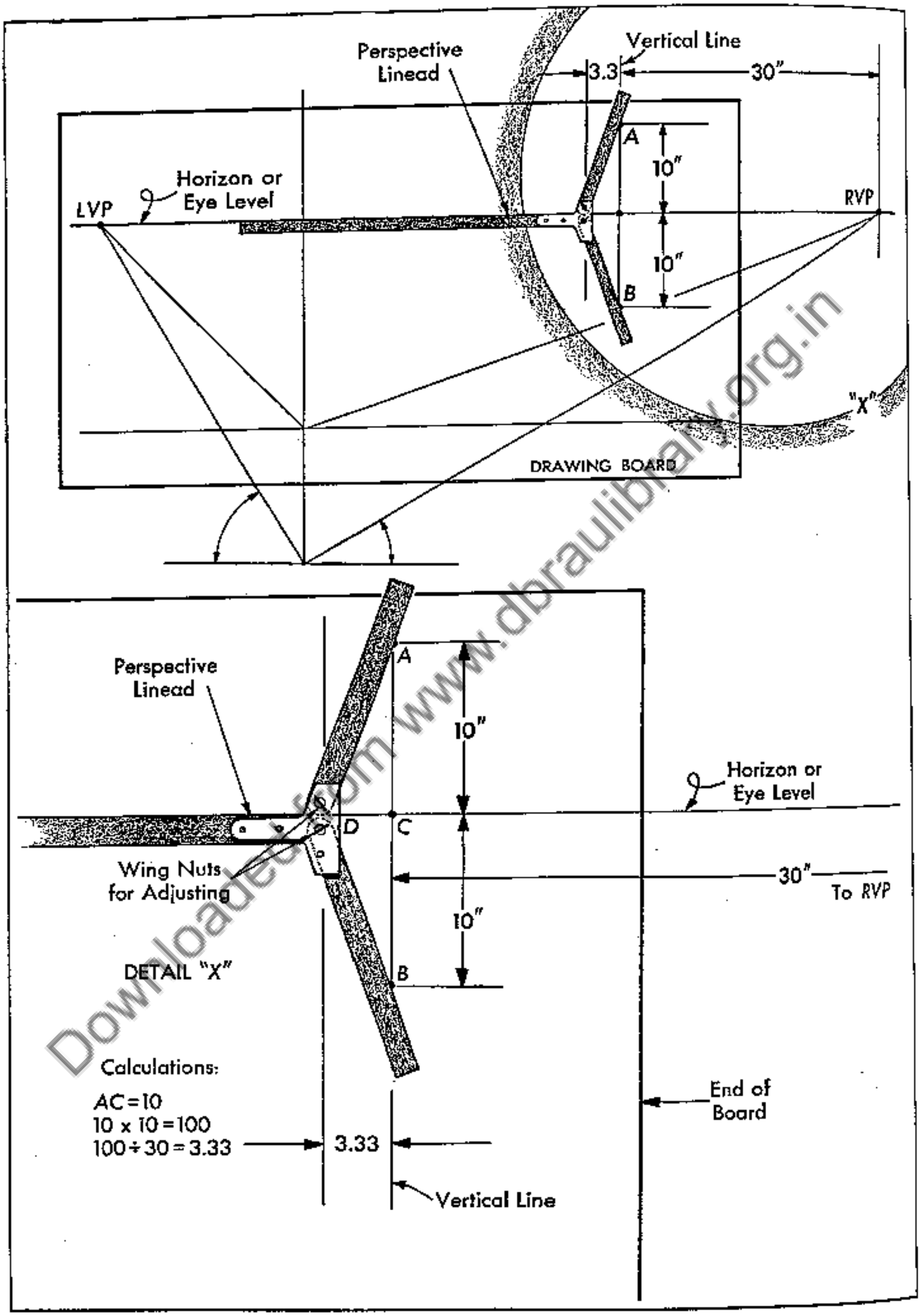
After the arms are fastened in place the instrument is ready for use By moving the horizontal straightedge up and down, sliding the movable arms along the pushpins at *A* and *B*, the true perspective of any part of the object will be projected.



Overall dimensions have been drawn in to construct the shape of the chest



The linead was removed and details straightened out to complete drawing


Vertical Line
Perspective Linead
3.3
30"
A
10"
Horizon or Eye Level
LVP
RVP
10"
B
"X"
DRAWING BOARD
Perspective Linead
A
10"
Horizon or Eye Level
D
C
30"
To RVP
Wing Nuts for Adjusting
10"
DETAIL "X"
B
Calculations:
AC=10
10 x 10=100
100÷30=3.33
3.33
End of Board
Vertical Line

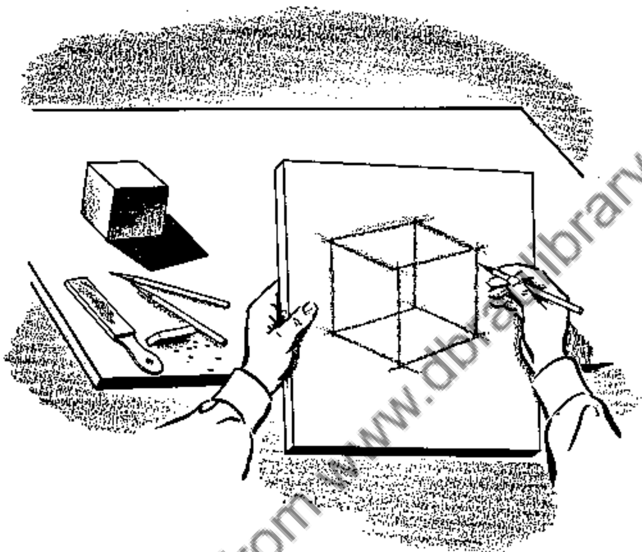
PART TWO

Making a Production Illustration

IN PART ONE the "kindergarten department" of a highly-developed field of art has been described in simple, easy-to-understand language. Nevertheless, before any illustrator in the field can boast of being a master of the more difficult drawings he may be called upon to do, he must have built some essential thought and habits of technique based upon the elementary methods pointed out in the foregoing pages.

Now there are bigger and more important challenges to the illustrator. In the following chapters the best techniques and principles for making renderings will be presented. It would be impossible in the space that follows to explain and illustrate with practical examples all the well-known, and often-used, mediums and techniques for making production illustrations. However, some methods of making illustrations which reproduce well in printed form are explained and shown. It is with this in mind that Part Two of *Illustrating For Tomorrow's Production* is presented.

Chapter 7 THE ROUGH LAYOUT



THE MANUFACTURER usually furnishes the illustrator with a complete description of the object to be drawn. It should be remembered that illustrations are made in order to give a visual description of the object. It should tell the observer what the object looks like from the outside, as well as the integral assembly of nuts, springs, wires, and pistons, or what-have-you that make up the inside. For example, if an alarm clock were the object to be rendered, it should be disassembled, or *exploded*, before making a layout of the assembly. Then each gear, spring, and screw would be drawn in perspective showing its proper relation to the others, and the position that each part takes in the final assembly. The parts that make the tick would be shown, and even the ticking sound itself might be depicted by the use of gremlin cartoons.

The most important matter to consider in preparing a drawing is the angle from which the object is to be seen. The side which is the most complicated, or has the most important gadgets on it, should be viewed along the longest vanishing-point line.

The parts that make up the object being drawn should be balanced on the layout, but should be so arranged as to give the observer an unmistakable understanding of the position they take in the final assembly. An illustrator should bear in mind that one of the functions of making production and exploded drawings in industry is to help inexperienced production-line workmen to understand thoroughly the position of each part and the role it plays in the final performance of the mechanism being put together.

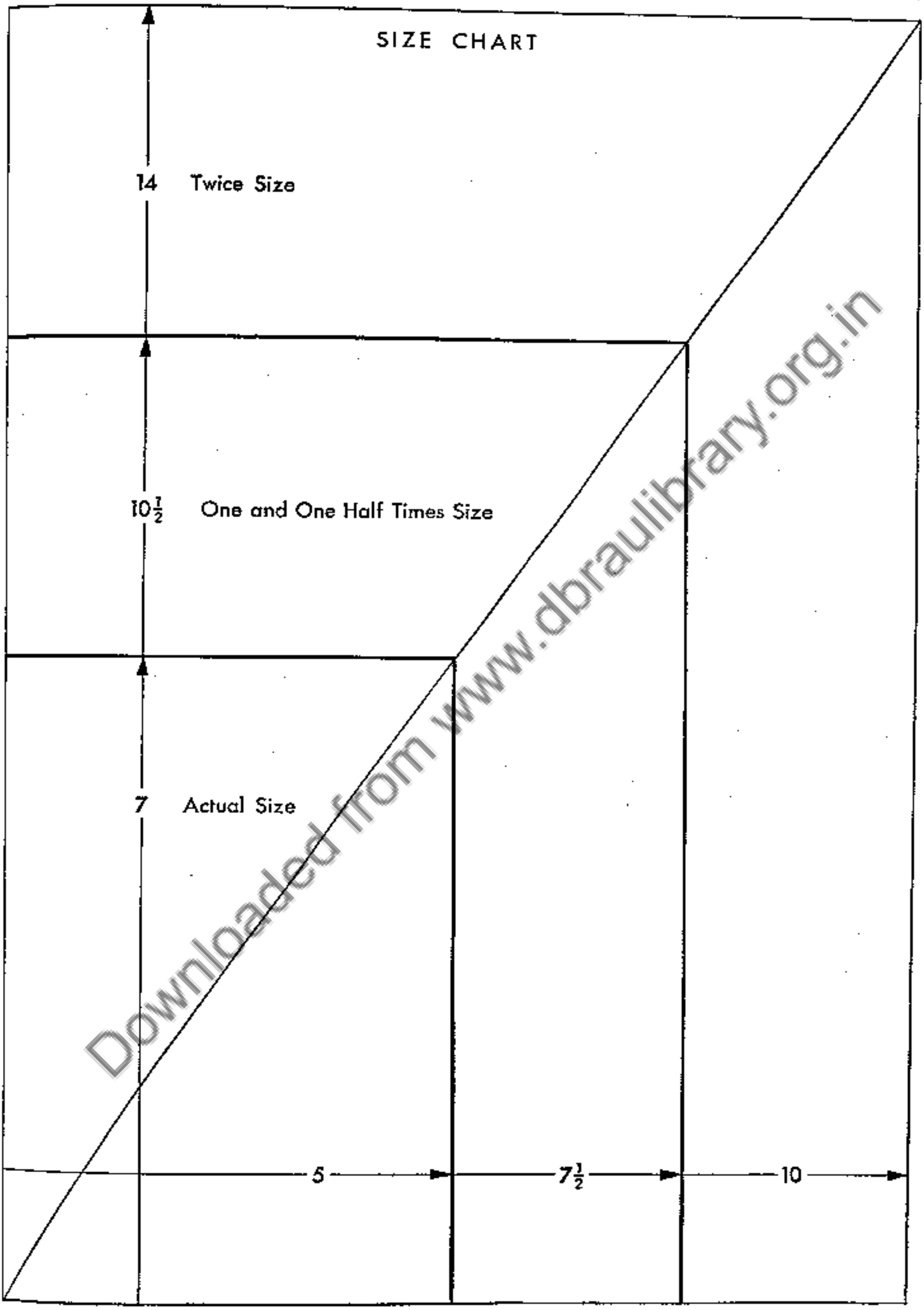
Service and maintenance manuals and parts catalogs are chock-full of illustrations. Most of these manuals are chiefly instruction books for the proper servicing, maintenance, and repair of various assemblies and parts. Therefore the artist must bear in mind, regardless of how elementary it may appear, that because the drawing is primarily a visual aid it should be the last word in simplicity. One thing that makes a drawing simple to read is the technique with which the parts are drawn.

The technique of handling the rough sketch is largely a matter of temperament; only practice and experience will teach you which technique and relative scale best suits your own particular ideas. The essential thing is that the technique of sketching should become so easy and natural that it does not get between you and your mental pictures.[1]

In beginning the rough layout the first step is to know the size of the text page of the magazine, book, blueprint, etc. in which the illustration is to be reproduced. Let us assume for the purpose of making a size chart, as shown by Fig. 73, that 5 by 7 inches is to be the reproduced size of the drawing. However, illustrations are seldom made to actual size and scale. By drawing an illustration one and one-half or two times the actual size it is possible to minimize the errors that usually occur, produce clean-cut lines, and add considerable neatness to the finished layout. Use the proportional method by drawing a diagonal line from the lower left hand corner of the 5- by 7-inch rectangle

[1] Harold Van Doren, *Industrial Design*, New York, McGraw-Hill Book Company, Inc., 1940, p. 188.

FIGURE 73


SIZE CHART
14 Twice Size
$10\frac{1}{2}$ One and One Half Times Size
7 Actual Size
5
$7\frac{1}{2}$
10

through the upper right-hand corner to a convenient distance. Then, add 2½ inches to the 5-inch width, and from that point extend a line up vertically until it intersects the diagonal. When a line is drawn through the intersection point, parallel to the base line, the rectangle which results will be one and one-half times the actual 5- by 7-inch size, or 7½ by 10½ inches. By adding 5 inches to the width, and 7 inches to the height, the resulting rectangle will be twice the actual text size, or 10 by 14 inches.

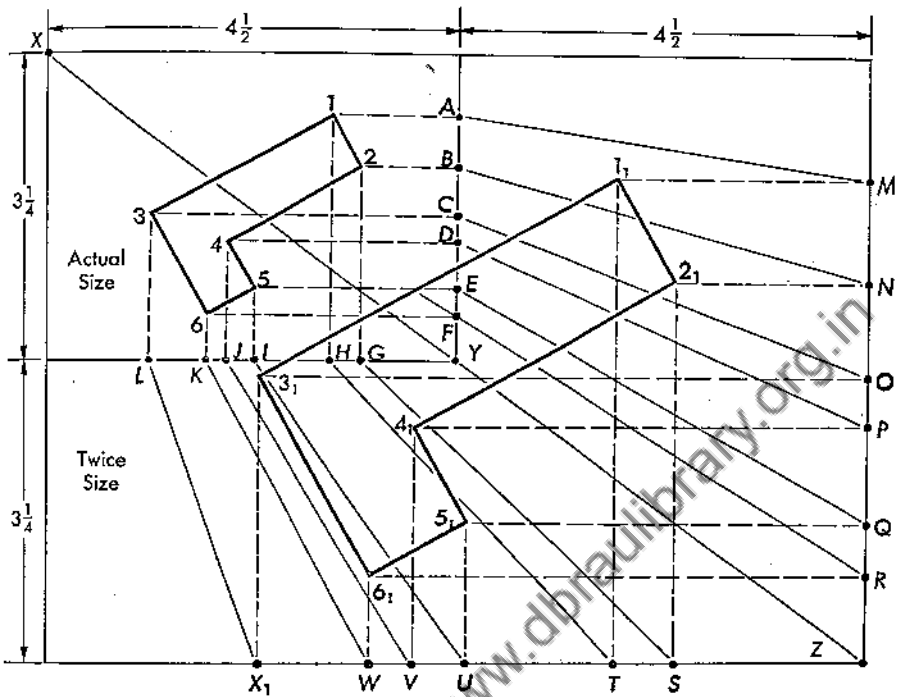
Let us assume that the illustrator has prepared the desired size chart and made a layout in actual size. Then if he wishes to enlarge the layout and the size of the object in proportion to the layout, he employs the method commonly used by art agencies and studios, which are often confronted with the problem of enlarging thumbnail sketches and rough layouts. This method is demonstrated in Fig. 74.

After completing the size chart as shown in Fig. 73, the illustrator is ready for the **rough layout.** Whether or not the one and one-half or the double size chart is used will depend upon the amount of reduction desired.

The term *rough layout* applies to a procedure generally followed for determining a practical size, shape, and view of the object to be drawn in order to make a good arrangement and a well-balanced composition. Remember that the finished layout is a visual aid to enable the unskilled or average layman to understand his job clearly.

When the rough layout is done well the greatest part of an illustration is completed. The thinking, arrangement, size, and view have therefore been decided upon and the balance of the illustration is mere routine. If the illustrator has the ability to shade, ink, and letter, and in addition makes an interesting layout composition, his ability and skill will provide security as well as a position in the commercial and industrial field in the future. All this can be accomplished by a diligent ambition and a persistent effort to succeed.

In Figs. 75, 76, and 77 three different sets of **thumbnail sketches,** which are commonly called *scribble sheets,* are shown at the beginning stage of making the rough. Each scribble-sheet set, as illustrated, shows several layout ideas for three different types of problems. These thumbnail scribbles are merely ideas of arrangement possibilities and are not



ENLARGING A LAYOUT

This actual size layout showing the L shape pattern is enlarged in the following steps.

STEP 1 Vertical and horizontal lines are drawn from corners 1, 2, 3, 4, 5, and 6 of the actual size layout. This will give the intersection points *A, B, C, D, E, F, G, H, I, J, K,* and *L* as shown.

STEP 2 Draw radiating lines from point *X* through *A, B, C, D, E, F, G, H, I, J, K,* and *L*. This will establish the points *M, N, O, P, Q, R, S, T, U, V, W,* and *X*.

STEP 3 Draw horizontal lines from points *M, N, O, P, Q,* and *R*, then vertical lines from points *S, T, U, V, W,* and *X*. This will result in acquiring the intersections 1_1, 2_1, 3_1, 4_1, 5_1, and 6_1.

STEP 4 Connect points 1_1, 2_1, 3_1, 4_1, 5_1, and 6_1. The result is a "twice size," L shape pattern.

necessarily exact proportion sketches. Fundamentally these scribbles are nothing more than visual results of thinking out loud. From these scribble sheets one thumbnail loyout in each set is selected to be used for making the full-size rough.

Figure 75 shows a unit which resembles a geometric cube and has very few parts, which are relatively simple to illustrate. Figure 76 shows a unit which is related to a cylinder, and has parts which make the arrangement of a good composition more difficult. Figure 77 shows a unit which involves several geometric shapes and has intersections which may lead to an extremely difficult spacing problem.

When these thumbnail sketches have been selected, the rough layouts are begun. The thumbnail sketches are mere patterns that the illustrator copies onto his layout pad in the miniature form of the drawing-size rough. In order that the rough shall have the proper perspective, the reference line chart is placed under the layout sheet on which the rough is being drawn. The guide lines on the reference line chart must be followed in order to obtain good construction and perspective when drawing the parts, as shown in Fig. 78. With the layout superimposed on the reference line chart, proper construction can be acquired, and the illustrator can arrange the unit being rendered so as to allow ample space for labeling parts, whereas if labels are added later, the illustrator may neglect to leave enough space and consequently cause the illustration to be redrawn. If, of course, rearrangement is necessary, it can be done more easily in the rough stage than later, since it eliminates unnecessary waste of time. See Figs. 79, 80, and 81 for the completed rough layouts which were made after the scribble-sheet arrangement patterns were selected.

THE SCRIBBLE SHEET

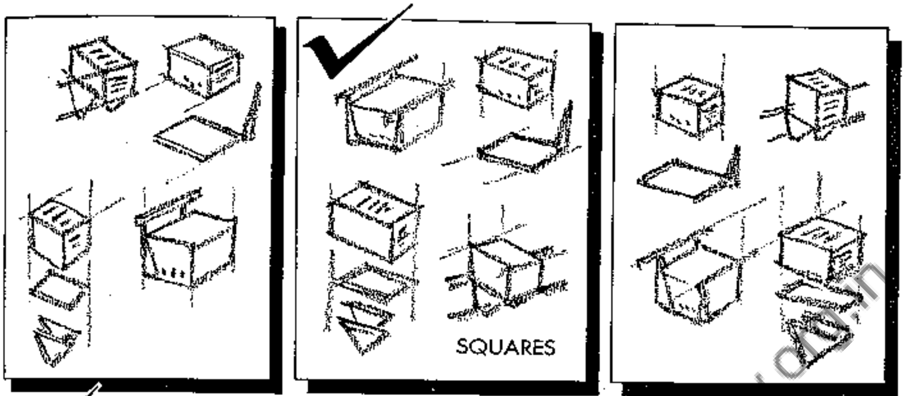


Fig. 75

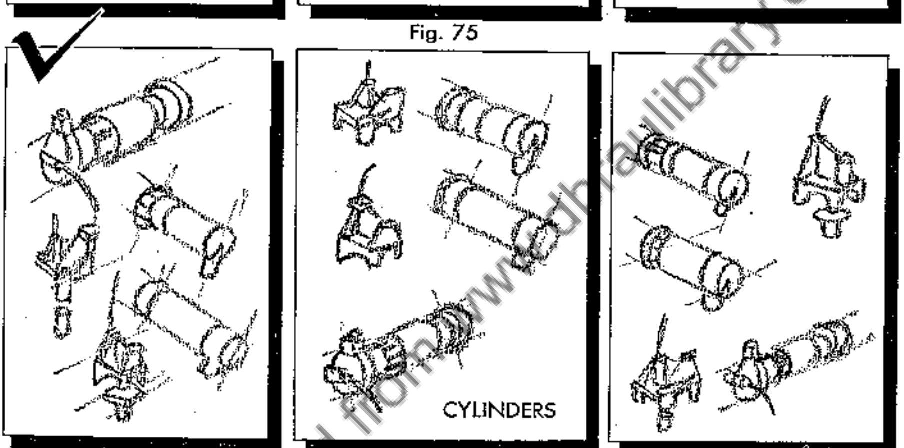


Fig. 76

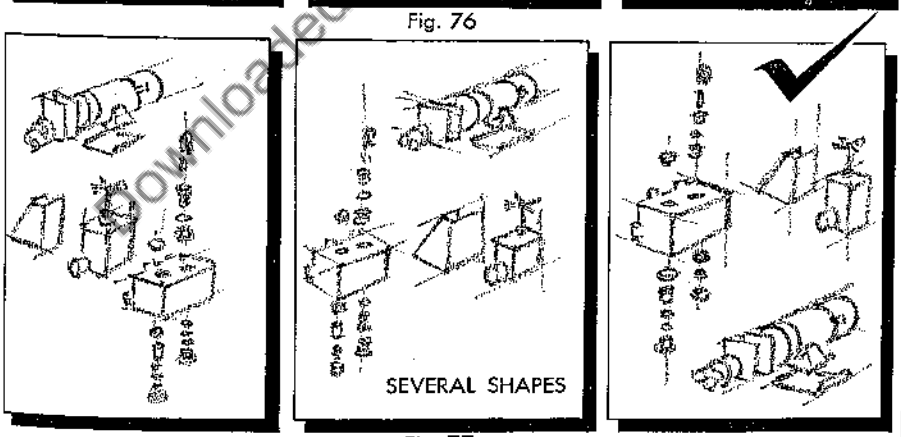
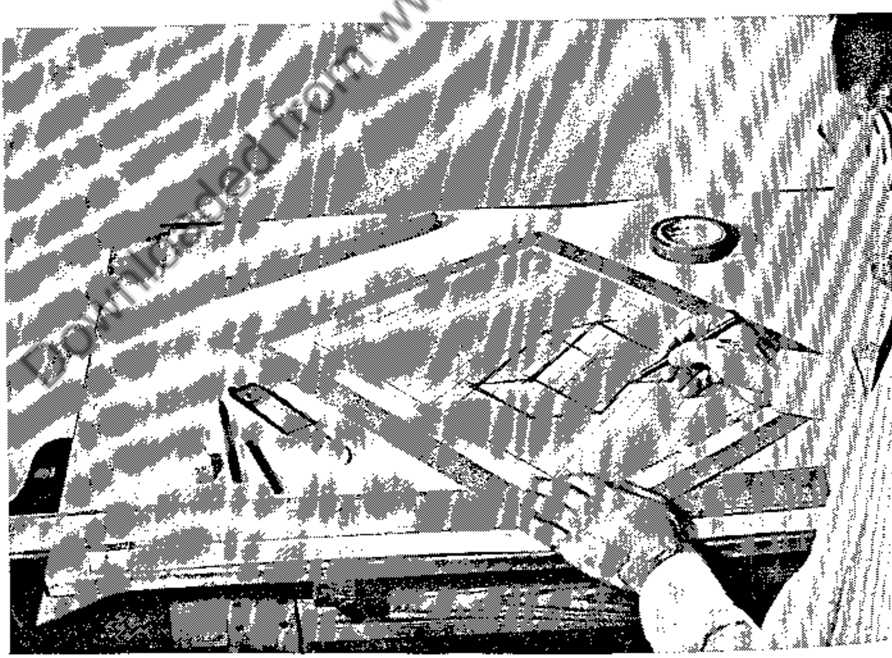
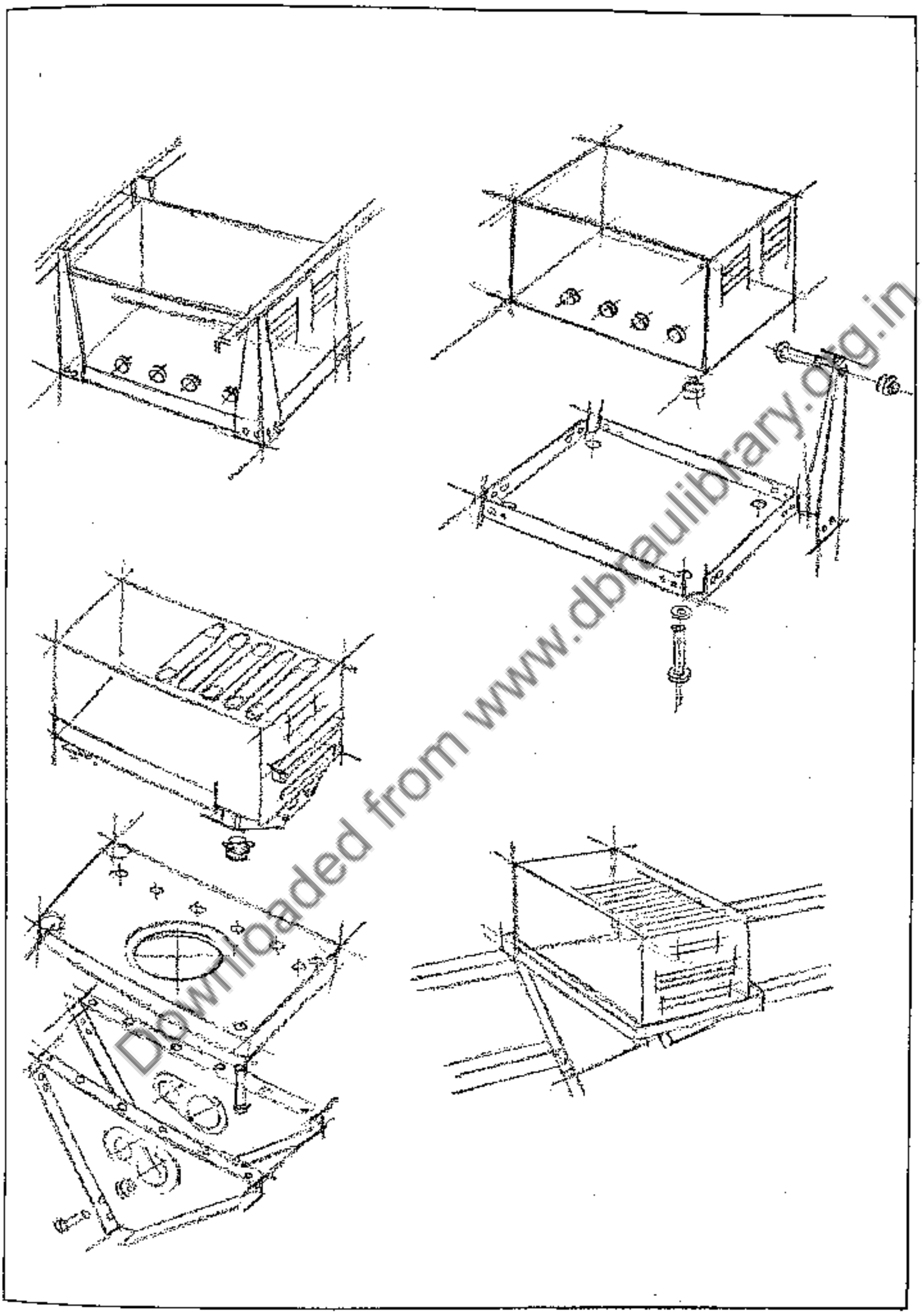
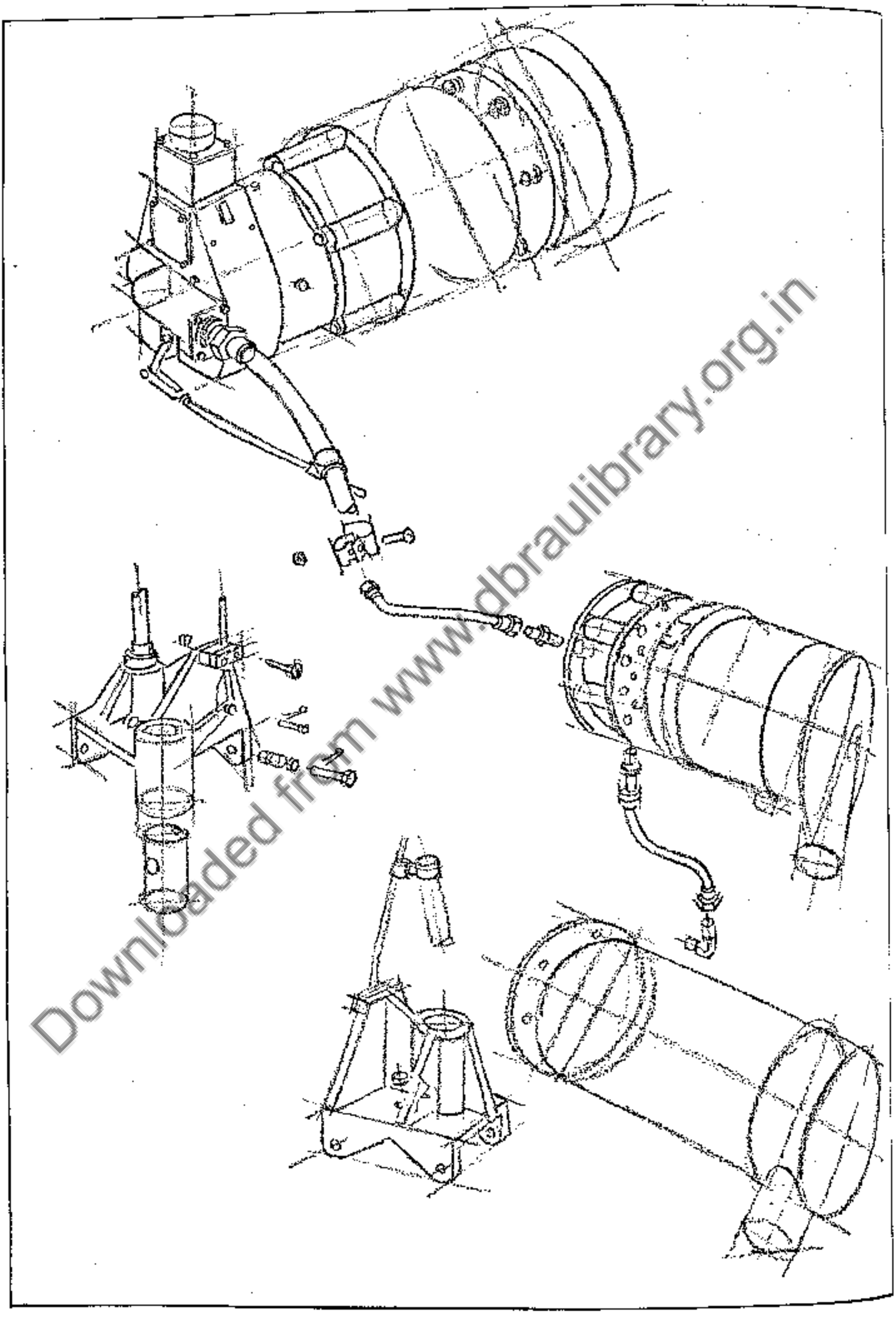


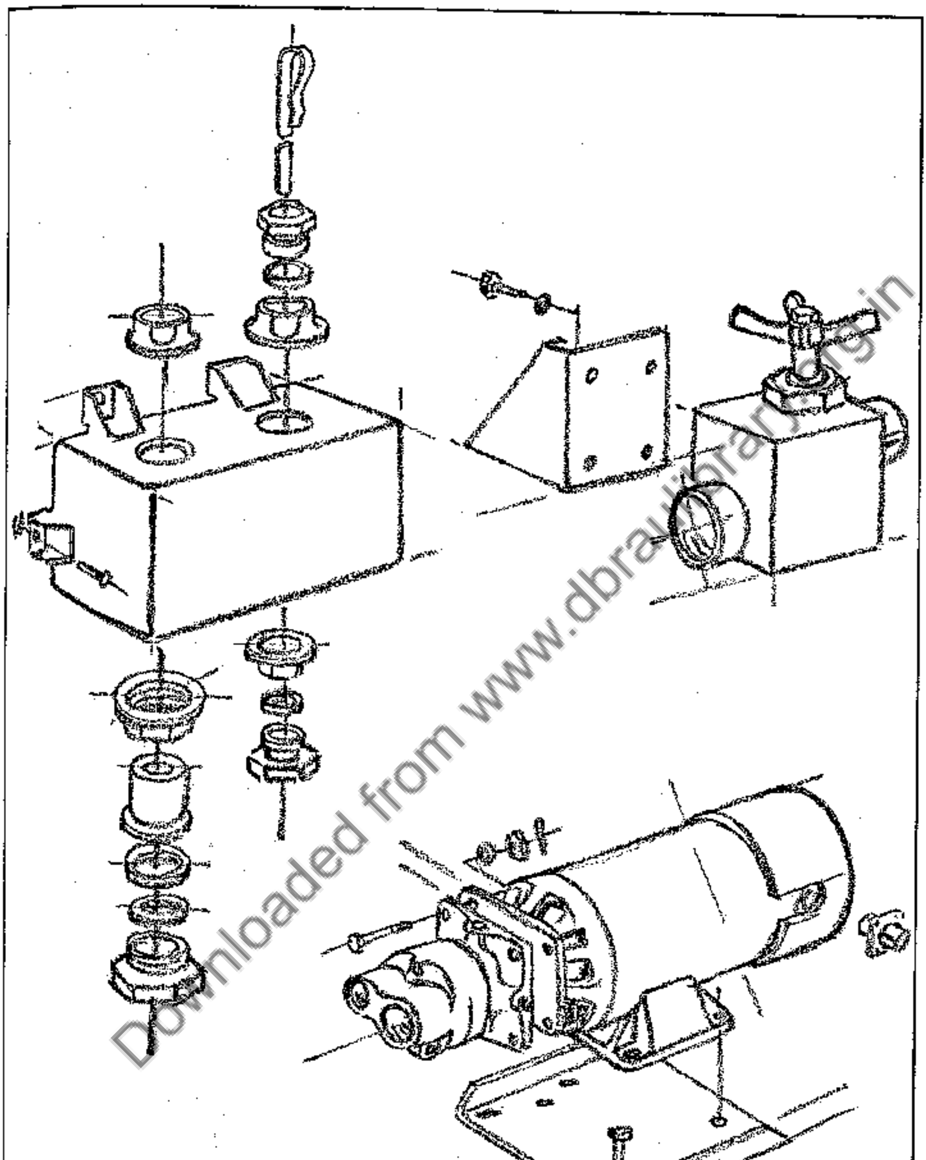
Fig. 77

FIGURE 78

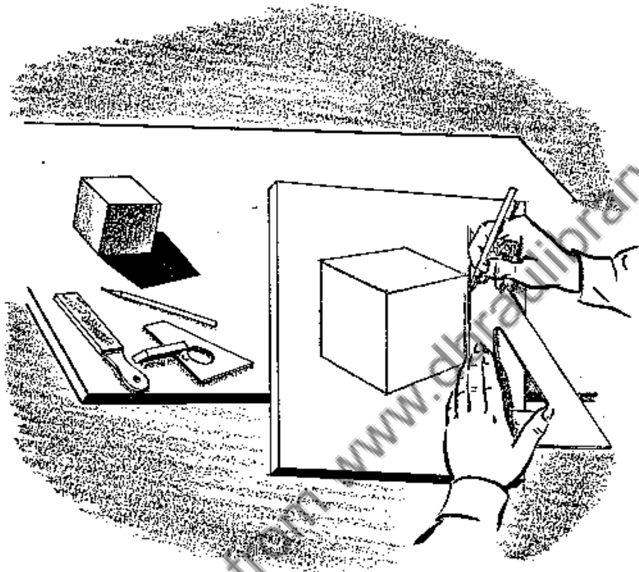








Chapter 8 THE COMPREHENSIVE LAYOUT



WHEN THE ROUGH LAYOUT has been completed the toughest part of the illustration job is over. The illustrator should now feel that there cannot be any more improvements or changes made in the rough. He is ready at this point to place a sheet of tracing paper over the rough layout and start the **comprehensive layout.** This is not altogether necessary as the illustrator gains experience, however, because the rough may be transposed into the comprehensive on the same layout, thereby eliminating the extra time required to trace the rough layout.

A comprehensive layout is an outline of refinement into which the illustrator pours the best of his talent and ability. It is good practice to begin the comprehensive layout by checking all vertical, horizontal, and diagonal lines to be certain that they follow their proper vanishing lines. Particular attention should be paid to curved lines and ellipses.

They must be correct if a professional touch is to be achieved in production illustration. If the curves and ellipses are distorted the rendering will probably be lacking in interest and tend to confuse the observer, because if they are not properly done it would be difficult to recognize the circles in perspective.

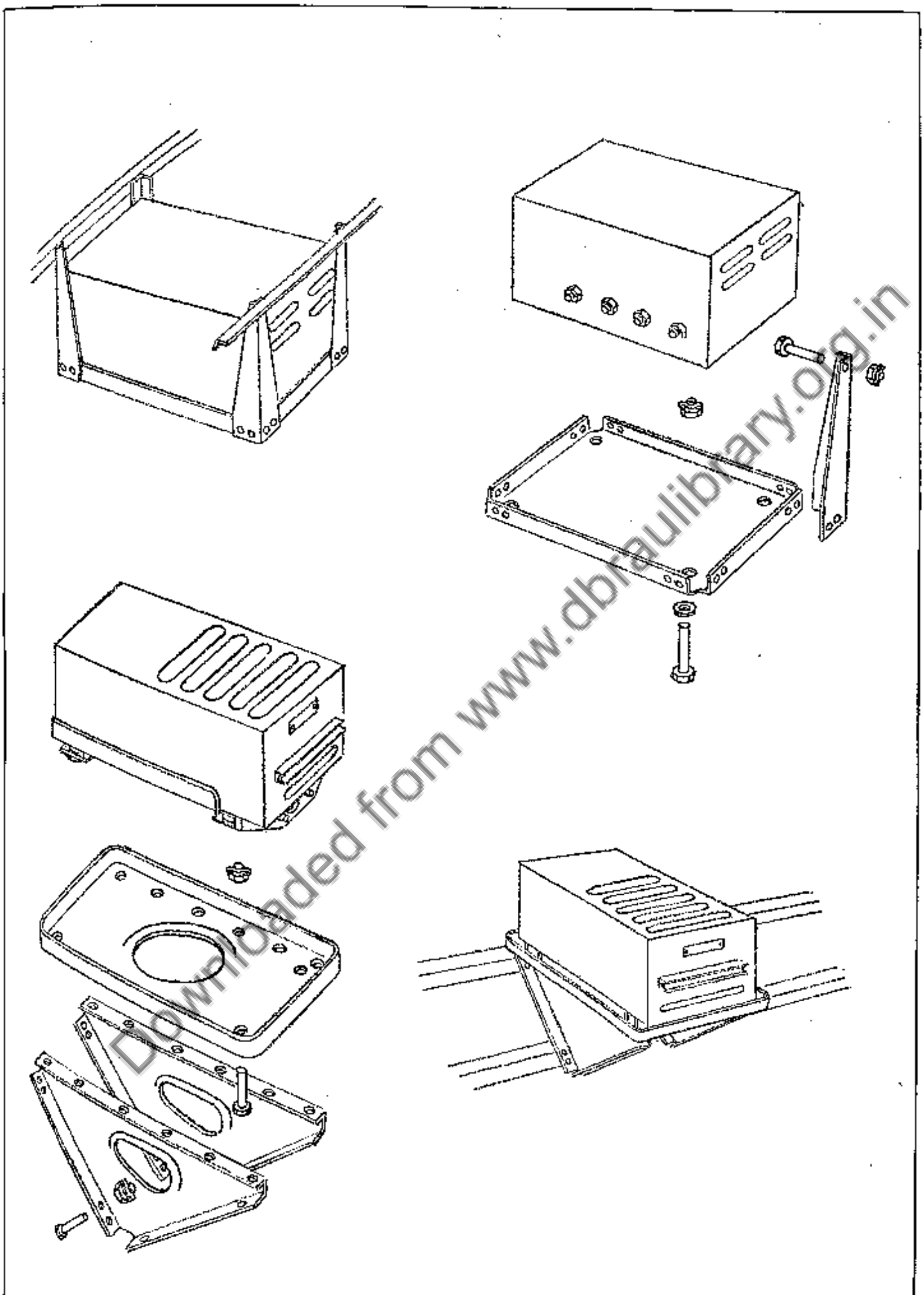
The importance of the comprehensive layout cannot be overstressed. In this step definite lines are strengthened, and in this phase of making the illustration, details are organized and given specific form.

With the tracing paper over the rough layout and the outline of all the parts completed, the comprehensive layout can be *lifted* from the rough layout. Then, when the comprehensive layout is laid over a clean white backing paper, the illustrator can darken the weak lines and correct errors that were not noticeable against the rough layout drawing.

Tomorrow's production blueprints will be accompanied by an accurate scale perspective illustration of the part, tool, or assembly which is shown orthographically, and it is for this reason that the comprehensive layout must be well rendered in firm, bold lines so that clear, even lines will be reproduced when it is added to the orthographic plans. Pains must be taken by the illustrator, as well as by the draftsman, if his drawing is to be blueprinted for use in the shop. Otherwise the lines of the comprehensive layout will appear weak and faded on the shop print.

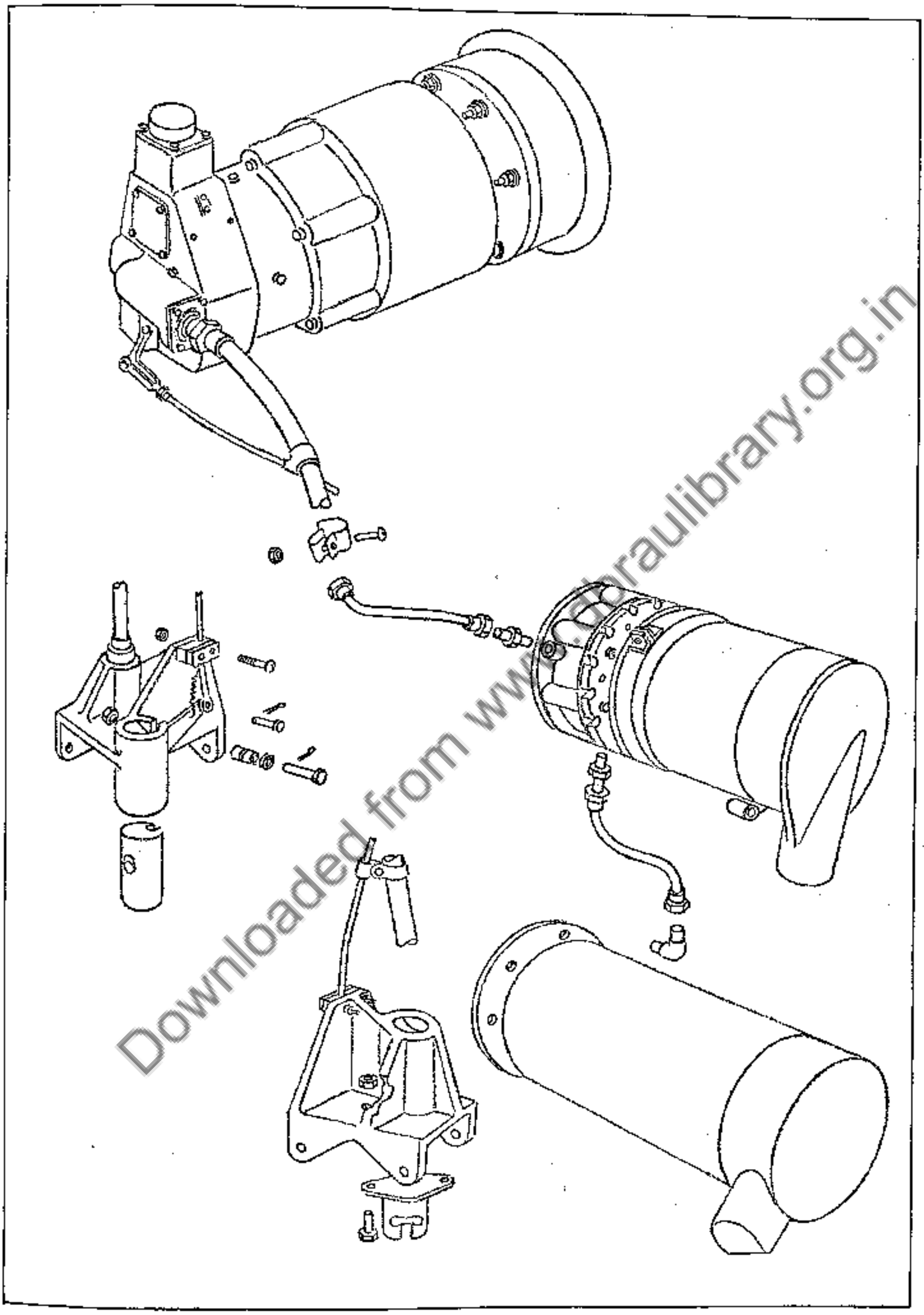
This comprehensive layout will undoubtedly serve several purposes because it will not only be reproduced but will also be the basis for making finished renderings for service manuals, bulletins, and parts catalogs. It may even be photostated for use in the sales department, engineering design group, and for conferences between executives and engineers. In addition it may be filed away neatly for pictorial references.

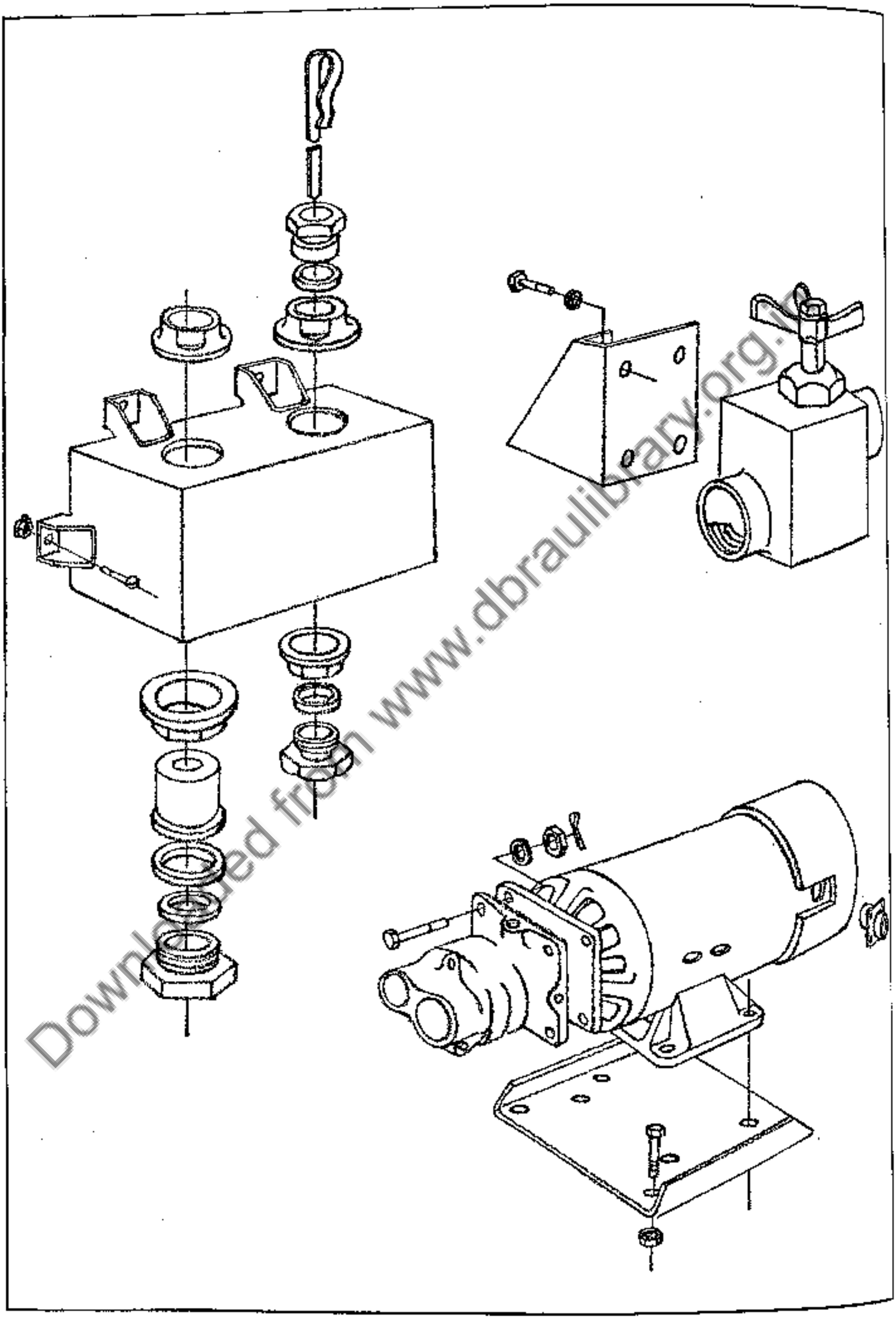
Using the same three rough layouts shown in Figs. 79, 80, and 81 of the preceding chapter, the correct approach for making the comprehensive tracings is shown in Figs. 82, 83, and 84. In these figures it will be noted that the refinement has been added to the rough layouts after they have been traced. Quite often the illustrator is tempted to spend too much time working out minute refinements which later will



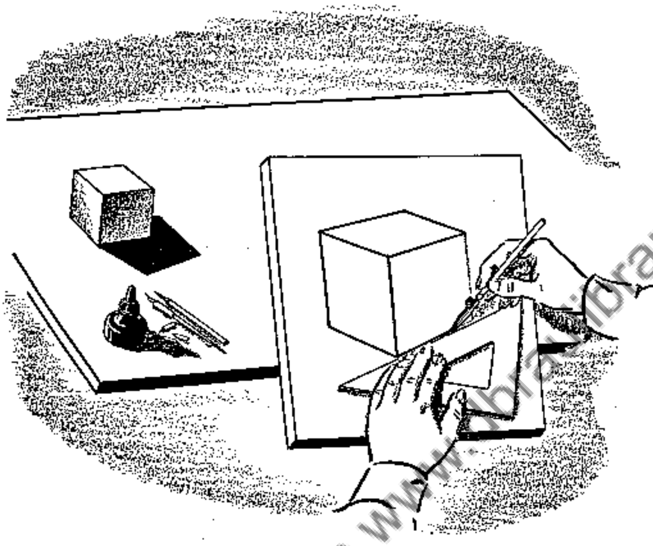
be negligible when tracing the comprehensive layout onto the illustration board for the finished rendering. These minute refinements and details can be added very easily on the illustration board before rendering. Nevertheless, it is often worth the illustrator's time to make the comprehensive layout as finished as possible, especially if it is to be reproduced in blueprint or photostatic form.

As pointed out in connection with Figs. 82, 83, and 84, there are certain details which are almost always held back until the comprehensive layout is traced on illustration board; then they are added directly to the illustration. For example, objects having machine threads for bolts and screws, various types of screwheads, grooves, embossed parts, and textures are all reserved to be sketched in on the final illustration. These are minor details that do not pertain particularly to the over-all shape. Usually the comprehensive layout is not shaded when it is completed; however, there are times when it becomes necessary to shade it. Generally a shaded comprehensive drawing is used only to simplify for the observer complicated objects which might be hard to interpret satisfactorily if they were left in outline form. For specific rules and methods of shading, refer to Chapter 9 which deals with rendering. The only exception to the rule, as mentioned, is to shade the comprehensive drawing in order to develop definite shadow shapes to be followed when the finished drawing is rendered. It is necessary to determine shadow shapes on the comprehensive drawing before rendering in order to prevent overdoing the shades and shadows.





Chapter 9 RENDERING



A RENDERING, as applied to production illustration, may be defined as a drawing which is complete in every detail, including shading. Often perspective renderings are made of objects before they are manufactured. One which is made before manufacturing begins is a *visualization* of the finished product; this usually is drawn while the object is yet in the engineering stage. Exploded production illustrations that are satisfactorily rendered (in any one of many mediums) are not only visual aids for the assembly-line workman, but are also used for telling a complete story of the make-up and assembly of the product to the production experts and the buyers of the manufactured product.

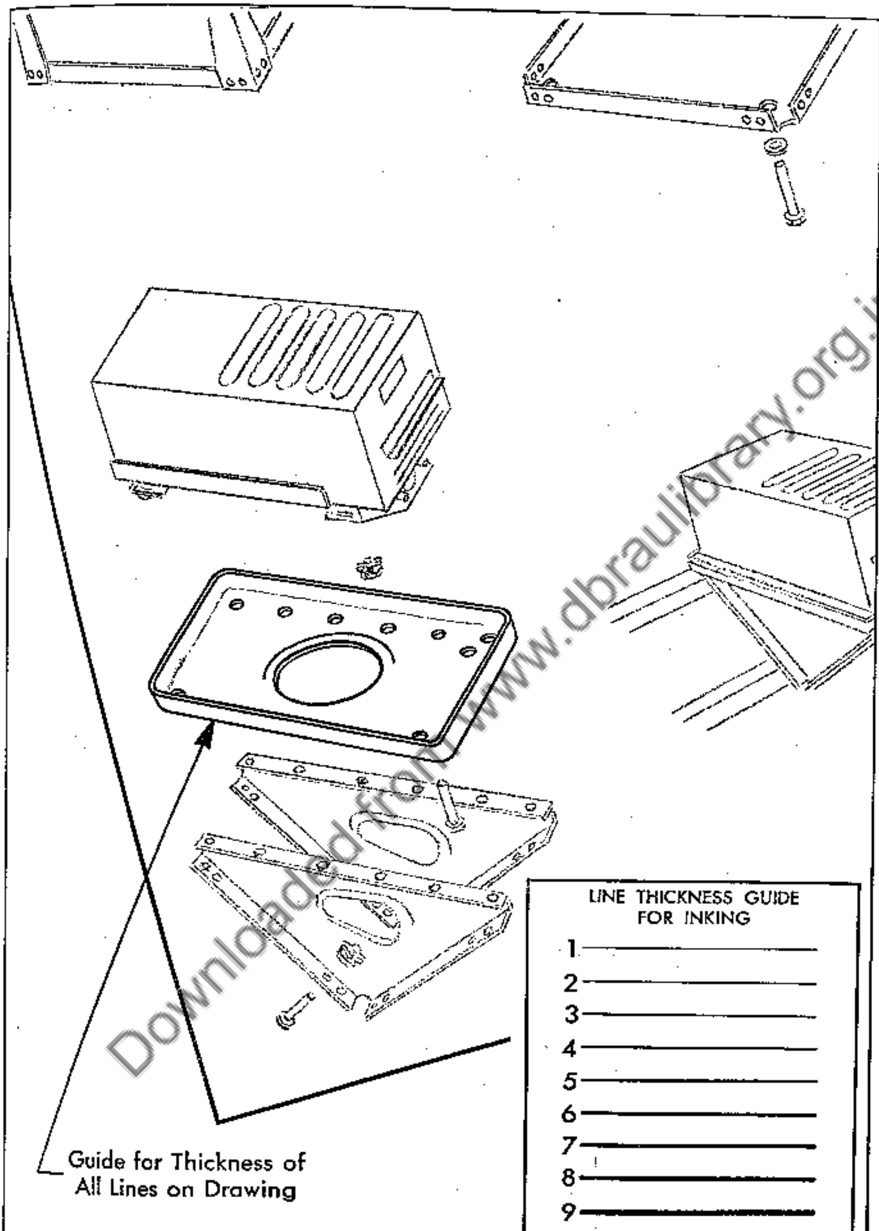
To make a good rendering after the comprehensive drawing has been traced onto the illustration board, the illustrator should make sure all lines are definite and clear. This is where the artist has an opportunity to exercise his ability to visualize the production illustration in its reproduced form. The size of the reproduction must be definitely established before making a drawing which is enlarged proportionally. The reason for considering the size of the reproduction is to determine the width, or thickness, of the lines so that the drawing, when reduced, will not appear weak or be hard to visualize. It should never be assumed that bad lines on the illustration (which have been traced from the comprehensive) can be straightened out, or corrected when the drawing is inked in. Many illustrators in the field have yielded to the bad habit of trying to correct lines while they are inking and shading the drawing. However, as mentioned in the preceding chapter, all ellipses, straight lines, and irregular curves should be carefully checked before beginning the finished rendering. By so doing, the time required for making the finished rendering will be reduced to a minimum.

In all cases be consistent throughout the illustration. There are many ways in which to obtain consistency of lines in an illustration. It is suggested that the illustrator prepare a *line thickness guide for inking* as shown in the lower right corner of Fig. 85, or a small section may be inked in as a guide anywhere on the drawing as in Fig. 85. Then, using the inked-in section to show the thickness of lines, the remainder of the drawing can be inked in accordingly.

With a section inked in as a keynote to the rest of the lines, the illustrator should now give his attention to the completion of the illustration so far as it pertains to outlining the drawing. Figure 86 is a good example of a satisfactorily inked outline drawing.

Outline drawing as depicted by Fig. 86 is the simplest form of rendering and is used where large quantities of production illustrations are needed, and when the time is limited for their completion.

While inked outline drawings are practical for some purposes, renderings which employ shading are much more desirable because they define the form of the object more clearly. The form of any object has to do with its shape, arrangement, beauty, and symmetry. All this is expressed only by the illustrator's ability to represent, in light and shade, the object's appearance, including the texture of its surfaces. Therefore, it must be said that shading expresses form, and if form is lacking the drawing will be spotty and will not show third dimension. This means that curved surfaces might not appear to be curved


LINE THICKNESS GUIDE
FOR INKING
1
2
3
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8
9
Guide for Thickness of
All Lines on Drawing

at all, but instead, flat and dull. The only reason a product or manufactured object is ever shaded is to enable the person who views the rendering to visualize, and recognize, every shape of the rendered object.

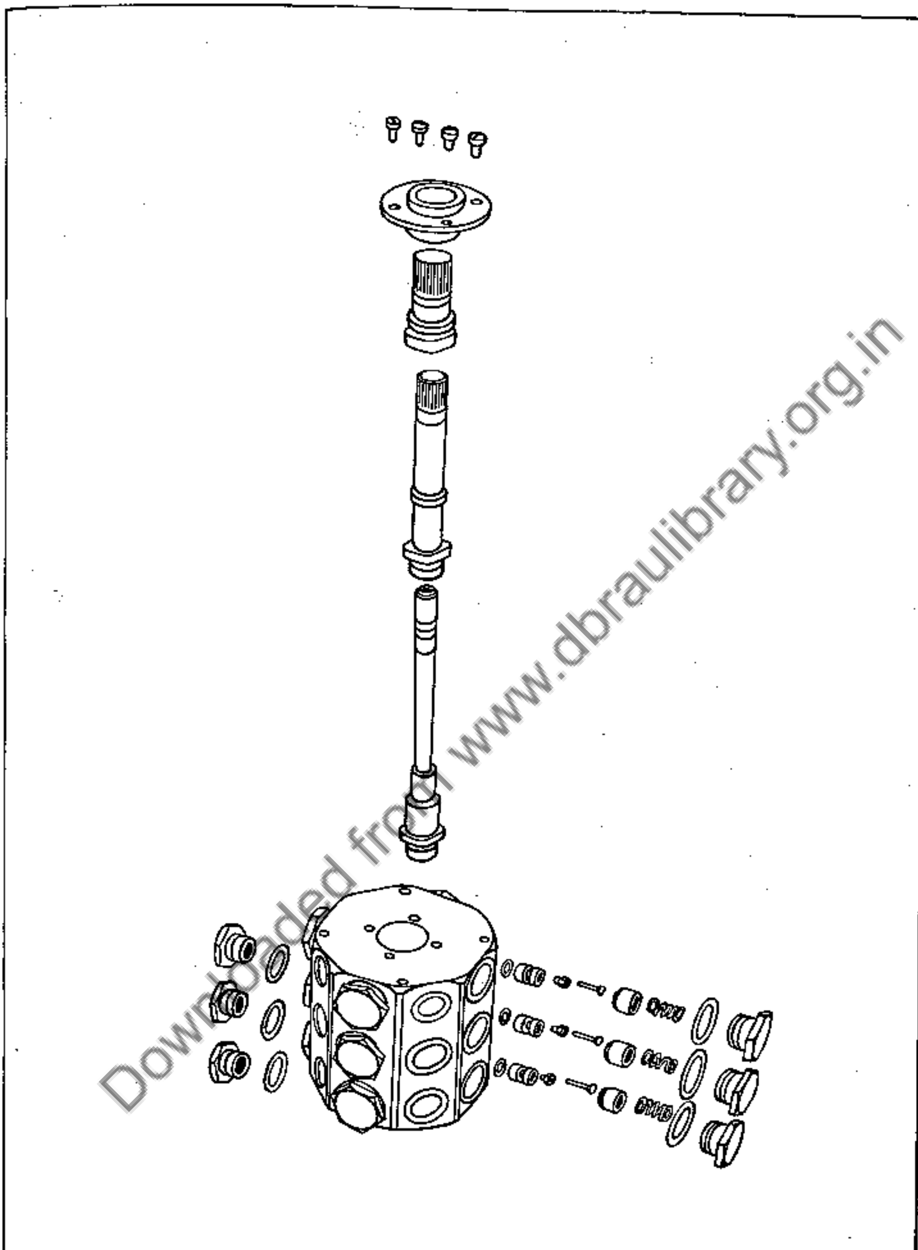
When starting to shade, assume that the light source is in such a position as to bring out effectively the form of the object. This means that the light directed upon the object may come from any position above, below, or from either side.

There are a number of ways in which shading may be applied to the rendering. Figures 87, 88, and 89 show examples of *black line and area shading.* This combination employs the use of a draftsman's ruling pen for the straight lines, a pen for the curved lines, and brush for filling in shadow areas. Drawings rendered in this manner present very little difficulty in reproduction.

Another effective method of shading a drawing is by means of *stippling.* Stippling, as illustrated by Figs. 90 and 91, is a process of shading which uses dots applied with a pen point that is suitable to the reduction size of the drawing. This is an excellent medium for indicating the texture of materials which have rough surfaces. Even though this method is widely used by production illustrators it requires a considerable amount of time and should therefore be used with discretion.

A very good medium for shading a rendering which is not nearly so meticulous as the stipple method is to use the *litho-pencil.* The desirable characteristics of the litho-pencil may best be appreciated through comparison with the ordinary graphite, or lead, pencil. The litho-pencil is black and will reproduce as such, while the ordinary graphite pencil actually appears grey when reproduced by the line process as in Fig. 92. Several good illustrations which demonstrate the application of the litho-pencil will be found in Figs. 93, 94, and 95. Notice in Fig. 93, particularly, that a good imitation of crackled finish has been obtained.

Still another method of shading which is commonly used by production illustrators is the use of various Ben Day patterns. Ben Day patterns consist of various arrangements of dots and lines. These patterns are printed on transparent film and may be cut to fit the areas to



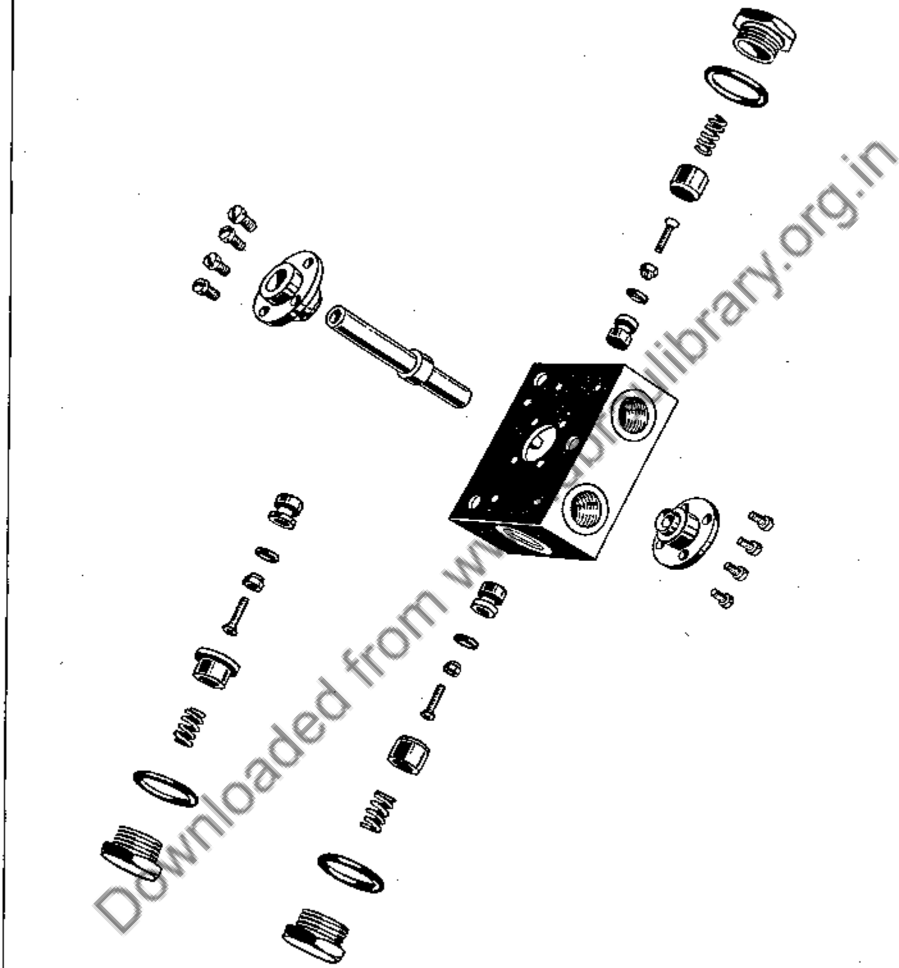
be shaded on the rendering and then mounted to the drawing surface with rubber cement. Several companies manufacture Ben Day pattern sheets which may be obtained at most artist material and supply stores. Two commercial lines which are popular with illustrators are the Craftint and Zip-A-Tone Ben Day patterns.

Besides the transparent Ben Day overlay patterns, Craftint drawing board is also very popular. The Craftint board has a specific type of sensitized surface. The most commonly used patterns are referred to as doubletone and contain both light and dark tones which may be developed on the drawing surface of the board by applying, with a brush, certain chemical solutions as shown by Fig. 96. For example of renderings made on Craftint doubletone board, see Figs. 97, 98, and 99. Notice in particular Fig. 99, which shows the possibilities for indicating various materials and textures.

Airbrush renderings, as in Figs. 100 and 101, are among the most refined mediums for presentation employed by production illustrators. The airbrush is extremely valuable because through its use the textures of metal surfaces, plastics, and textile fabrics are best depicted. Ideal blending of tones can be acquired, and a complete drawing can be made to resemble an expert photographic reproduction. In other words, the airbrush rendering when expertly done has a freshness which is pleasing to the observer. It has crispness and appeal. When compared with other mediums, the airbrush rendering resembles more realistically the actual manufactured product. For this reason airbrush drawings are usually included as a part of the sales promotion material of the manufacturer. Airbrush drawings convince—they sell!

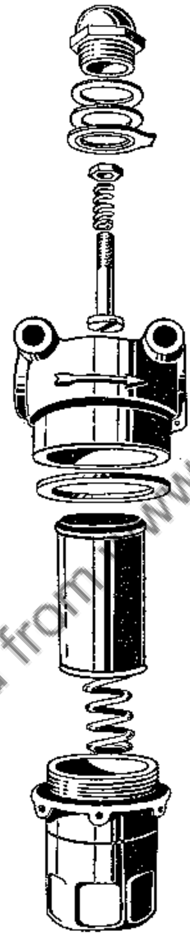
It is true, however, that the mediums previously described are more economical and timesaving, but there are times when more elaborate illustrations are required and it is here that the airbrush serves its purpose best.

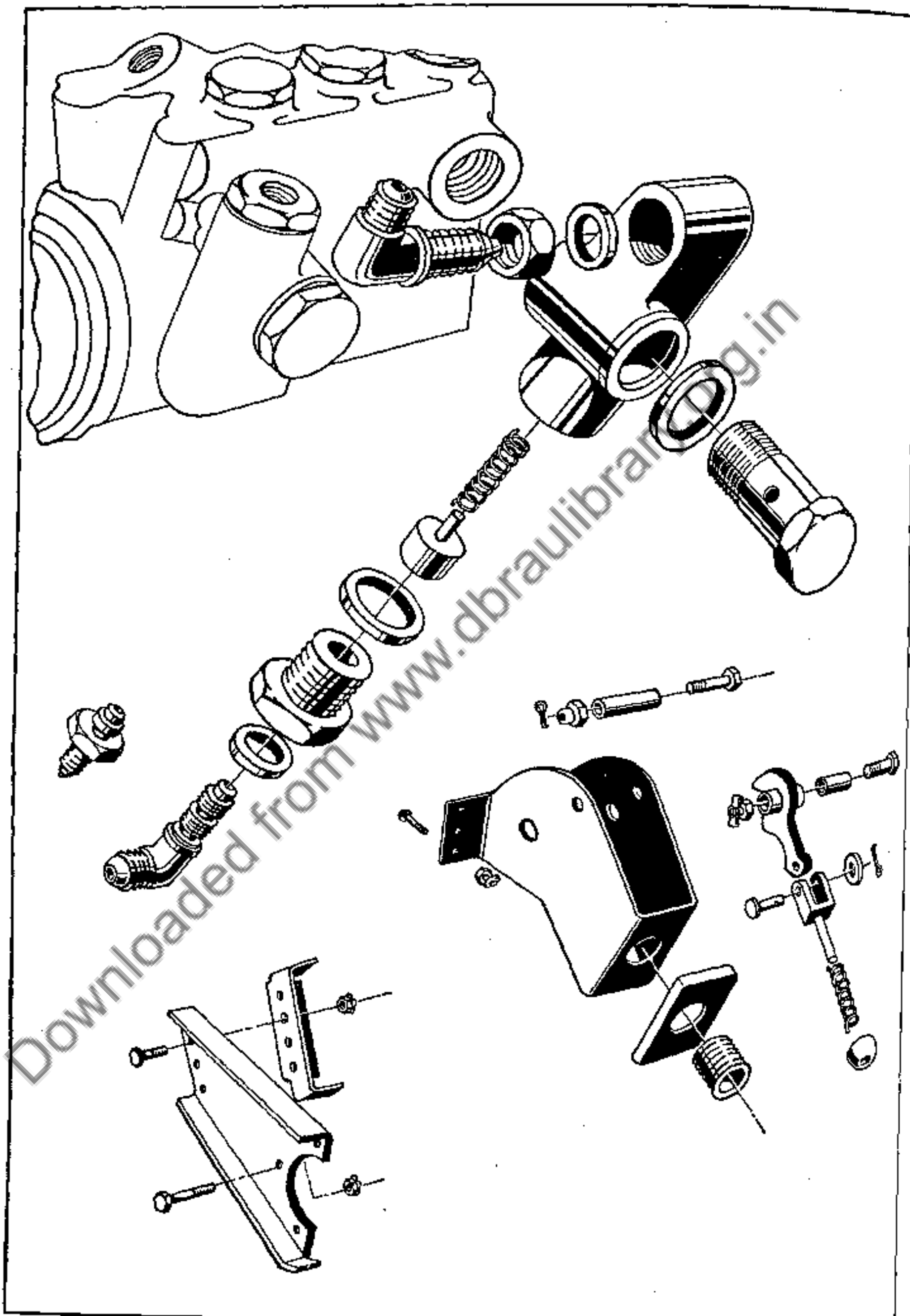
The steps involved in making an airbrush rendering are simple and easy to understand, as shown in parts A, B, and C of Fig. 103. Observe that Fig. 102 shows the outline of the object to be rendered, while part A of Fig. 103 shows a *frisket* being cut. A frisket is a very thin, transparent paper with rubber cement applied to one surface so that it will adhere to the drawing. Then the area to be sprayed is cut out

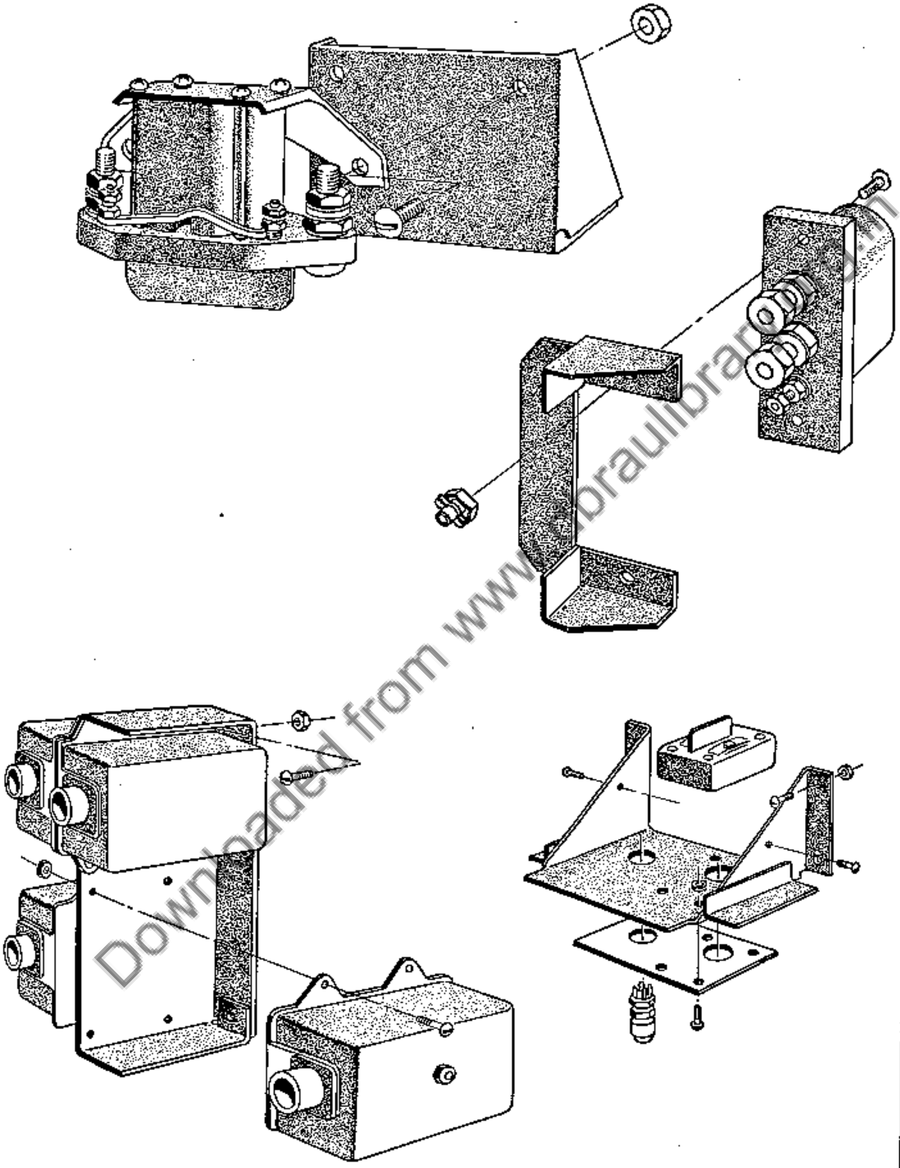


of the frisket. Part B of the same figure shows the cut-out area being sprayed in with the airbrush; finally the frisket is lifted from the surface of the drawing as shown in part C. This process is repeated until the rendering is completed. Figure 104 shows the completed airbrush rendering after all areas have been sprayed.

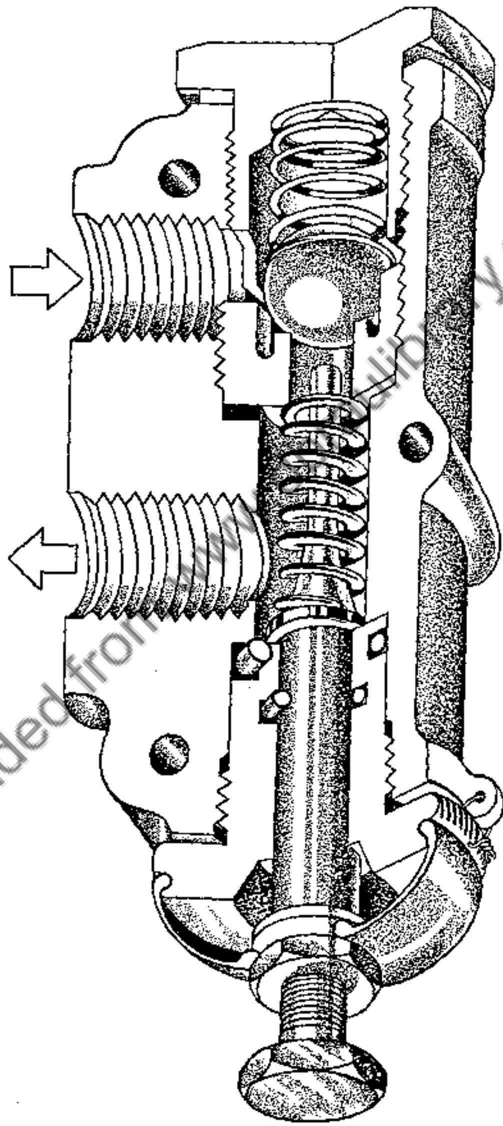
Whenever the actual manufactured object is on hand there is no need for an airbrush rendering when a retouched photograph, as in part A of Fig. 105, will serve the purpose. Compare part A of Fig. 105 with part B of the same figure which shows an unretouched photograph of the same manufactured object. Notice that part B of the figure gives some indication as to what the various parts of the object look like, while part A presents a more clean-cut appearance due to the fact that highlights and reflected light have been strengthened with the airbrush, and that detracting shadows which lessen the value of the form have been sprayed out.



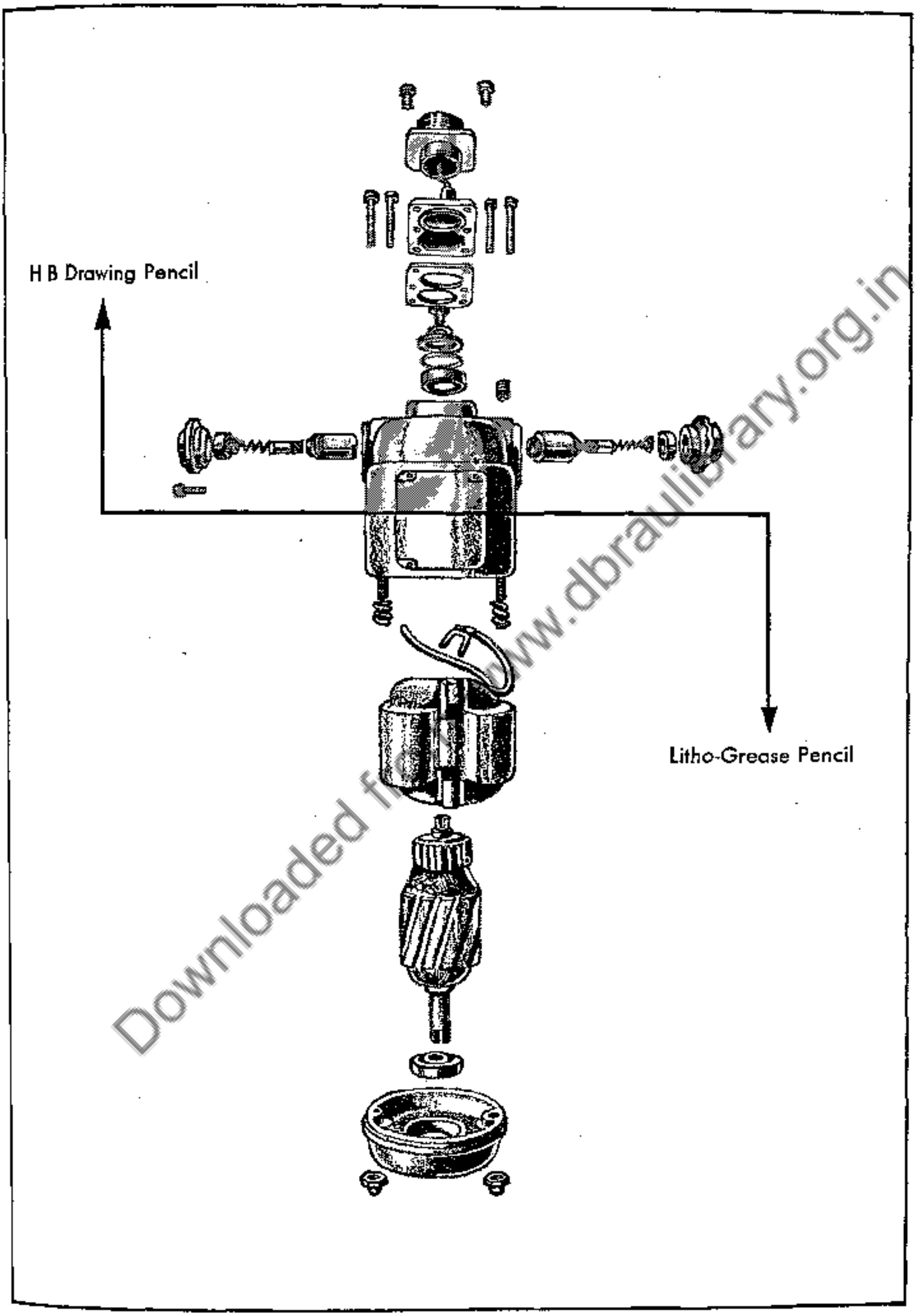


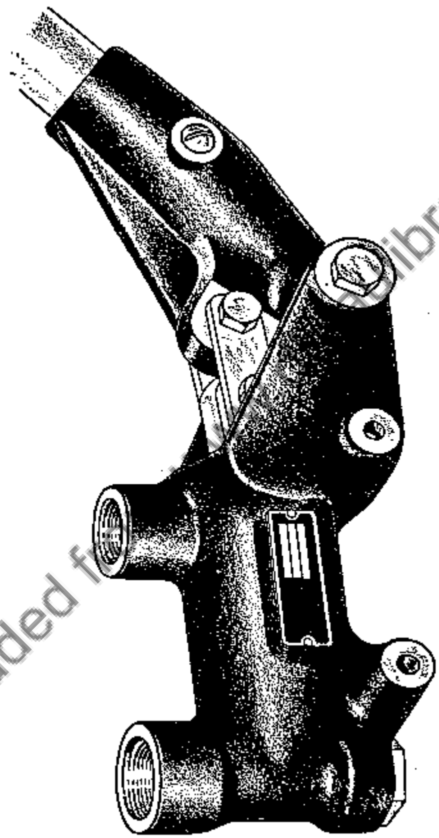


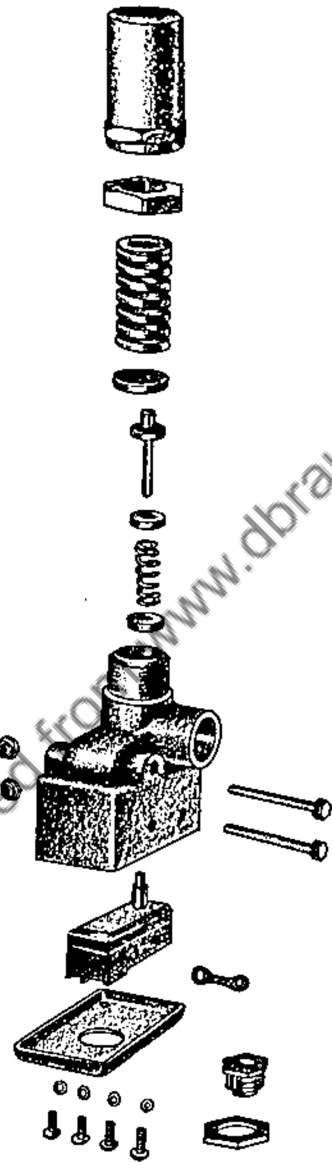
STIPPLE-SHADED RENDERING

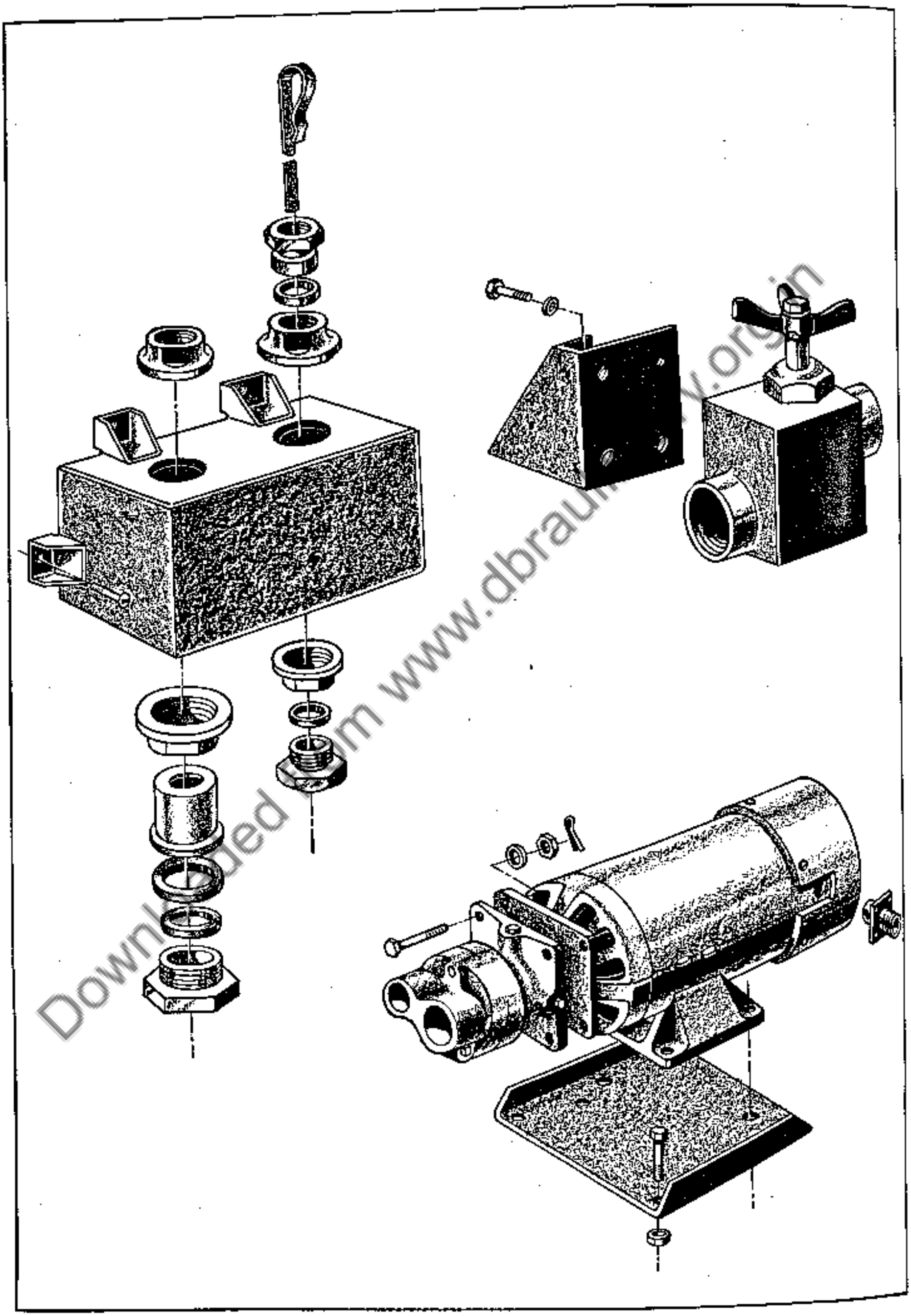


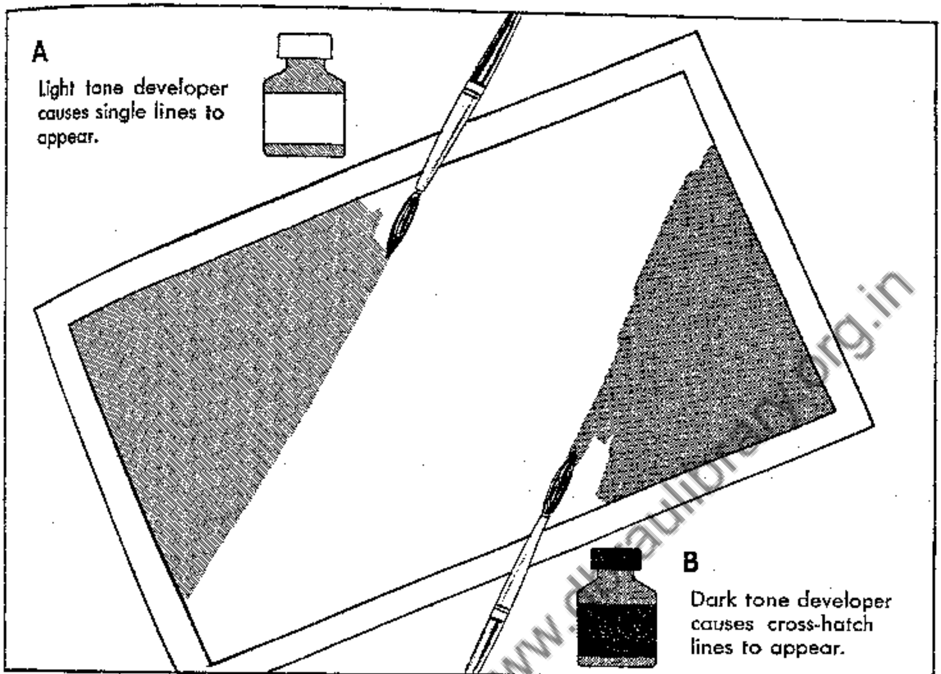
STIPPLE-SHADED RENDERING

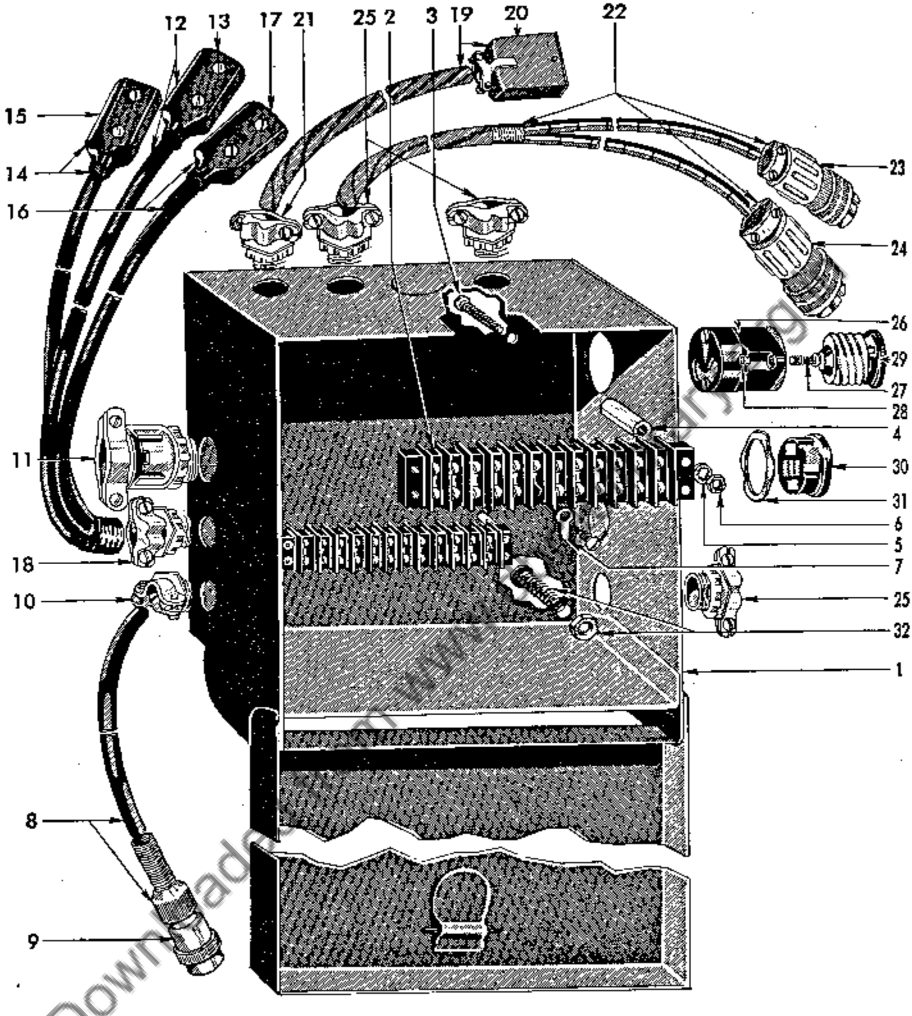

H B Drawing Pencil
Litho-Grease Pencil








A
Light tone developer causes single lines to appear.
B
Dark tone developer causes cross-hatch lines to appear.



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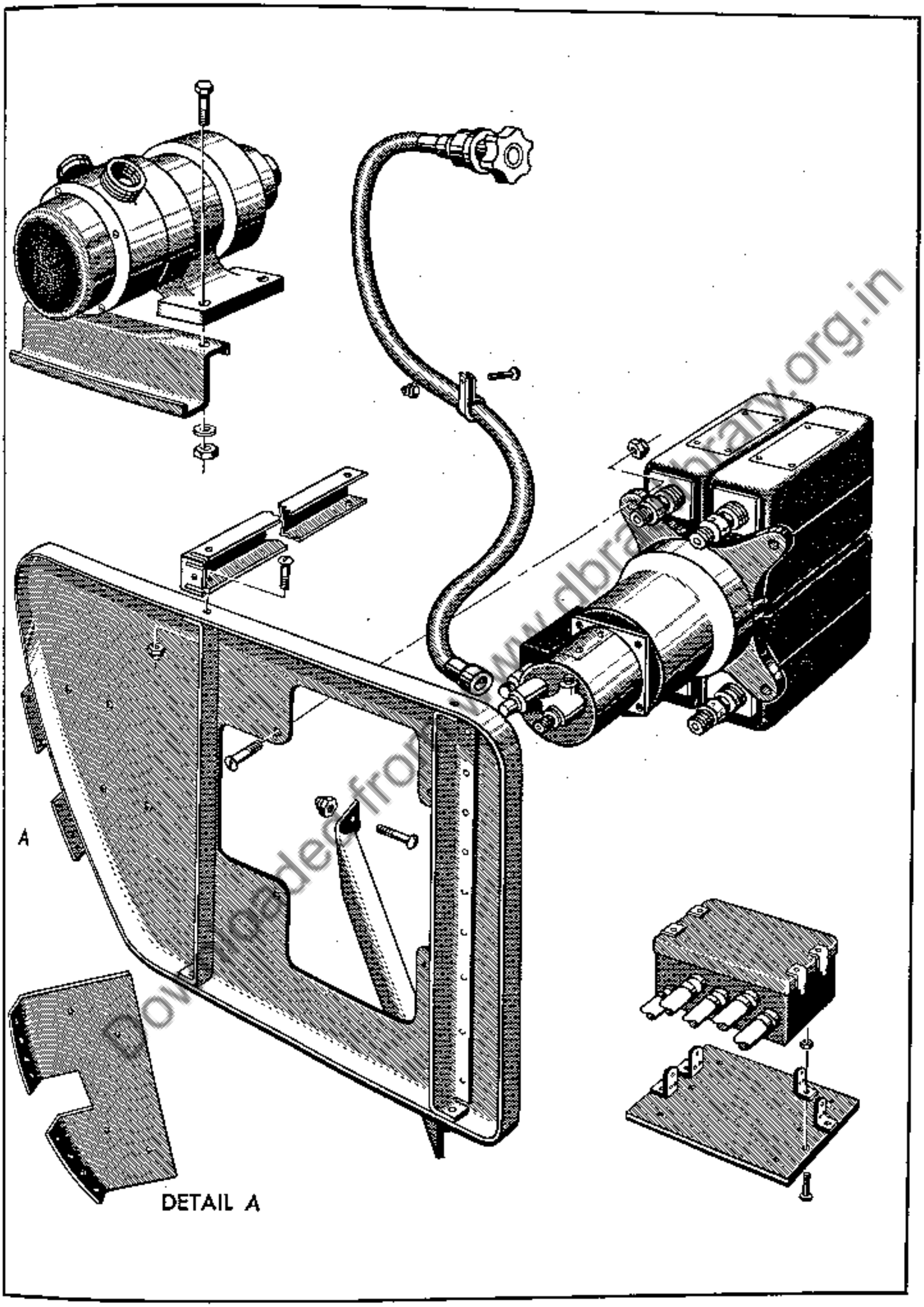
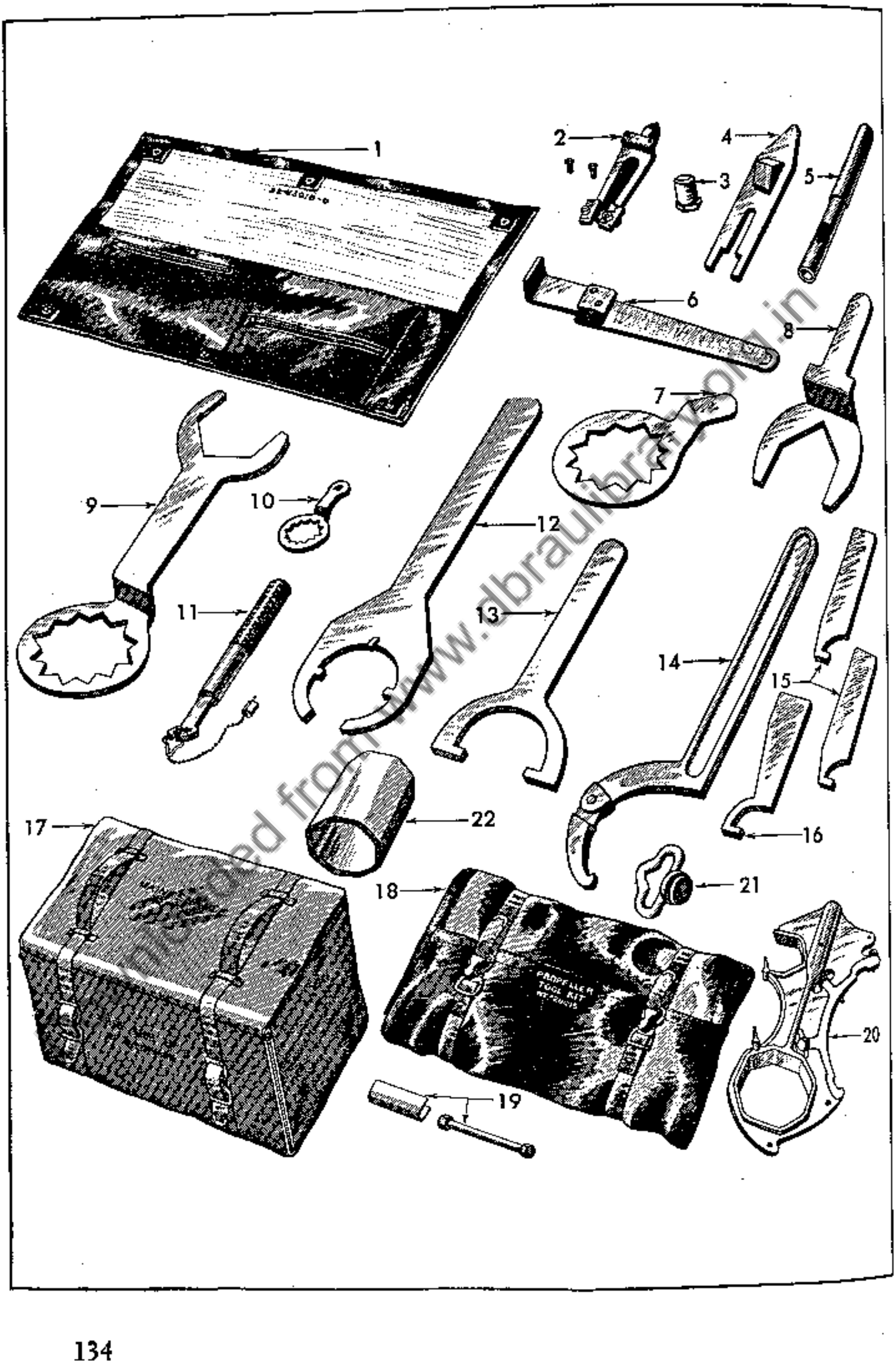

A
DETAIL A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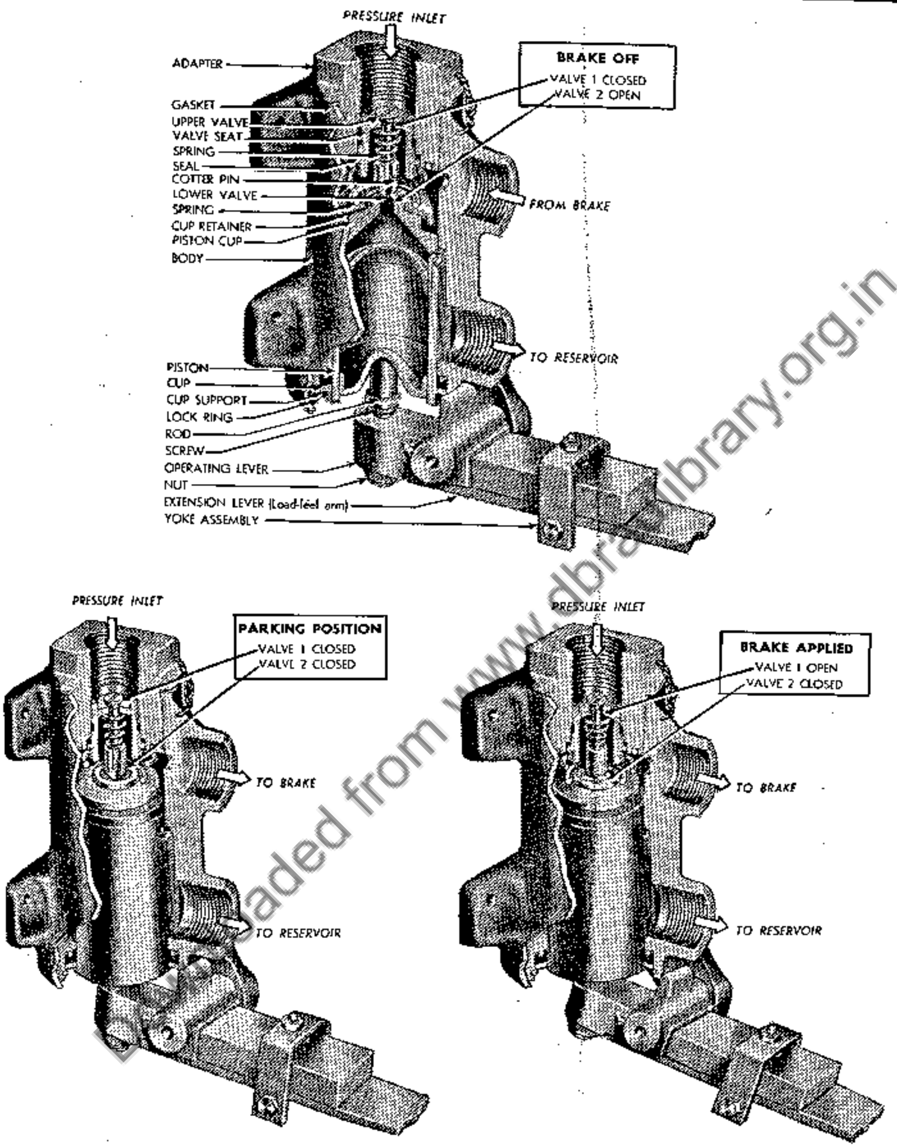
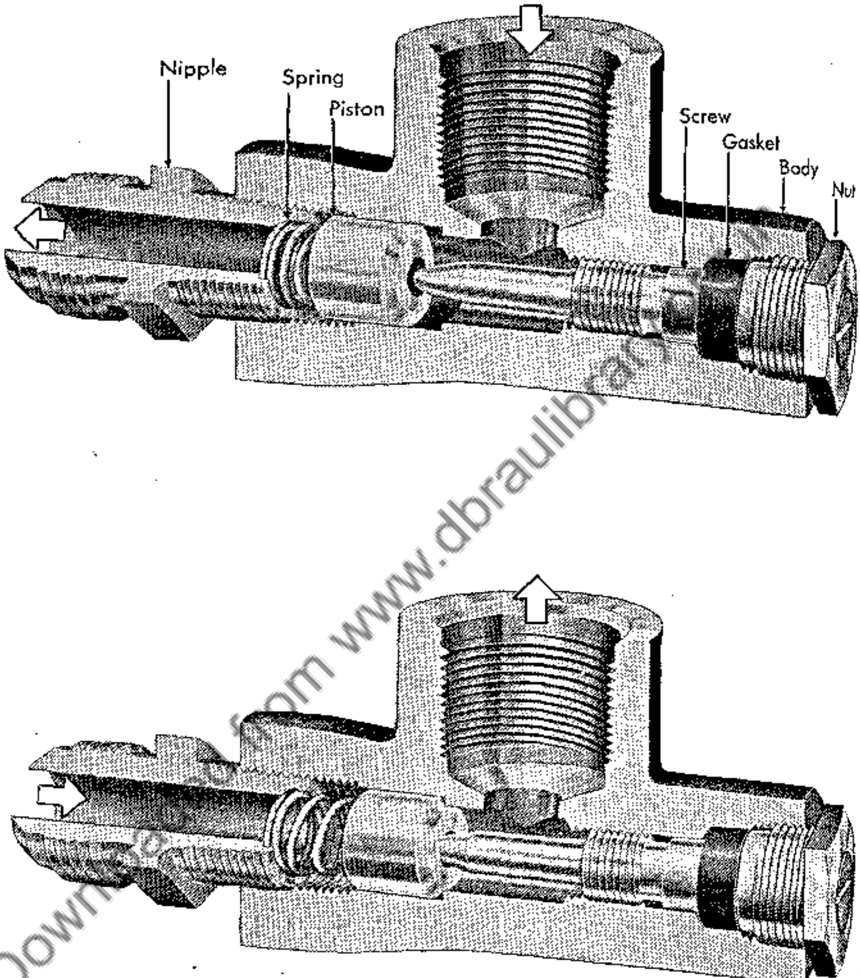
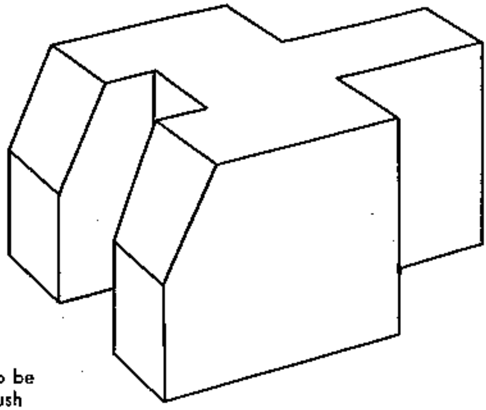


CUTAWAY RENDERINGS SHOWING THE FUNCTION OF A POWER BRAKE VALVE



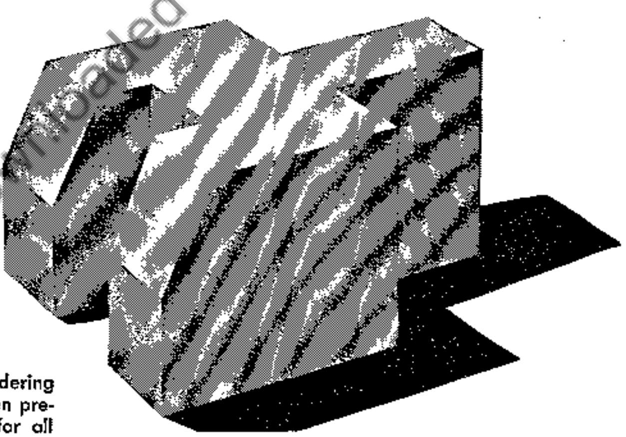
AIRBRUSH RENDERING OF A DRAWING SHOWING
THE "IN" STROKE AND "OUT" STROKE OF A VALVE



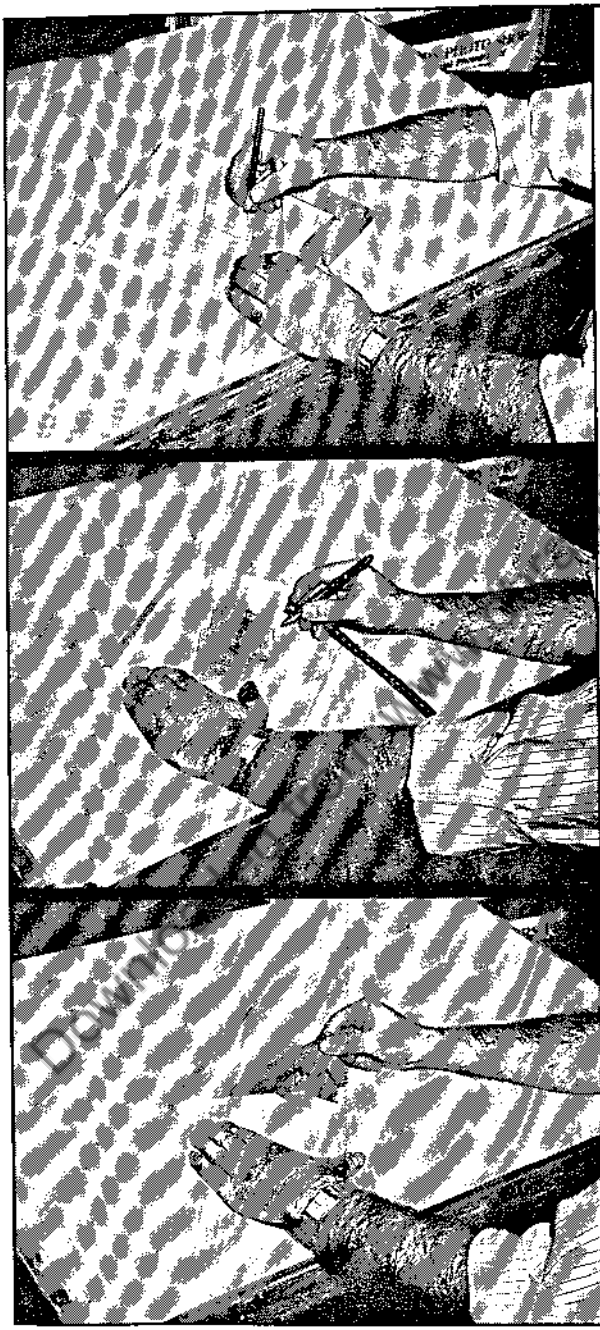
Example of object to be rendered with airbrush

Fig. 102

Fig. 104



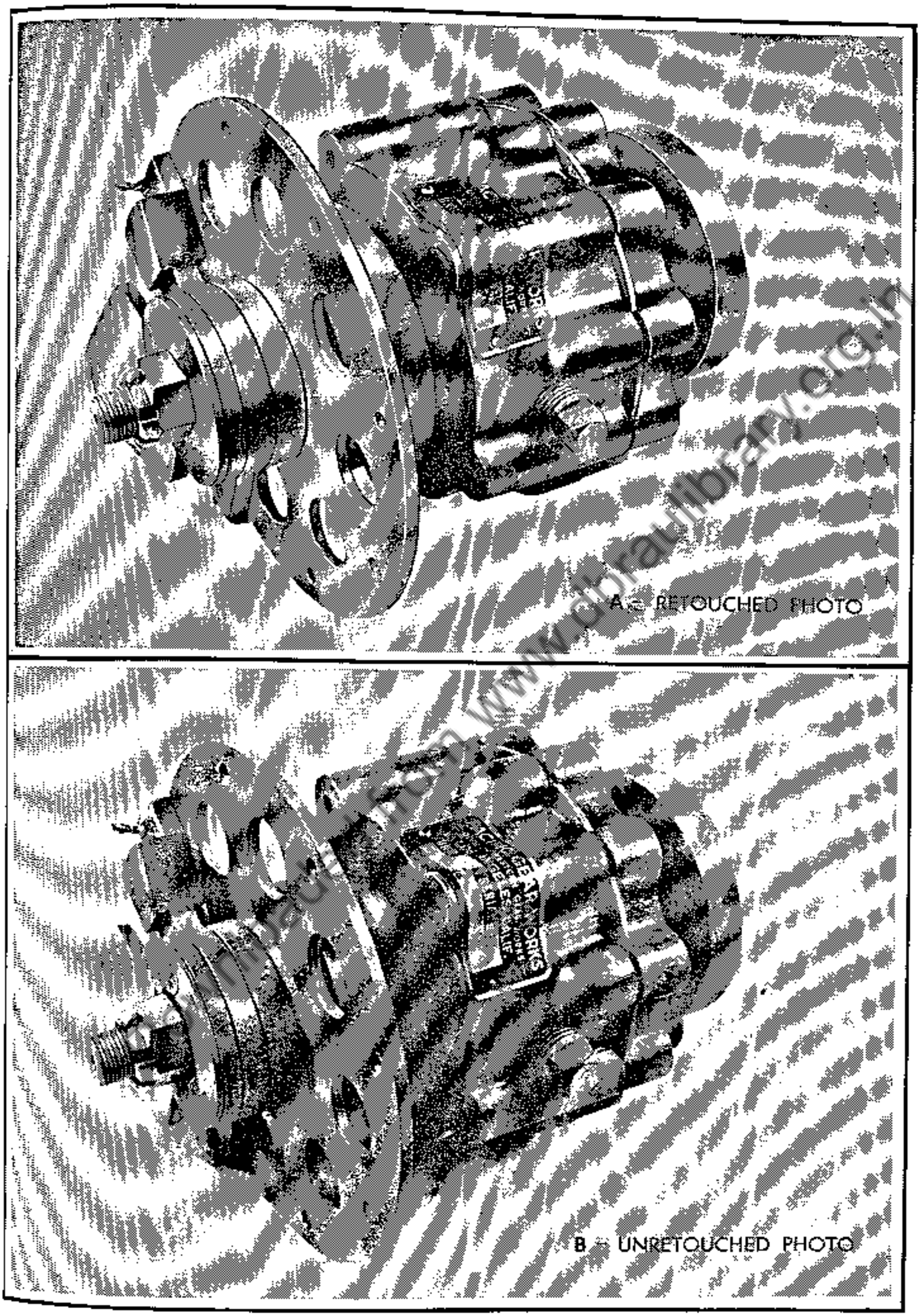
Finished airbrush rendering after friskets have been prepared and sprayed for all surfaces.



A The frisket is being cut

B Spraying area left open by frisket

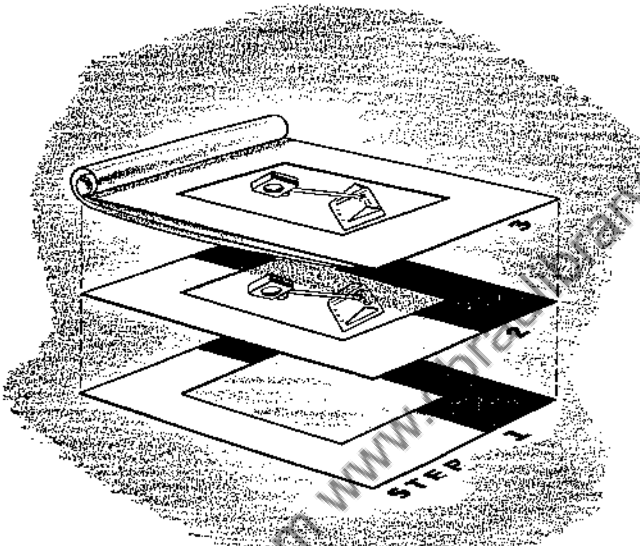
C Removing frisket after spraying



A — RETOUCHED PHOTO

B — UNRETOUCHED PHOTO

Chapter 10 MOUNTING AND PRESENTATION OF DRAWINGS



ONCE A RENDERING is completed on the layout board the artist should prepare to make the kill. The real zip or punch must be added to the finished sketch, or illustration. The rendering is lifeless and often dull to the viewing public until the artistic product of tireless labor is mounted on a sheet of fresh, crisp mat board and covered with a sparkling sheet of ply film, acetate, or cellophane. That is the knockout blow, and any employer, boss, or customer likes to be mildly knocked out occasionally. Therefore, it is imperative that care be taken in the selection of a mat board; be sure that the grain and texture are suitable to the rendering. It should flatter the layout. Don't display an illustration, into which hours of eyestrain and ability have been poured, as though it were a cheap shirt or tin horn.

In all cases use neutral mats if the illustration is to be reproduced.

Use white, eggshell, light buff, and pale gray for illustrations of a subassembly, fitting, or exploded view of various parts. If the illustration is a decorative design, rendered in color, it is good to use a light shade of a color complementary to the prevailing color in the design. For example, if the predominating color is violet it would be good to use a cream-colored or pale yellow matting to create a harmonizing effect.

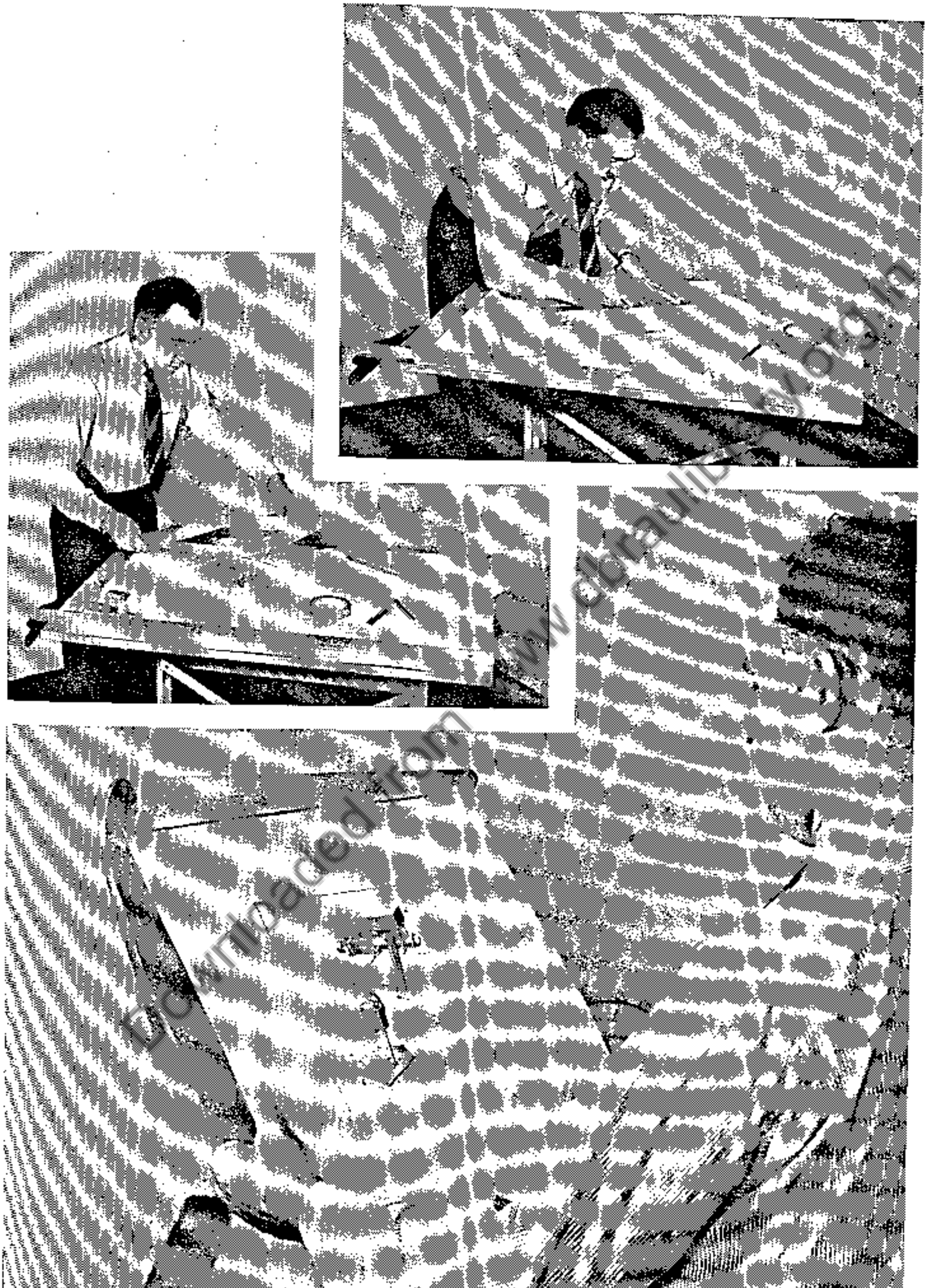
The best mounting effect may be obtained by cutting the mat board as a mask with a beveled frame-line edge. To do this, draw in lightly with pencil a frame which is the size of the space through which the picture is to be viewed. Then with a sharp mat knife, or single edge razor blade, cut along the line, holding the knife at about a 60-degree angle (see Fig. 106). Place the sketch behind the mask and hold firmly in place with rubber cement and cover with clear ply film, cellophane, or acetate film. Ply film is more desirable than cellophane because it does not wrinkle easily and is not readily distorted by moisture. Both are reasonable in price.

Avoid the appearance of having thrown the masterpiece together. Remember, the manner in which a rendering is mounted and presented is the window through which is seen the artist's ability as an illustrator.

In the two preceding paragraphs the more elaborate method for mounting an illustration has been described. However, there are two other commonly used methods for mounting that are also excellent when the drawing is to be reproduced. One of these methods is referred to in Fig. 107 as the ordinary mounting. This method, as suggested by the term applied to it, is very simple. A sheet of mat board of sufficient size so as to allow ample border space around the drawing is used, and the finished illustration is simply mounted neatly on the mat board. The mounting may then be covered with a sheet of ply film for protection.

The other of the two methods shown in Fig. 107 is one which employs a very thin Strathmore paper window mask. Illustrations which are to be mounted in this manner are first cemented to a stiff sheet of cardboard. Then the window mask, cut from one ply Strathmore illustration paper (medium surface) is cemented directly over the drawing and cardboard so placed as to allow the drawing to show pleasingly

FIGURE **106**

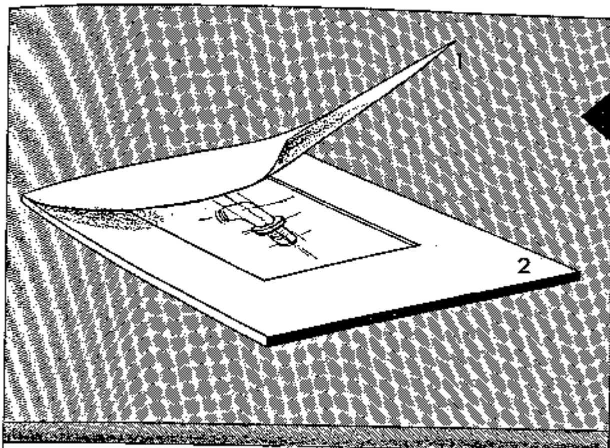


through the cut-out window. This method of mounting is good for use on drawings which are to be reproduced, because it is economical and timesaving.

Still another method is the mounting of photographs which are to be retouched for reproduction, as in Fig. 108. This requires a careful selection of the photograph to be retouched. Such photographs should have the best lighting possible, and show the product to the best advantage. It is at this point that the illustrator should realize that close cooperation with the photo laboratory, and vice versa, is important and essential if he is to have the proper variety of photographs from which to choose. When the illustrator has selected the best photograph, it is cemented to the mat board in a manner similar to that shown in Fig. 107. It may be cemented to the mat in several ways, but there are two that are worthy of mention: first, the **dry mounting** process with which all photographers are familiar, and second, the **rubber cement** process.

Dry mounting is a process in which use is made of a thin sheet of especially prepared dry mounting (adhesive) tissue and heat. The tissue is placed between the illustration and the board on which it is to be mounted. Then the illustration is placed in a dry mounting press where, under heat and pressure, the illustration, the mounting tissue, and the board become laminated into one.

In the rubber cement process the illustration and the mat board are held together directly with rubber cement. That is done by applying the rubber cement very thinly to the back of the illustration and also to the mat board. When both cemented surfaces have thoroughly dried, they are pressed together.



1

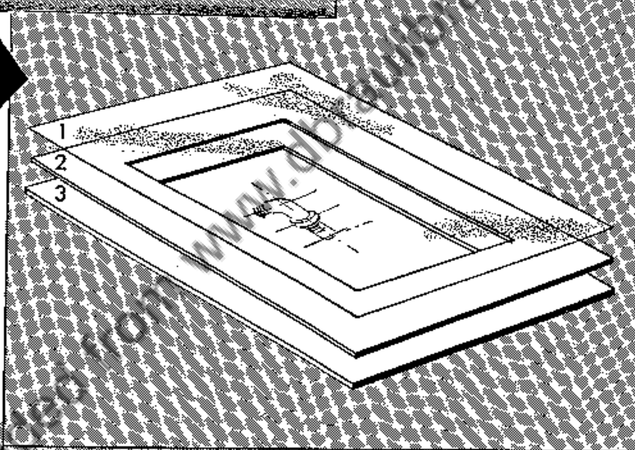
ORDINARY MOUNTING WITH ONLY A TRANSPARENT PLY-FILM COVERING

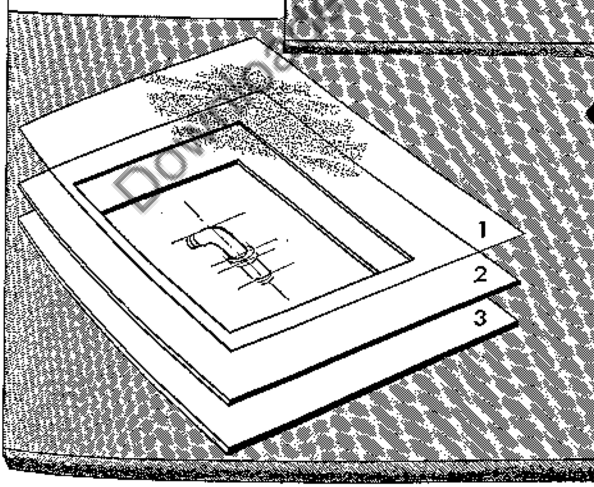
1 Ply Film
2 Matting

2

VERY THIN STRATHMORE PAPER MASK AFTER ORDINARY MOUNTING AND TRANSPARENT PLY FILM

1 Ply Film
2 Paper Mask
3 Ordinary Mounting

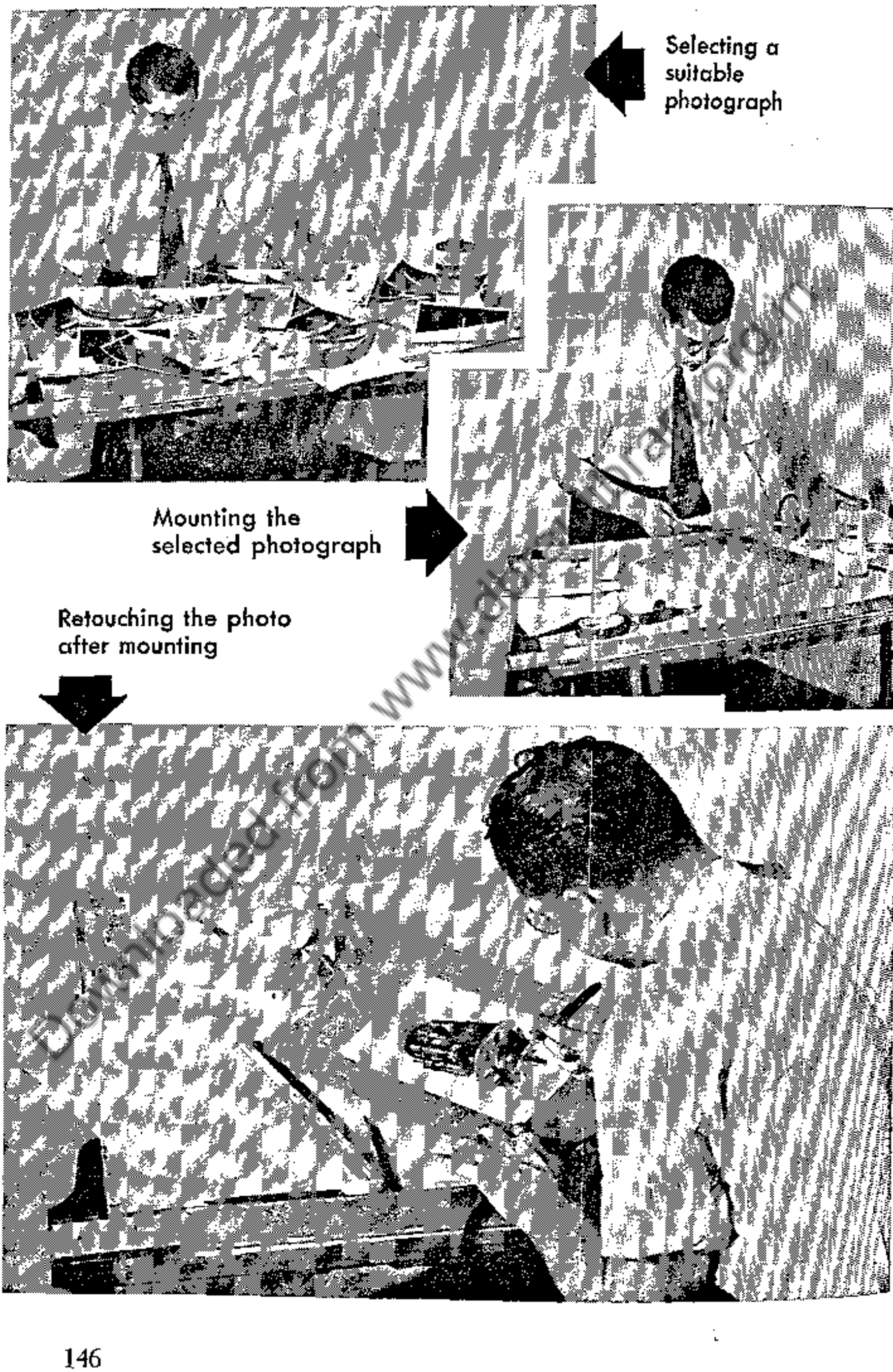




3

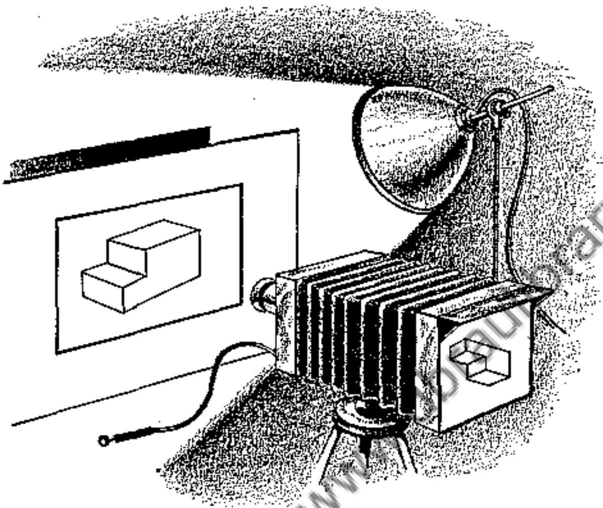
THE MORE ELABORATE MOUNTING

1 Ply Film
2 Window Matting
3 Ordinary Mounting


Selecting a suitable photograph
Mounting the selected photograph
Retouching the photo after mounting

Chapter 11

REPRODUCTION OF ILLUSTRATIONS



REPRODUCTION, as referred to in this chapter, has to do with producing a copy of an original drawing by any one of many processes. The most economical method for reproducing an illustration or drawing is known as the **line process.**

The line process is used to reproduce drawings made of ruling-pen lines, pen-point lines, brush lines and strokes, stipple shading, Craftint textures, and litho-crayon shading. (See Fig. 109, for examples of Craftint drawings for line reproduction.) These are but a few of the mediums used for line reproduction. In this process zinc-etched cuts are usually made for printing unless great quantities are desired, in which case copper-etched cuts or electrotypes are used. The reason the line process is outstandingly popular with manufacturers who reproduce great quantities of drawings in printed form is because of the cheapness of the materials and the simplicity of the reproducing process. The line process, as illustrated by Fig. 109, will reproduce all black lines, or dots, or other patterns such as Ben Days, and does not require screening. In addition, the line reproduction can be printed on almost any paper stock.

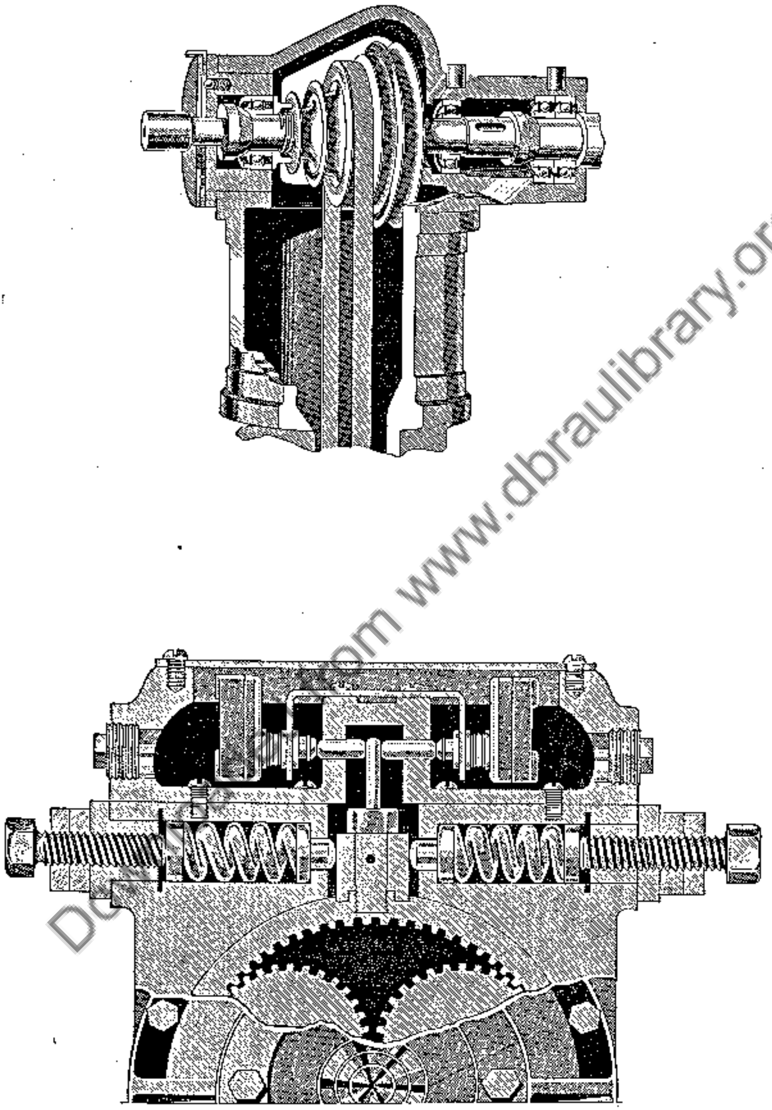
Before beginning to ink in the finished drawing which is to be reproduced, the illustrator must consider the amount of reduction of the drawing. Make certain that all lines have sufficient weight with enough space allowed between lines so as to give clean-cut and definite reproduction.

The **silver print, or bleach print,** process is one which must be considered along with the line process. This is a process which uses a special photographic print to which waterproof black ink lines are added by the illustrator to bring out the form and shape of the object. After the desired line drawing has been made on the photograph, the photograph is bleached with a cyanide solution, leaving only the ink-line drawing, which is suitable for line process reproduction, as illustrated by Fig. 110.

The **halftone** process is a process in which an engraved plate having a screen, or dotted surface, is used to reproduce a continuous tone illustration. The screen is placed in front of the emulsion plate in the engraver's camera in such a way as to produce small dotted areas on the negative. From this negative the printer's cut, or zinc etching, is made. Halftone drawings or illustrations are usually rendered in one or a combination of the following mediums: carbon pencil, colored pencil, wash, water color, airbrush, pastel, and oil paint. For an example of halftone reproduction, see Fig. 111 of an airbrush rendering.

The **offset** process is a process in which the image of the illustration is photographically placed on an aluminum plate which is then inked and offset on a rubber blanket roller under which the paper is run and the impression is produced. This process is also known as lithography, planography, and photo-offset. Offset reproduction is very economical and is used for the reproduction of drawings for manuals, catalogs, and books.

The **photostat** is a vital instrument to the production illustrator. It is often used to enlarge and reduce (to suitable size) drawings or photographs which are to be used in the preparation of drawings to be reproduced. A photostat is sometimes used instead of a pantograph,



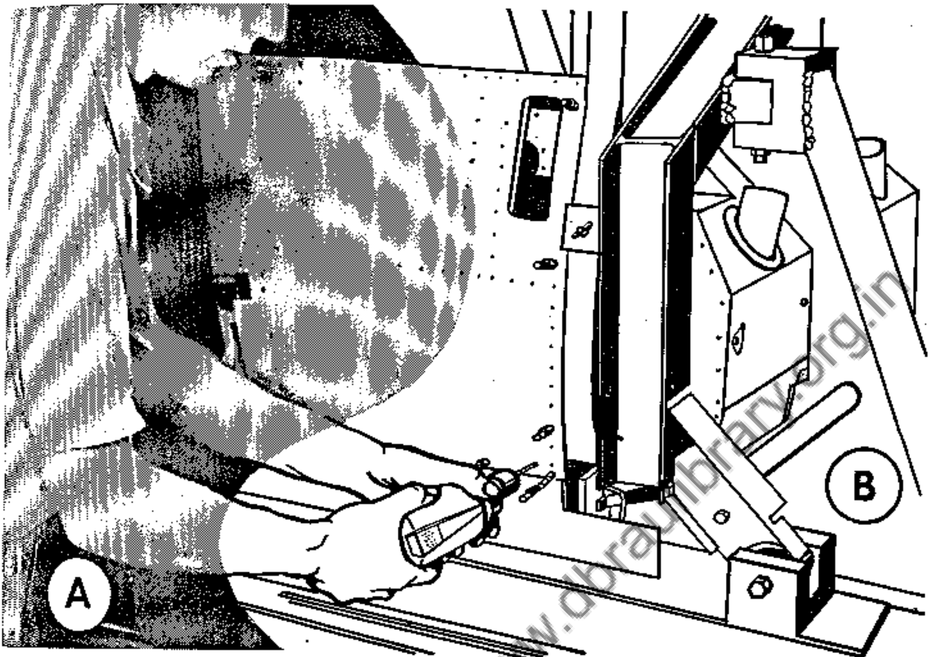
EXAMPLES OF DRAWINGS FOR LINE REPRODUCTION which is an instrument the illustrator uses to trace or copy a picture which must be either enlarged or reduced to the necessary size. The photostat is a reproducible photographic process which produces a paper negative. To produce a positive print, this negative is used and the process is repeated.

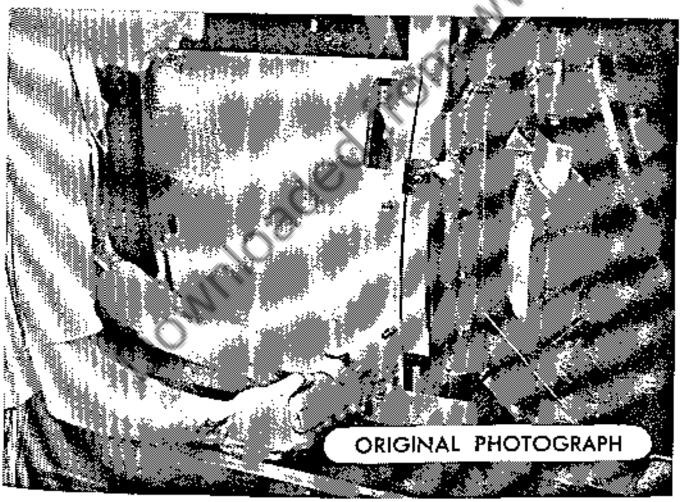
The **overlay** is a transparent or translucent covering that is fastened and registered to the original illustration in order to show illustrations which are to have more than one color when they are reproduced in printed form. Clear acetate overlays (flexible plastic sheet stock) are commonly used for showing labels on the drawing. Frosted acetate overlays (flexible plastic sheet stock which has one side treated with a ground-glass finish) are more practical than the clear acetate for ordinary color overlays because the material has a toothy texture and the color being applied will not creep or crawl away, like mercury on glass. In addition, the overlay is used to carry specific information concerning the treatment of the illustration, corrections, additions, and retouching instructions, if necessary. In preparing the overlay, carefully-placed register marks, as shown in the lower part of Fig. 112, are imperative if good final reproduction is to be obtained. Crop marks which indicate the over-all size of a drawing may also be indicated on an overlay, or on the face of the drawing, as shown in the upper part of Fig. 112.

Color in reproduction is important.

The problem facing every copywriter and illustrator in preparing catalogs and technical manual information is how and when to use color. The important axiom to remember is the restriction of color to where it serves a functional purpose only. In other words, color should be used only to clarify, identify, or distinguish between parts which otherwise would be difficult to identify. Color may also be used to indicate paths of travel, or fluid lines, pressure areas, and so on.

Before a photograph can be reproduced it is sometimes necessary to make certain alterations and touchups in order to emphasize the part being shown. **Retouching for reproduction** is the process of applying various grays, white, and black to an illustration by means of brush, airbrush, pencil, pen, etc., for the purpose of making corrections, ad-





A
Shows the photo before being inked-in.

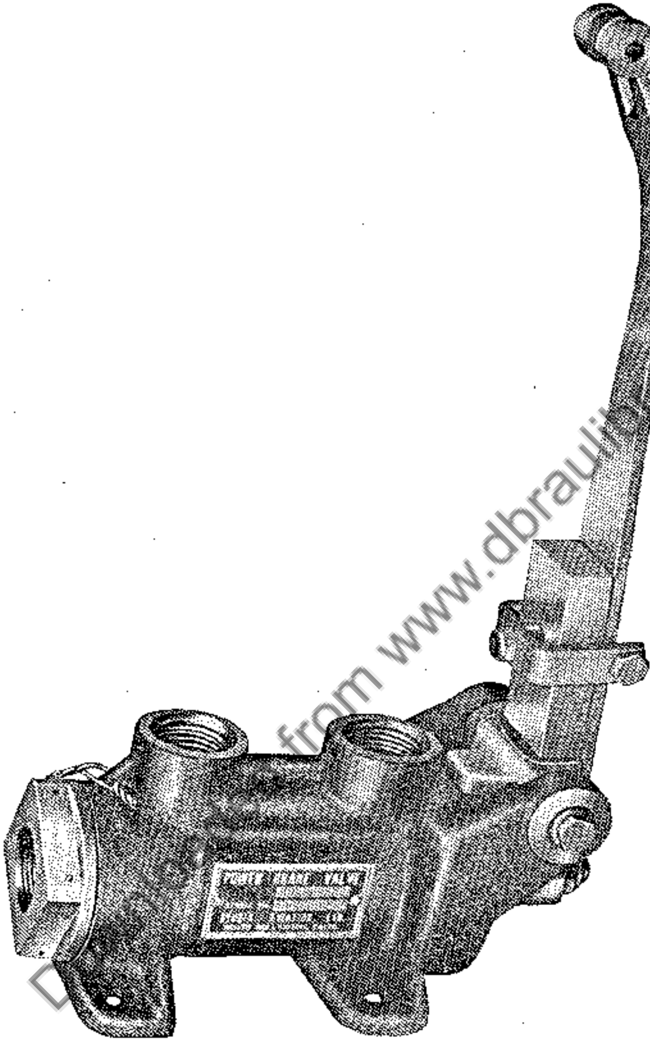
B
Shows the photo after it has been inked-in and bleached for line process reproduction.

A photograph of the subject to be rendered is taken from an advantageous view point and then enlarged to the appropriate bleach print size.

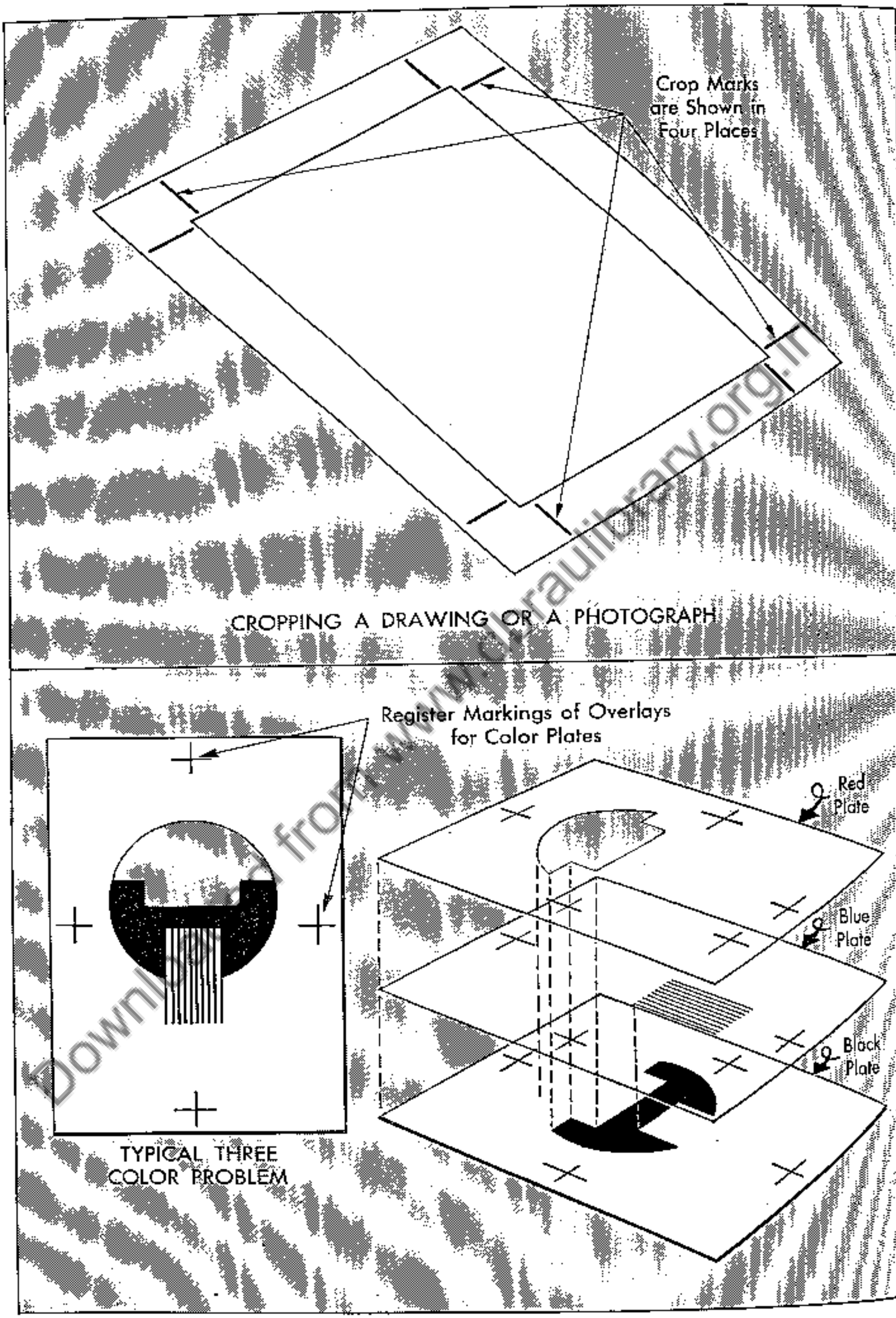
ditions, deletions, emphasis, and securing clarity and contrast. (See Fig. 105 for examples of retouched and unretouched photographs.)

In some printing processes the printed image is often lacking in the clarity and detail of the original. Thus, it is necessary to overemphasize these aspects of the original, so that despite a partial loss of detail in the reproduction process the illustration is still clear in its printed form.

Bad reproduction may be prevented if all drawings are inspected carefully before they are photographed. The illustrator should be certain that all copy is of a reproducible quality. He should take care to strengthen and repair areas which appear doubtful. Thin, weak, and broken lines lose strength in reproduction. Sometimes the error is so noticeable that a **mortise patch** is necessary. The error is actually cut out of the drawing and the corrected drawing is inserted in its place. This is done by placing the corrected drawing over the part of the original drawing that was in error and lining it up with the other lines on the drawing; then the mortise is cut through both drawings at the same time, thus making the correction fit the space left by the error. The correction is then inserted and backed up with transparent tape.



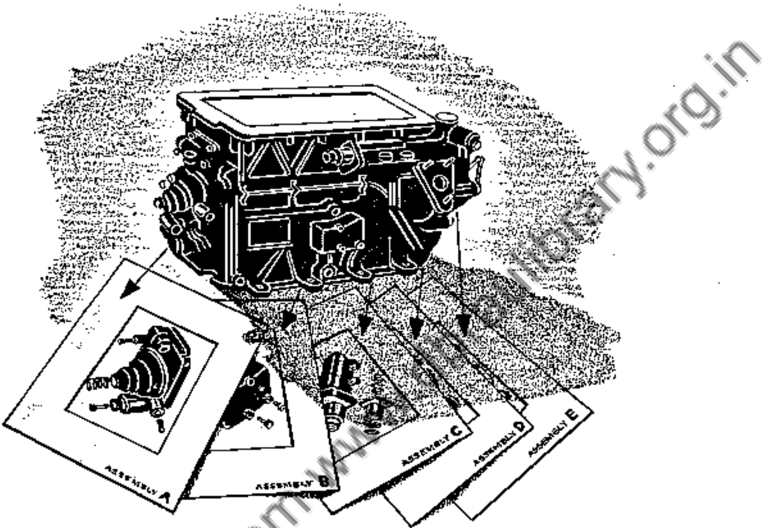
RETOUCHED RENDERING OF AN ASSEMBLED
BENDIX POWER BRAKE VALVE FOR
HALF-TONE REPRODUCTION



CROPPING A DRAWING OR A PHOTOGRAPH

TYPICAL THREE
COLOR PROBLEM

Chapter 12 THE CONTINUITY OF PRODUCTION ILLUSTRATIONS



IT IS IMPORTANT that proper relationship of parts be maintained clearly in production illustrations. Very often the illustrator may work on only a few of the total illustrations which go to make up the final assembly. Nevertheless, the illustrator should be careful in planning his layout in order to show how the particular unit which he is illustrating fits into the next assembly, which may be illustrated by another artist. Figures 113, 114, 115, 116, 117, 118, 119, and 120 show the continuity of various unit assemblies to the complete final assembly of a Chandler-Evans carburetor. The first illustration, Fig. 113, shows an airbrush rendering of the assembled carburetor, which is usually made before other exploded unit assembly drawings are begun.

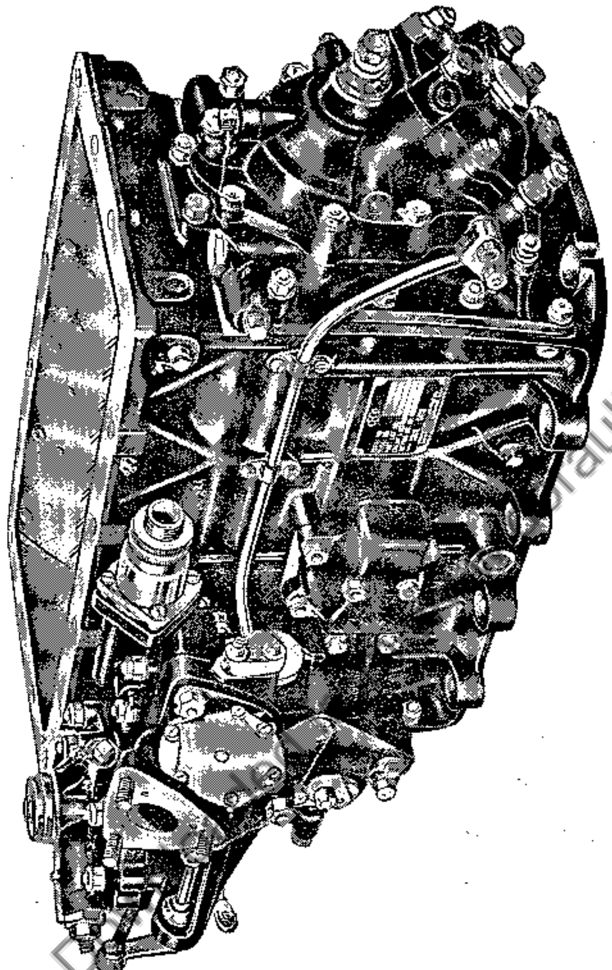
When the illustration of the assembled product has been completed, the next step is to make an exploded drawing as shown in Fig. 114, which indicates the over-all position and relationship of the unit assemblies to each other. Note that in this drawing the unit assemblies are labeled so as to identify the location of each unit.

After the exploded drawing of the entire unit is completed, separate exploded drawings of the individual units are made. These drawings of the individual units which make up the entire assembly are shown independently, so that each part of the unit may be clearly identified by number, as in Fig. 115.

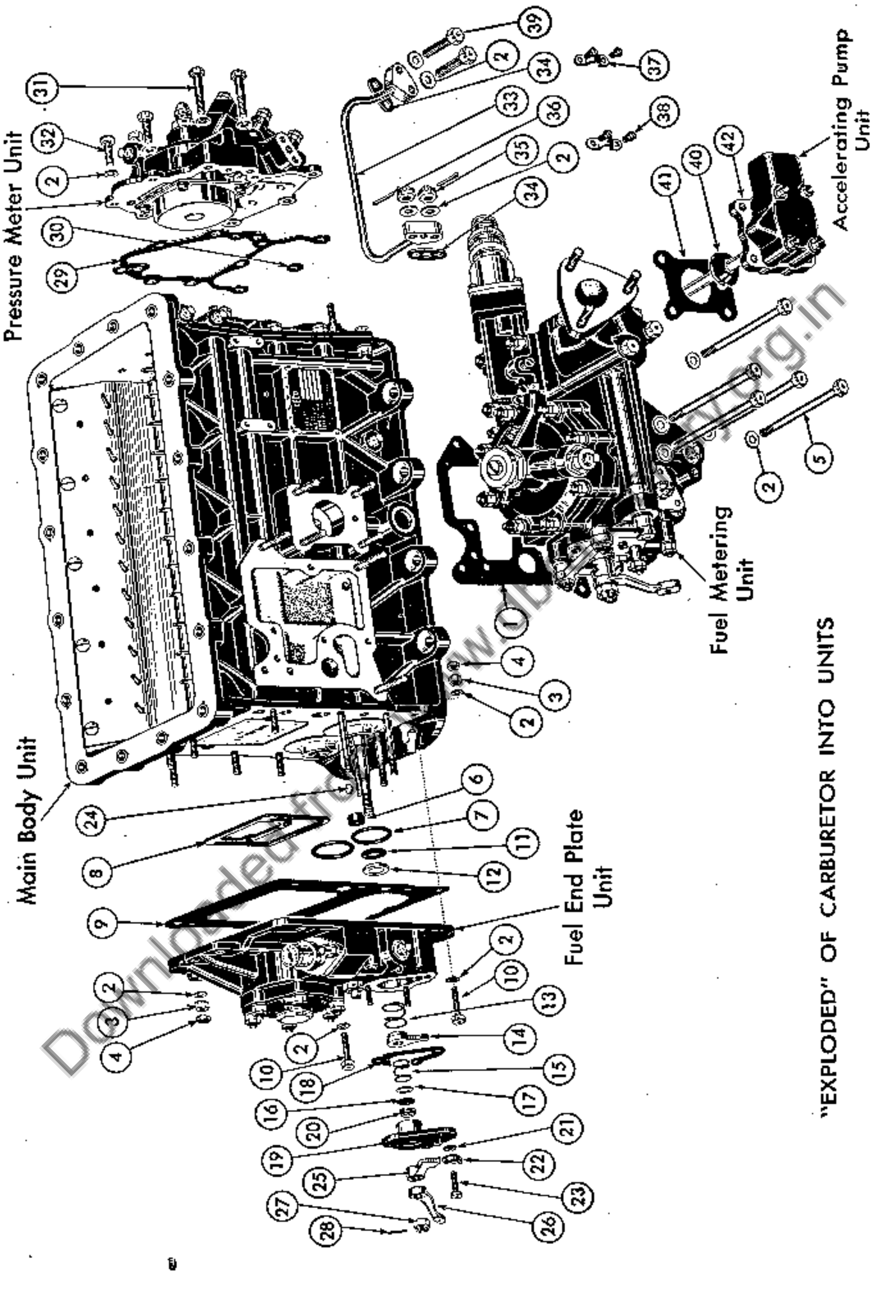
If a product having many intricate parts, as in the Chandler-Evans carburetor, were not illustrated by exploded units it would be extremely difficult to show all the parts in one illustration. In some instances even unit assemblies have so many parts that it would be confusing to show them all in one exploded view. For example, notice in Fig. 116 that the load compensator shown in Fig. 117 had to be drawn in a partial disassembly illustration; and in Fig. 118, the pressure meter of the carburetor had to be partially disassembled.

Often unit assemblies are so intricate that even they must be broken down into subassemblies, as in Fig. 119. Here it is especially important that a separate exploded drawing be made of the subassemblies, as well as the unit assembly, if these drawings are to be used in the factory to expedite production.

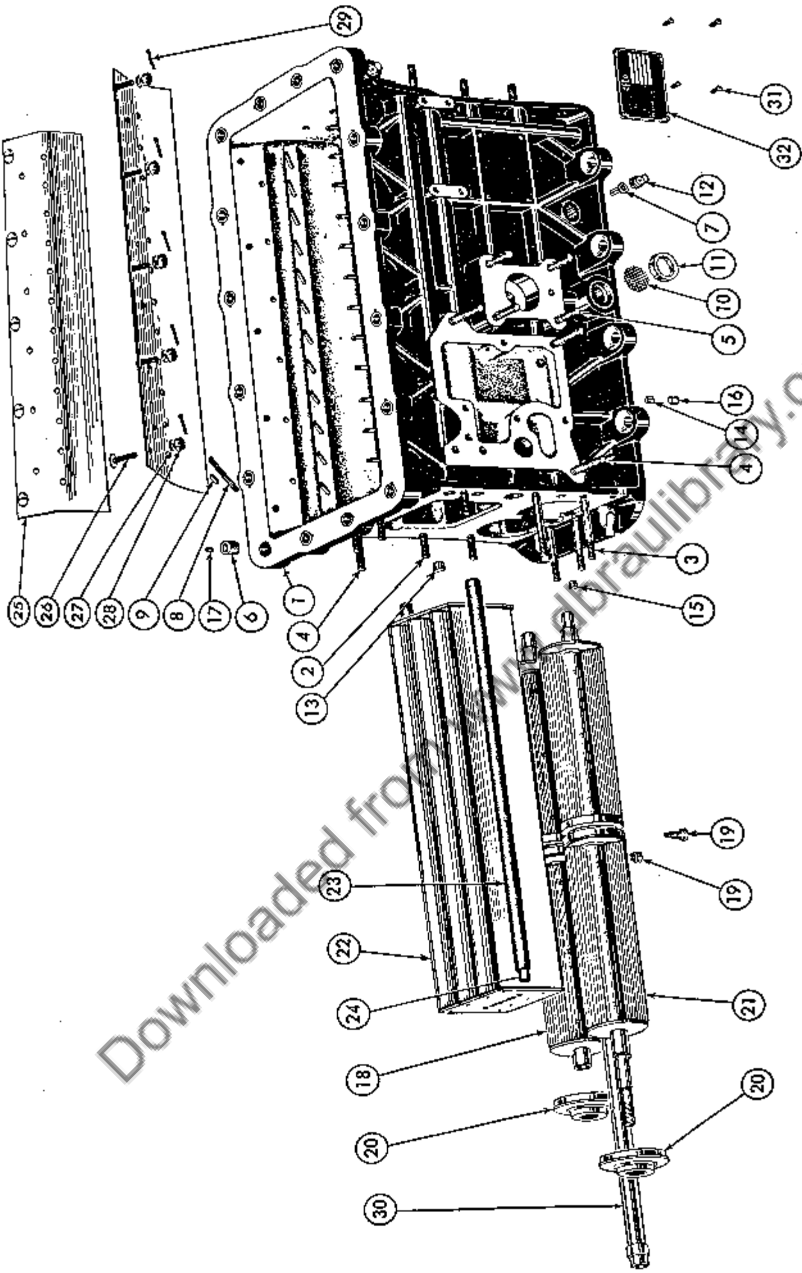
Usually, however, unit assemblies as in Fig. 120 may be illustrated in a manner which will show all the parts that make up the unit.



MODEL 58 CPB-4 CARBURETOR SEEN FROM PRESSURE METER END



"EXPLODED" OF CARBURETOR INTO UNITS



"EXPLODED" OF MAIN BODY (FUEL END)

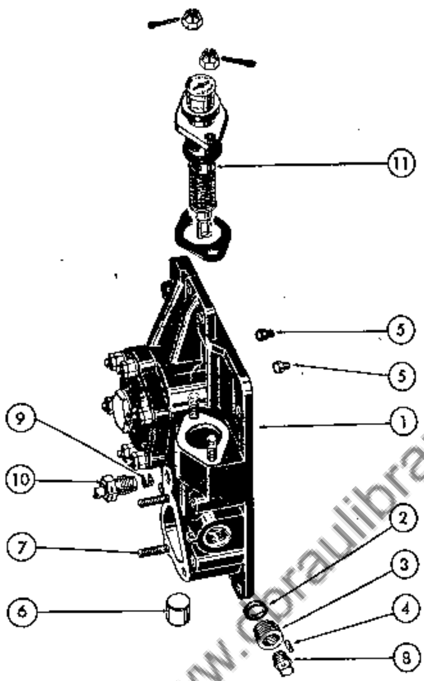


Fig. 116 PARTIAL "EXPLODED" OF A FUEL END PLATE

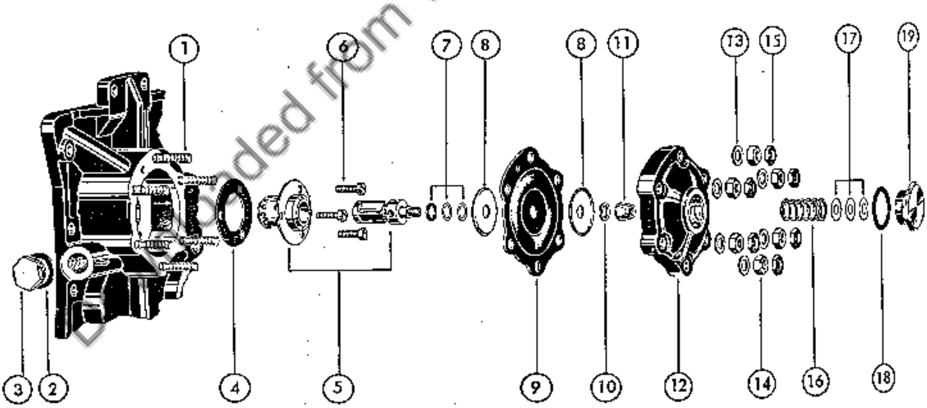
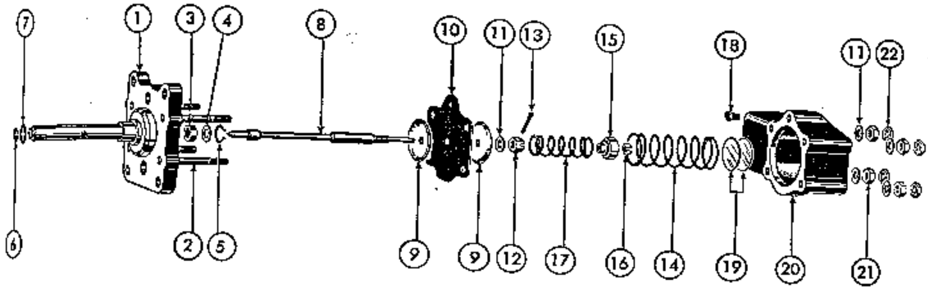
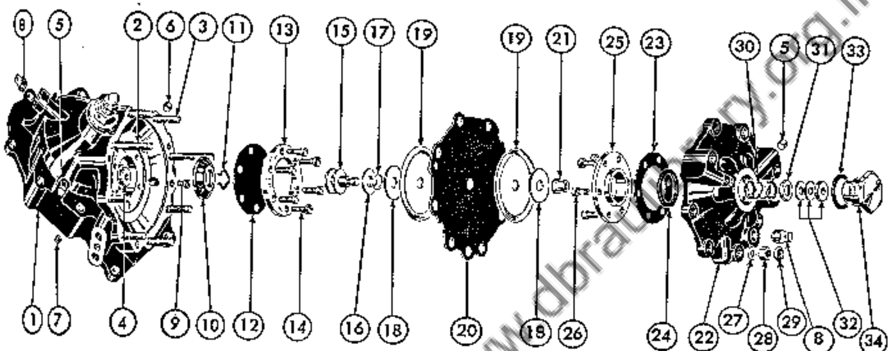


Fig. 117 "EXPLODED" OF LOAD COMPENSATOR

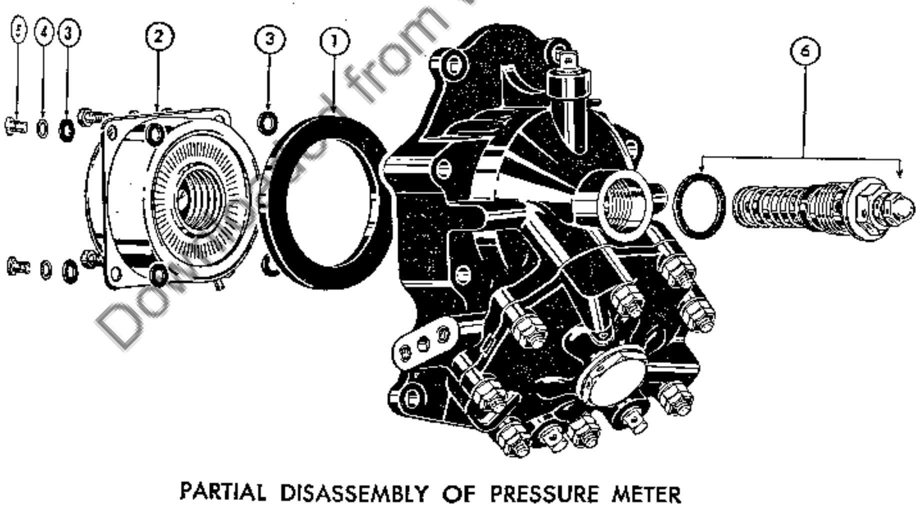
FIGURE 118



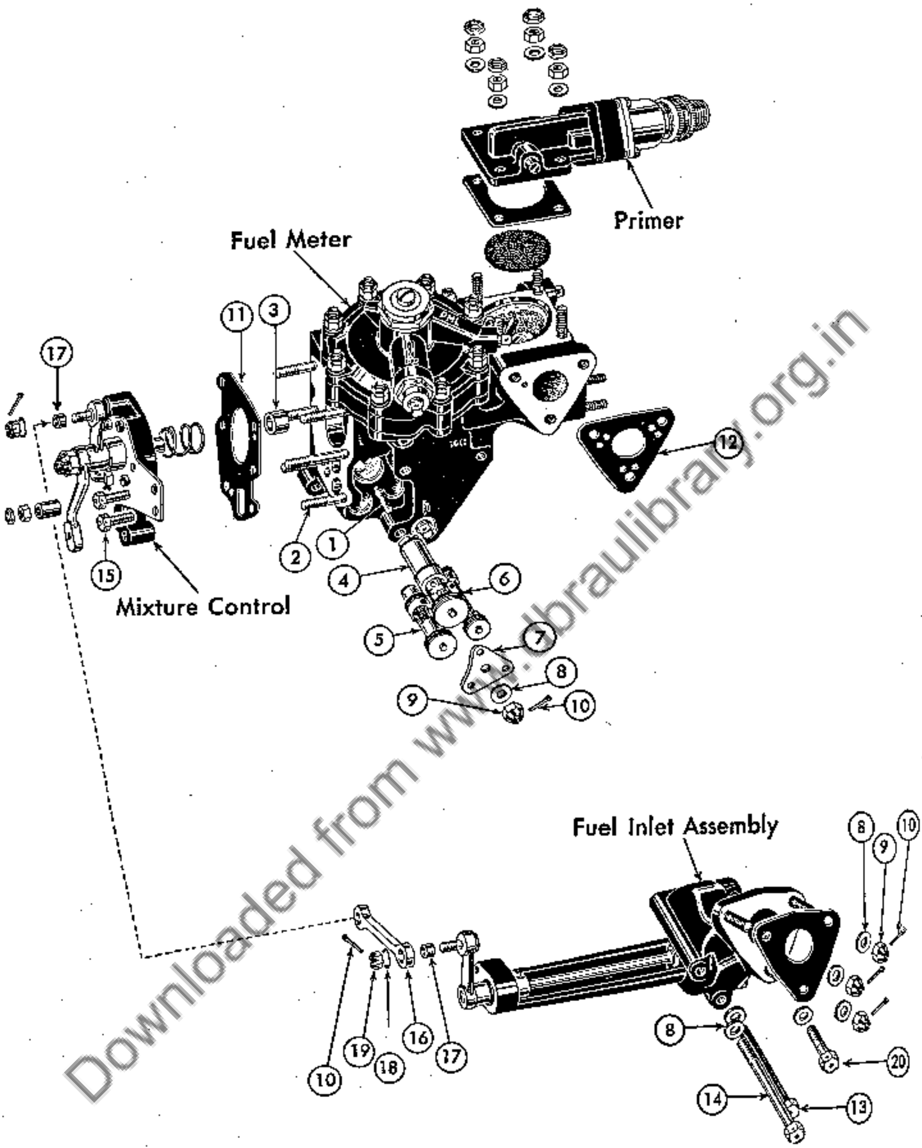
DISASSEMBLY OF ACCELERATING PUMP



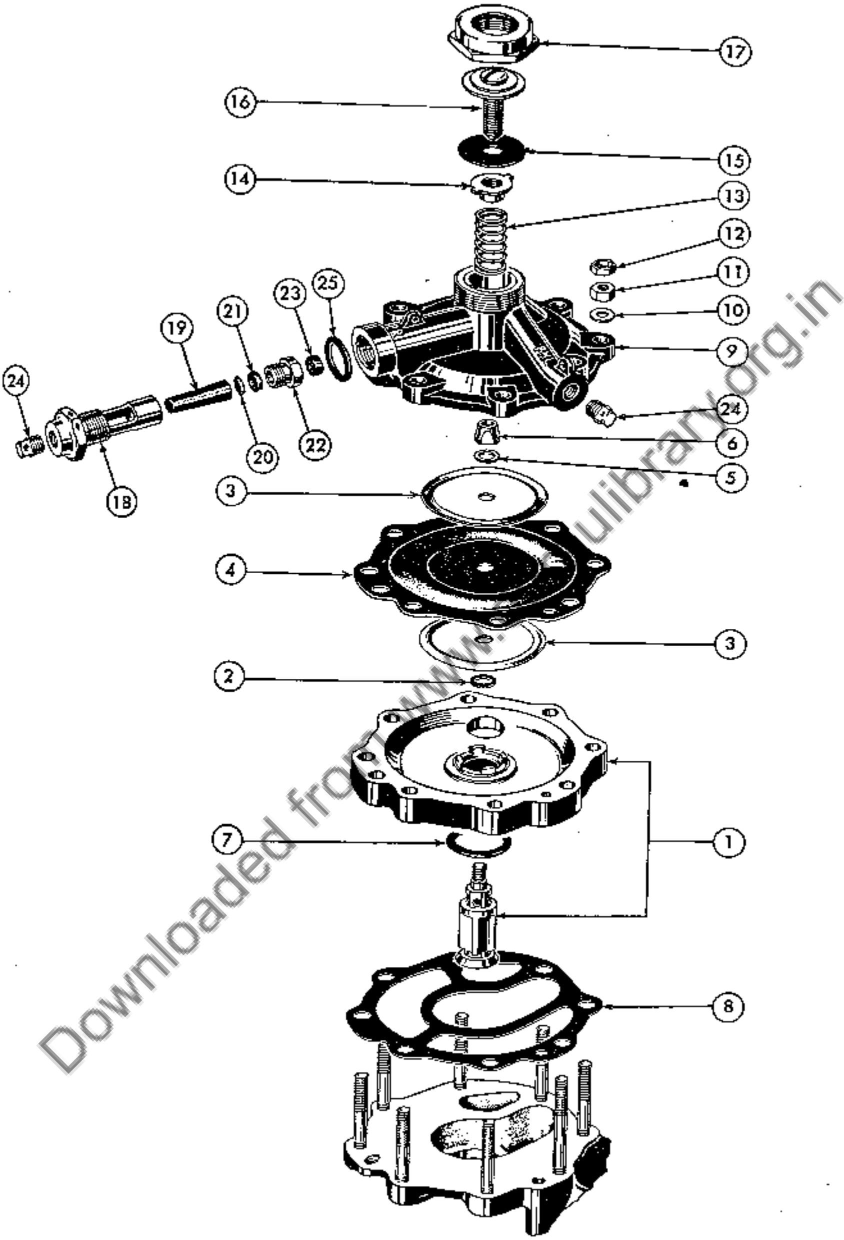
DISASSEMBLY OF PRESSURE METER



PARTIAL DISASSEMBLY OF PRESSURE METER



BREAKDOWN OF FUEL METERING UNIT INTO SUBASSEMBLIES

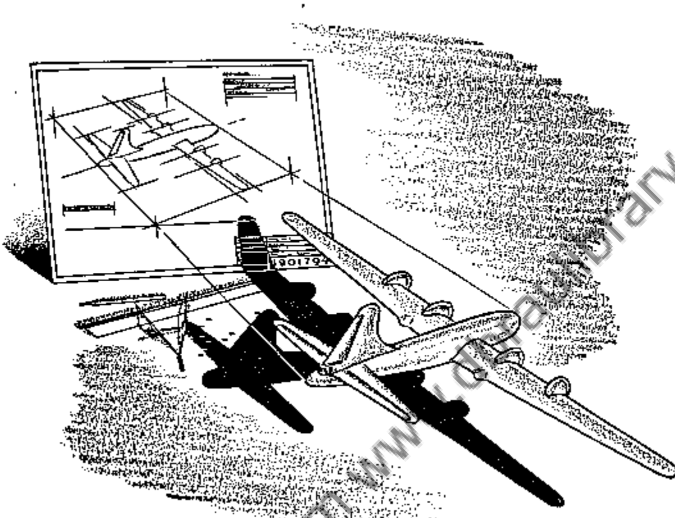


DISASSEMBLY OF PRESSURE REGULATOR

PART THREE

Aircraft Illustrating

Chapter 13 THE AIRPLANE IN PERSPECTIVE



THE AIRPLANE is drawn in true-scale perspective, using the method set forth in Chapter 3 in order to show each major part, or assembly, in its proper relationship to the assembled airplane. The scaled perspective is therefore a **master** that will be enlarged or reduced, as may be required for all practical representations of the airplane.

In the beginning the illustrator gathers all essential data and information which will be necessary in order to project the required airplane. He must, of course, have prints or engineering specifications which will give over-all dimensions as in part A of Fig. 121. This material should give all principal dimensions of the airplane.

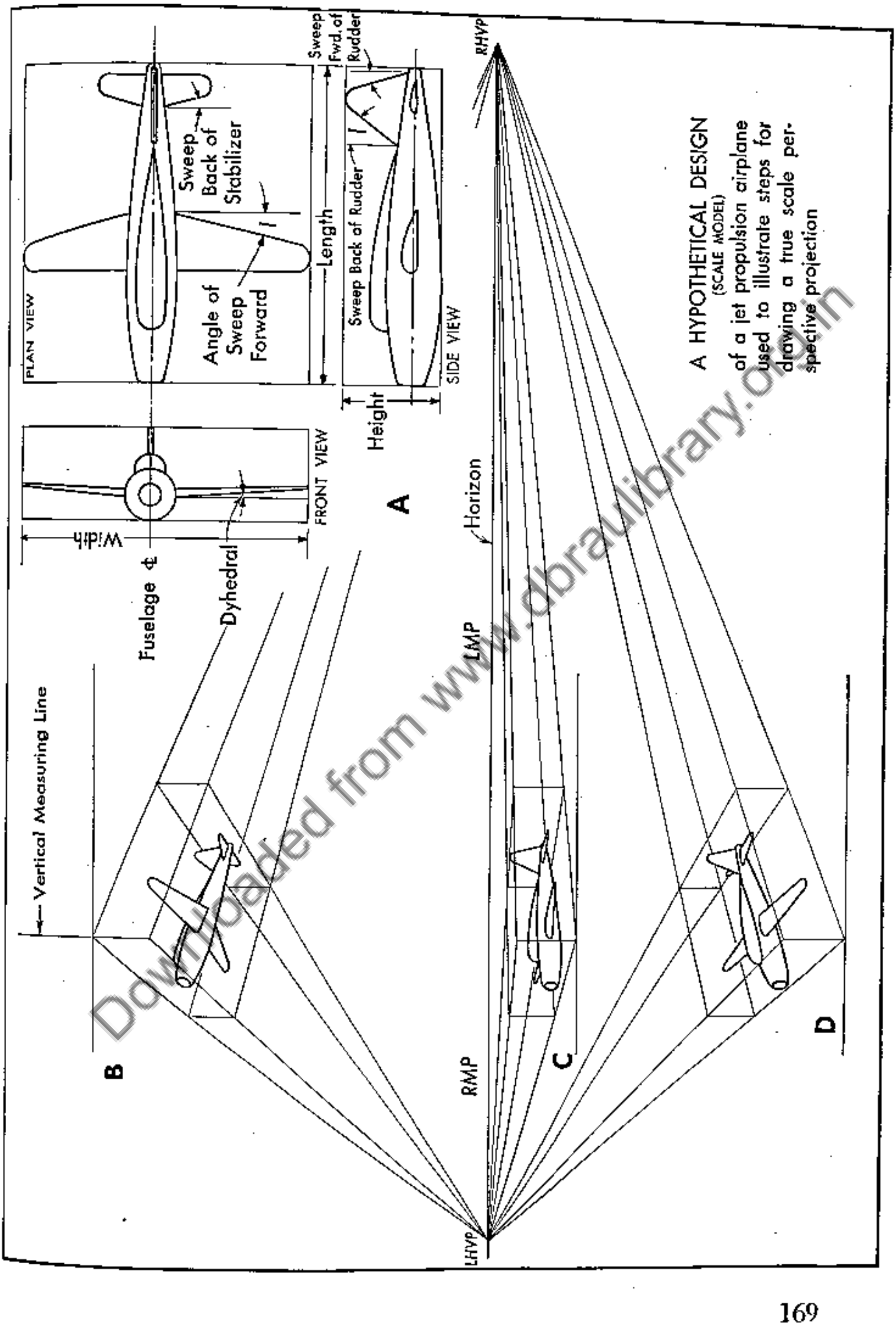
With these specifications in hand he will begin work on a series of miniature scale projections of the airplane in different views, with special attention given to the over-all **picture,** or body lines, of the airplane as in parts B, C, and D of Fig. 121. By drawing several miniature sketches using varying horizontal measuring lines the illustrator will arrive at a practical view, as in part D of Fig. 121, which will enable him to show all the major components or sections of the plane with as little distortion as possible.

Having selected the approximate view and having decided upon the distance from which the airplane is to be viewed, **in front** and **above**, he must calculate all dimensions in their proper proportional scale. A practical proportional scale would be $\frac{3}{16}$ inch or $\frac{1}{4}$ inch, or any other similar scale which fits the purpose best. There are two methods for laying out the perspective drawing:

1. Project the entire layout on a large drawing board which is long enough to accommodate the relatively great distance between the vanishing points.
2. Use the linead described in Chapter 6.

When laying the perspective out on a large drawing board, care must be taken to make certain that the vanishing points lie in a straight line and that the vertical measuring line is perpendicular to the horizon. After locating the vanishing points, a fine wire or a very strong thread can be used as leads from the vanishing points. These leads are used to set off points in space when projecting the airplane.

The first step involved in the making of a projected perspective of an airplane, as illustrated by part A of Fig. 122, is to draw in the over-all rectangle which represents the over-all dimensions of the airplane. Then, using the scale perspective method, as described in Chapter 4, the illustrator projects all dimensions that will determine the shape of the fuselage, as shown in part B of Fig. 122. Note that the thin black lines denote projected dimensions. The width of the fuselage is determined by scaling the dimensions along the horizontal measuring line and to the left of the vertical measuring line. The height of the fuselage is determined by scaling the dimension along the vertical measuring line. Next, the wing is projected as in part C of Fig. 122. Here the illustrator must bear in mind the dihedral angle as indicated by the front-view drawing of part A in Fig. 121. He will observe that the tip of the wing is higher than it is at the center of the fuselage. By projecting the location of the wing at the center line of the fuselage and the wing tip, the angle of the dihedral is determined,



A HYPOTHETICAL DESIGN
(SCALE MODEL)
of a jet propulsion airplane used to illustrate steps for drawing a true scale perspective projection

in perspective, by drawing a line through these points. Also, the illustrator must give consideration to the *sweepforward* of the wing as shown in the plan view of part A in Fig. 121. The next step is to project the dimensions which determine the shape of the cockpit enclosure. This procedure is similar to that required for determining the shape of the fuselage as described above. Now project the dimensions which define the shape of the empennage, or tail surfaces. Notice in the plan view of part A of Fig. 121 that the stabilizer sweeps back, and in side view of part A, Fig. 121, that the rudder has both sweepback and sweepforward. The results of the projections shown in Figs. 122 and 123 will determine the pictorial representation of the airplane in perspective as viewed from the desired station point. See part F of Fig. 123.

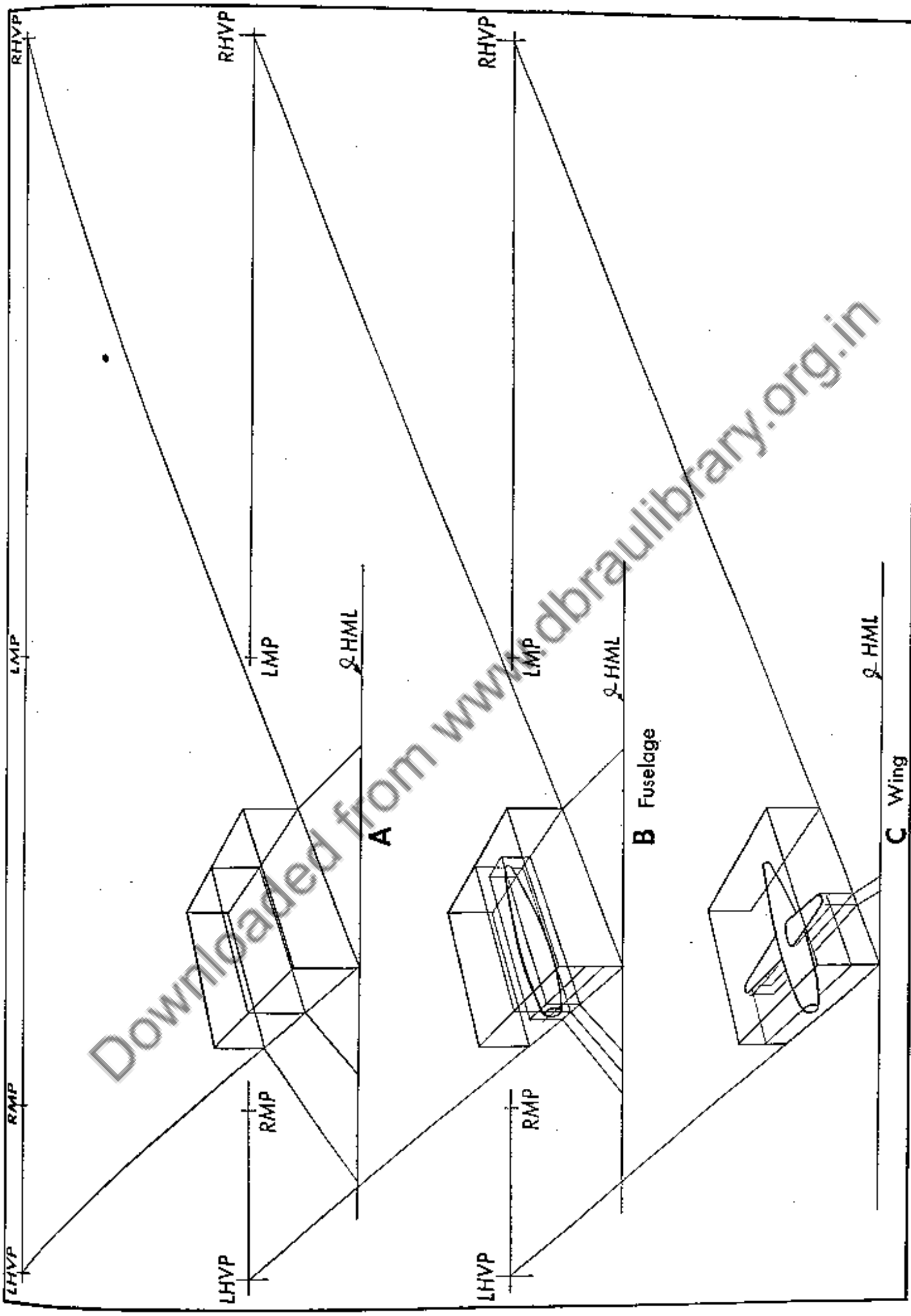
Another method which is modern in its approach to perspective has been developed by Professor George J. Hood of the University of Kansas.

Professor Hood's method provides an easy means for making perspective drawings by photographing the section or hull lines of an airplane, or of any other structure or object. The general appearance of the perspective drawing may be observed on the ground glass of the camera, and the best point of view can be readily determined. This plan does not require a knowledge of how to make basic layout for perspective drawings, yet it permits the making of any number of perspective drawings of a structure as seen from various suitable points of view. The accompanying photographs illustrate the method and show the results when applied to an airplane.

In Figs. 124 and 125, the sections of a fuselage, as shown at various stations on conventional blueprints, have been traced in ink on sheets or *tabs* of transparent plastic. These tabs fit snugly into slots cut into a baseboard. The spacing of the slots in the baseboard conforms to the scale to which the sections are drawn.

The assembled tabs are now ready to be photographed from any point of view. The image on the ground glass of the camera is studied and the model or the camera is moved until the perspective view is exactly as desired.

The perspective photograph of the model, enlarged to any suitable


RHVP
LMP
RMP
LHVP
℄ HML
A
B Fuselage
C Wing

size, is now placed on the drawing board. The lines of the photograph are traced, and any needed details added. The resulting perspective drawing is then duplicated to provide production illustrations. The use of this plan should greatly reduce the time required to produce the basic lines of perspective drawings.

Figures 124, 125, and 126 show three different views of a fuselage. If a view from below is required, the tabs may be inserted with the other (top edges) in the inverted baseboard and then photographed. This has been done in Fig. 127, which shows the fuselage inverted.

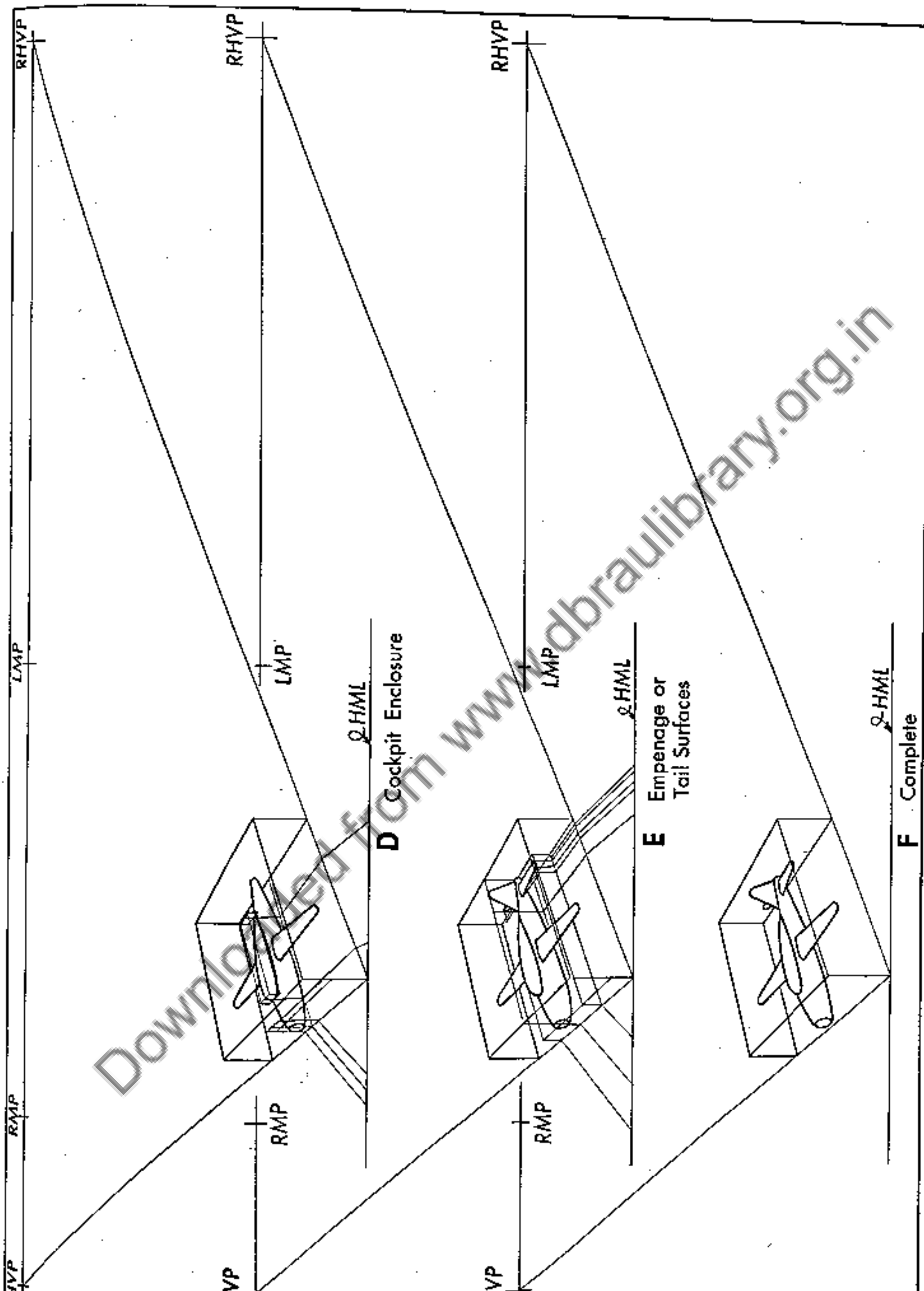
Figure 128 illustrates the assembly of a fuselage with a part of a wing and nacelle. Each part has been mounted on a separate baseboard, so that it may be shifted as desired, or so that each may be photographed independently, or any two in combination. More wing sections may be added, or the nacelle may be removed and wing sections put in its place. The wing assembly may be changed from right to left simply by inserting the tabs in the baseboard in reverse order, or a set of tabs may be made for each of the wings.

Glass tabs are used in the nacelle model shown in Fig. 129. Glass has some advantages over the transparent plastic used in the models shown in the preceding figures, as glass does not warp. Lines may be drawn in ink on glass quite readily, and these lines do not scuff so easily as when drawn on flexible plastic. In Figs. 124 to 128, the plastic sheet is 0.020 inch thick. The glass tabs of Fig. 129 are 0.040 inch thick.

The thicker edges of the glass tabs do not seem to interfere materially with the lines of the sections in the photograph, nor does refraction seem to introduce any difficulties. Centers for the compass may be provided on glass by sticking small pieces of Scotch tape where the centers are to be located. Two thicknesses of tape are desirable; or a small drop of celluloid cement placed on glass can be used as a center after drying.

Vanishing points may be located by extending the center lines of the sections and the edges of the baseboard. Vertical and horizontal scales may be drawn on the tabs before photographing, or separate scaled tabs may be included in the model to aid in measuring in any direction.

The background and the baseboards should be entirely white so as


RHVP
LMP
RMP
LHVP
℄HML
D Cockpit Enclosure
E Empenage or Tail Surfaces
F Complete

to reduce reflections that otherwise might show in the photograph. Careful lighting will reduce the reflections and also the prominence of the edges of the tabs as they appear in the photograph. The baseboard may be of wood, masonite, or similar board, or of cork board—which will hold the tab with a cushioned grip that has friction but will not crack the glass.

The tabs may be aligned with the aid of center lines on the tabs and on the baseboard. Each tab should be marked with its section number to facilitate assembling the tabs in proper order. Tabs may be readily added, removed or introduced at any angle. A comb of transparent material, with notches having the same spacing as the slots in the baseboard, may be placed along the edges of warped tabs to keep proper spacing. Such a comb is shown in several of the illustrations.

The drawings on the tabs may be as simple or as intricate as required. These drawings are made with the ruling pen, compass, and pen, employing ordinary drawing ink. The tools must be sharp, and the drawing surface of the tabs must be clean. The production of tabs by photography or by printing has possibilities. Various details and methods of procedure will suggest themselves to those who try this method.

Many difficulties are inherent in the conventional methods of making perspective drawings by laying out front, top, and side view on the drafting board, and then attempting to choose a desirable point of view, or point of sight, so that the resulting drawing may clearly show the details to be emphasized without interference from other details. At this juncture many hours of tedious work still remain to be done in locating a multitude of points for the delineation of the perspective view.

The plan proposed here eliminates most of these difficulties and greatly reduces the time required to produce production illustrations. The model itself may be studied by the engineers as an aid in visualizing the appearance and proportions of the structure. Changes may readily be made. The method is universally applicable, and should prove useful in many fields of design and construction.[1]

[1] George J. Hood, "Perspective Drawings by Photographing Sectional Views," Aero-Digest, Oct., 1943, pp. 150, 151, 194.

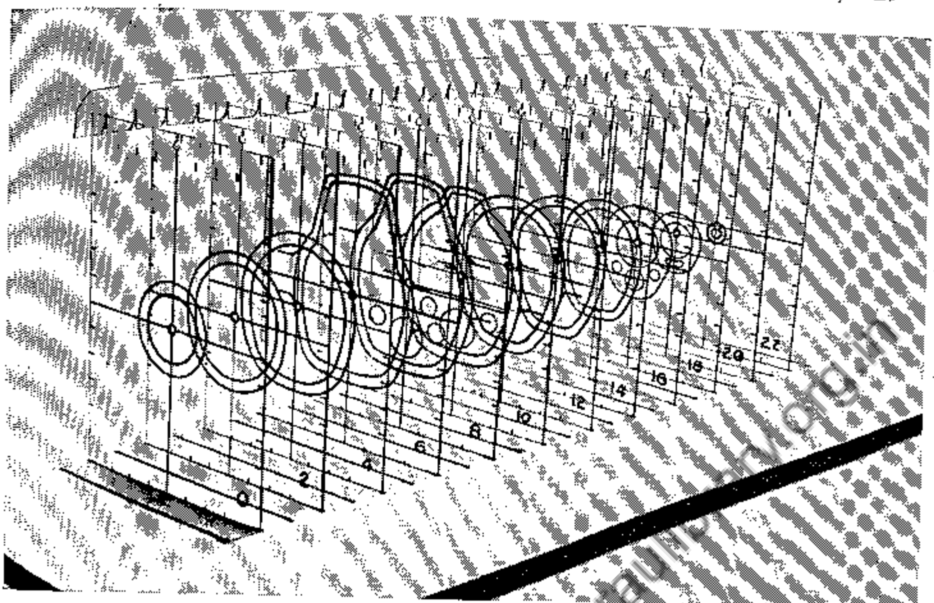
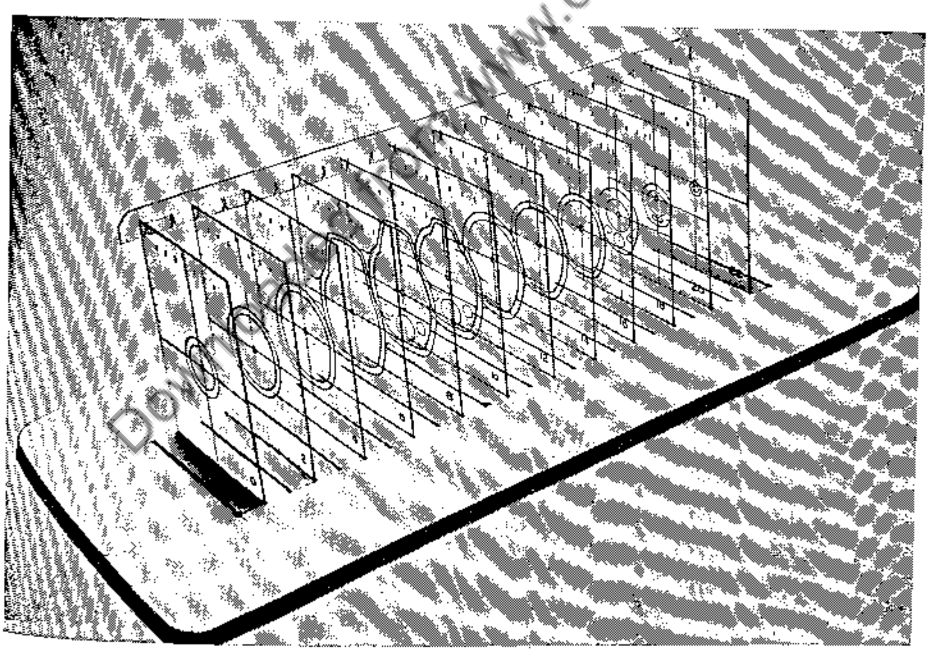


Fig. 124

Fig. 125



Still another method which is used when scale models of the airplane or the airplane itself are available is to take a photograph (or a series of photographs) of the model to be used. After satisfactory prints of the photograph to be used are acquired, enlarged bleach prints are made. Then these bleach prints bearing the image of the airplane are inked in. The reason for using bleached prints in this method is to insure accuracy. After they are inked in the prints are bleached so that only the inked lines remain. Then vanishing points are established. This print is then suitable as a master layout for the various drawings which are to be made.

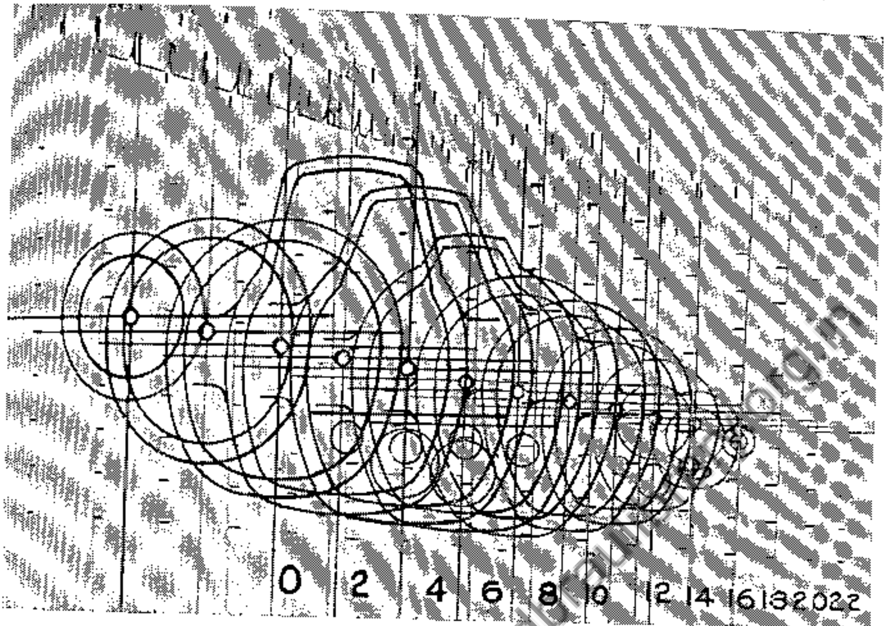
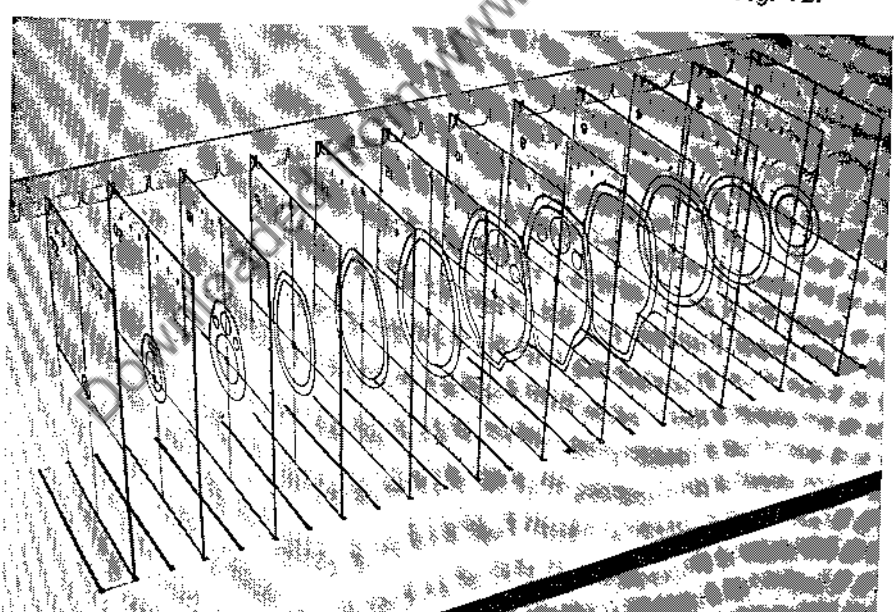


Fig. 126

Fig. 127



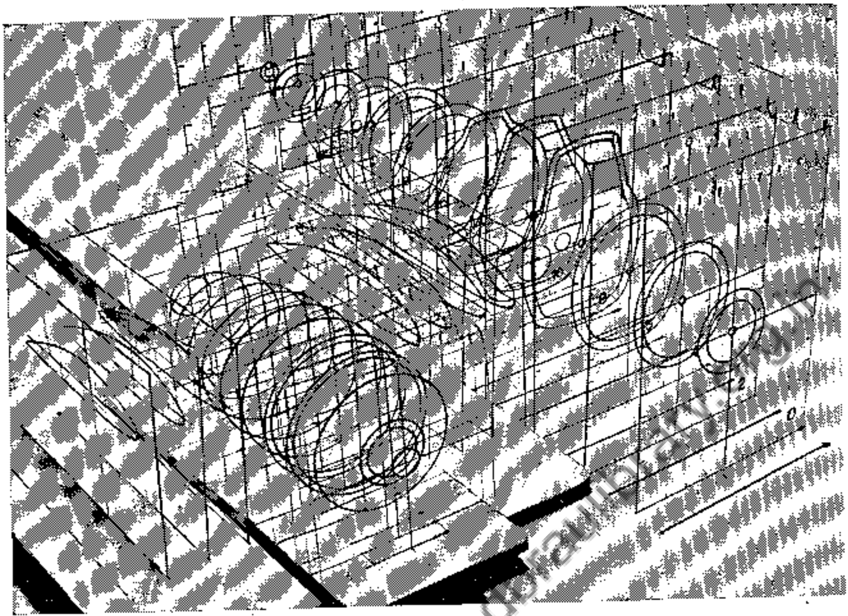
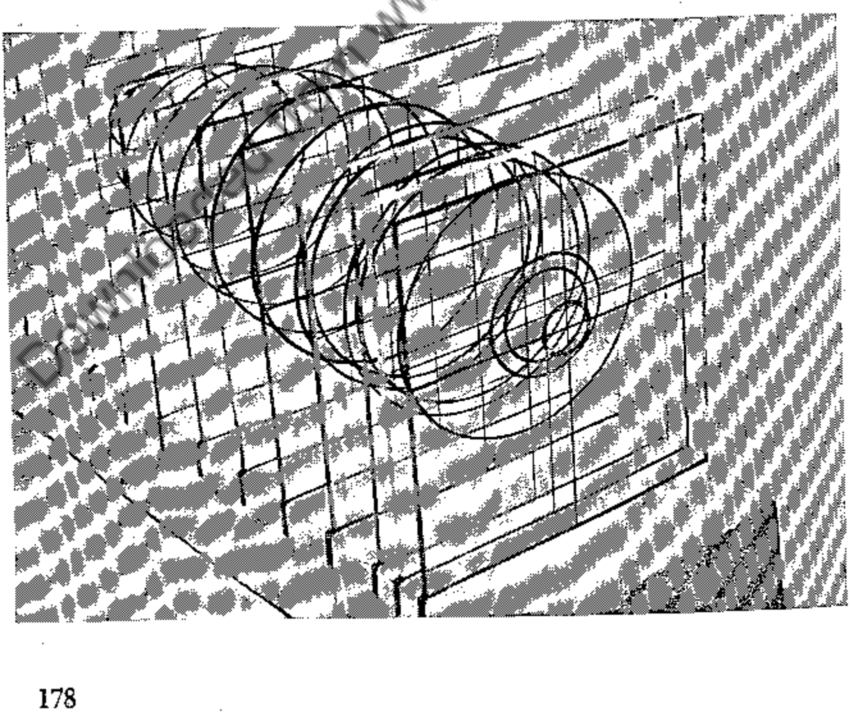
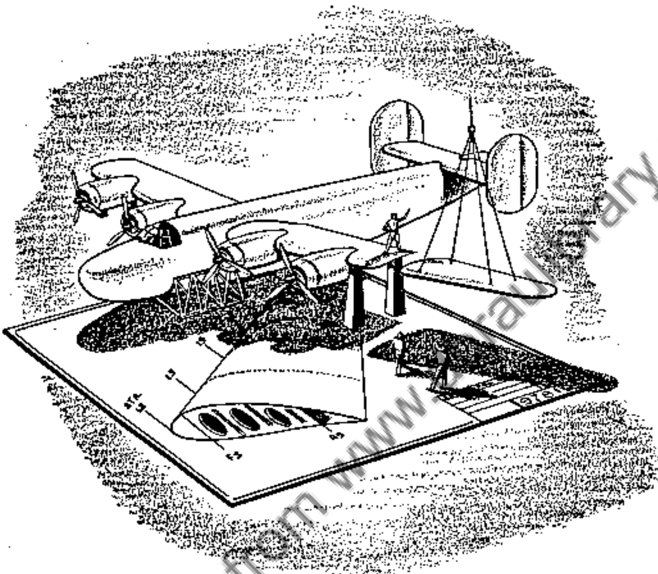


Fig. 128

Fig. 129



Chapter 14 ILLUSTRATING FOR AIRCRAFT PRODUCTION



WHEN A SUITABLE master drawing of the airplane has been made in perspective, the next step is to make an exploded breakdown illustration as shown in Fig. 130. In beginning a breakdown illustration for aircraft production, the illustrator selects a satisfactory perspective drawing which presents the airplane in the desired point of view, or selects an appropriate photograph that is in the desired view, such as that shown in Fig. 131. The illustrator must then gather essential data from the manufacturer's engineering department. This data will show exactly where the main divisions and sections are to be found. With this information in hand, the illustrator may begin locating the sections, which for all practical purposes are called *zones*, as in the Douglas Aircraft drawing shown in Fig. 130.

In the case of the Lockheed Constellation the airplane is divided into various zones such as: the power plant, the pilots' enclosure, the wing, the empennage, the landing gears, the fuselage, the elevators, the ailerons, and the rudders.

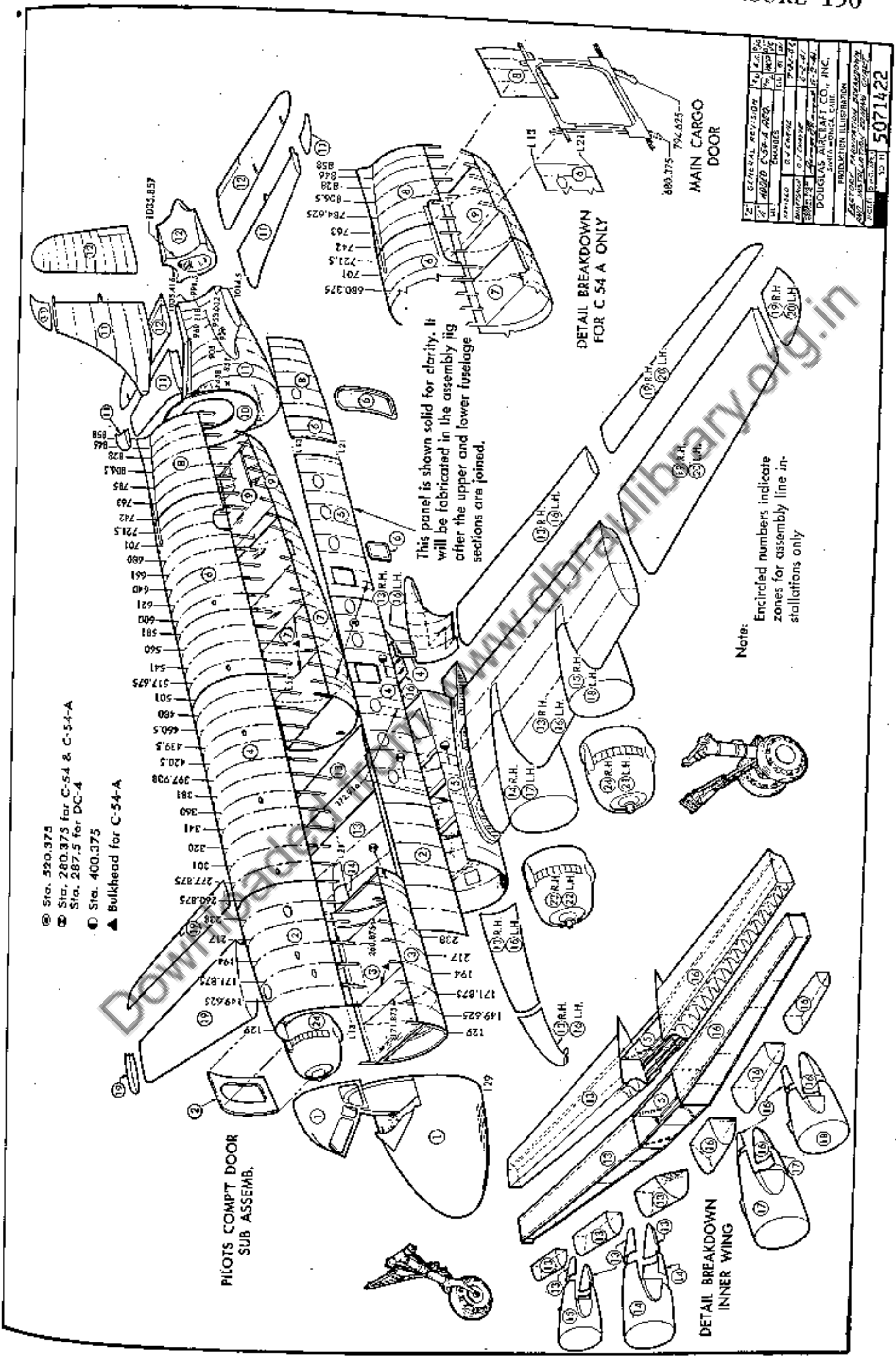
When each of these zones has been properly located, as in Fig. 132, the illustrator is ready to prepare an exploded perspective layout of the airplane. This exploded view helps to separate and clarify each zone, or individual section, so that it may be considered by itself as a unit. From this step, each zone may be enlarged in order to present more clearly the complete details.

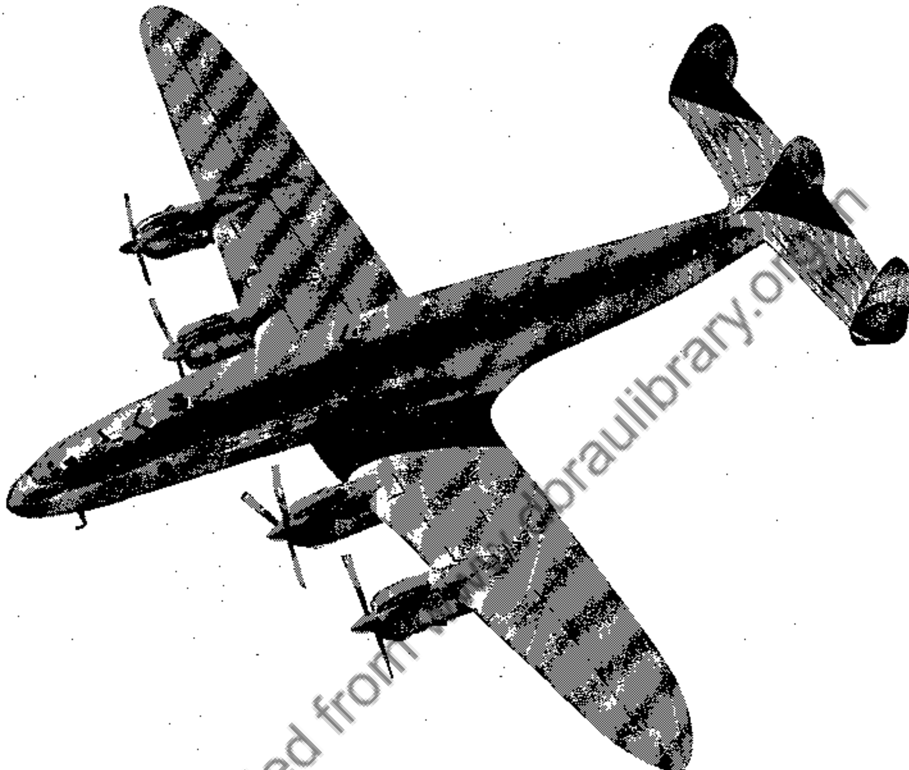
This exploded picture of the airplane, as in Fig. 132, is an essential and important reference piece for the tool planners, industrial engineers, and others who have anything to do with the actual manufacture and assembly of the product. Often various subassemblies are released to subcontractors for manufacturing. In that case the exploded view of the airplane accompanies the blueprints for the particular subassembly which the subcontractor is to manufacture, thereby enabling him to relate his work to the finished airplane.

By assuming that the entire exploded drawing of the airplane is the major assembly, we can assume also that there must be other assemblies to clarify this. Therefore, we have the major assembly, the minor assembly (such as the sections or zones), the assembly (clarification of the zones), and finally the subassemblies.

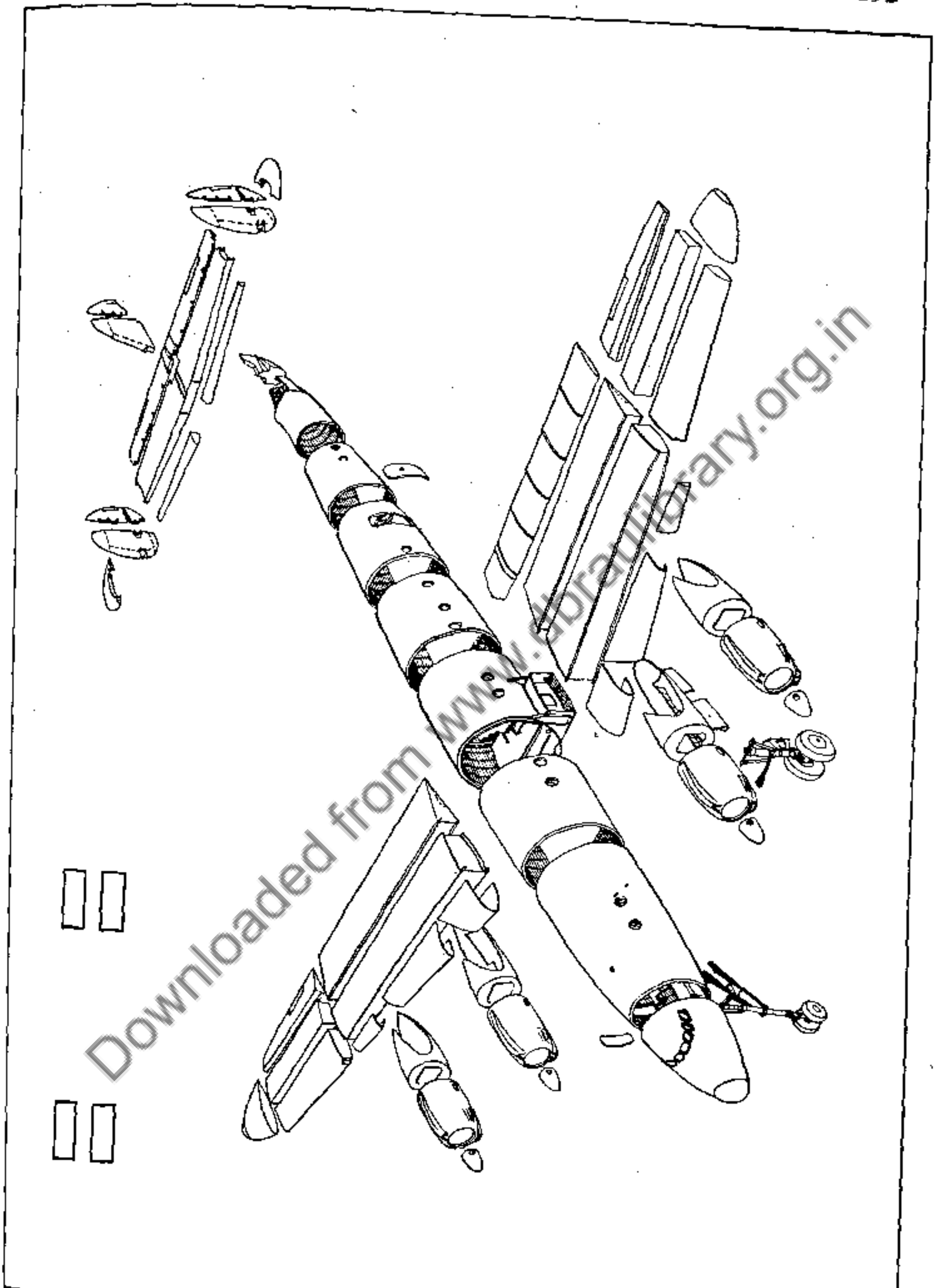
When the exploded drawing is complete, the component parts are enlarged and details added. Then, as in Fig. 133, the component parts are rendered in exploded views. Several examples of exploded and detailed assemblies are shown in Figs. 134, 135, 136, 137, 138, 139, and 140.

In addition to the various exploded drawings, the illustrator also prepares **schematic drawings** as in Fig. 141, which show the arrangement of the deicing system and the fuel and oil system.


Sta. 320.375
Sta. 280.375 for C-54 & C-54-A
Sta. 287.5 for DC-4
Sta. 400.375
Bulkhead for C-54-A
PILOTS COMP'T DOOR SUB ASSEMB.
This panel is shown solid for clarity. It will be fabricated in the assembly jig after the upper and lower fuselage sections are joined.
DETAIL BREAKDOWN FOR C 54 A ONLY
MAIN CARGO DOOR
Note: Encircled numbers indicate zones for assembly line installations only
DETAIL BREAKDOWN INNER WING
DOUGLAS AIRCRAFT CO., INC.
PRODUCTION ILLUSTRATION
5071422



THE LOCKHEED CONSTELLATION



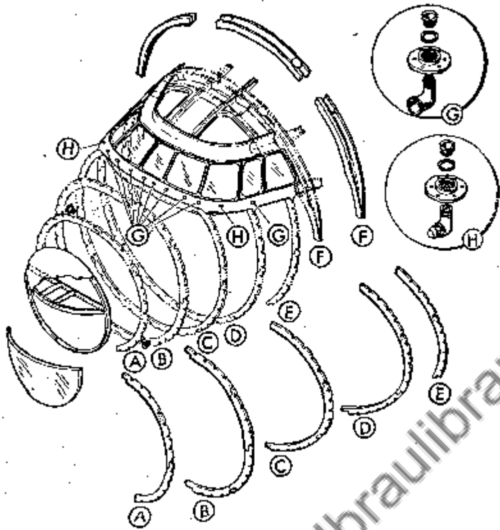


Fig. 133

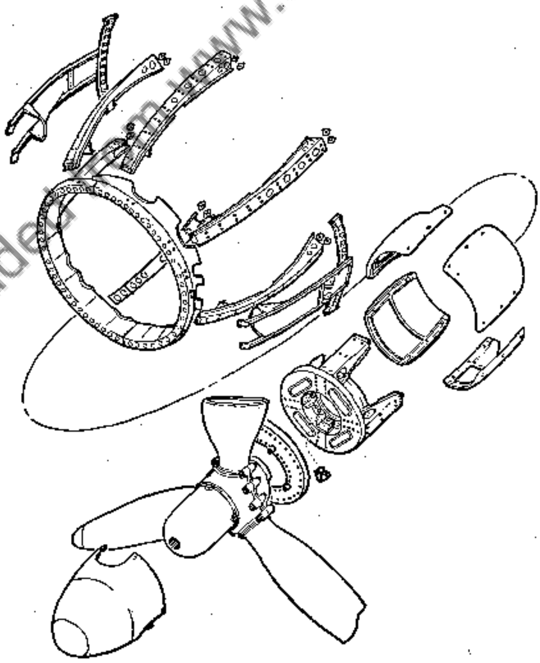


Fig. 134

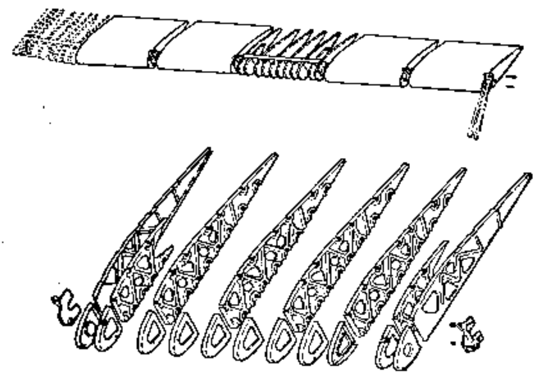


Fig. 135

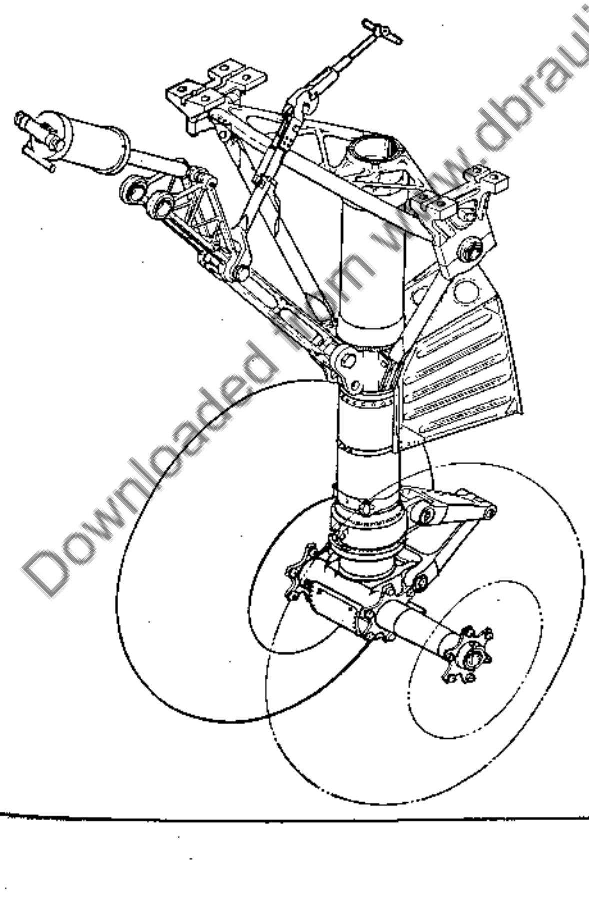


Fig. 136

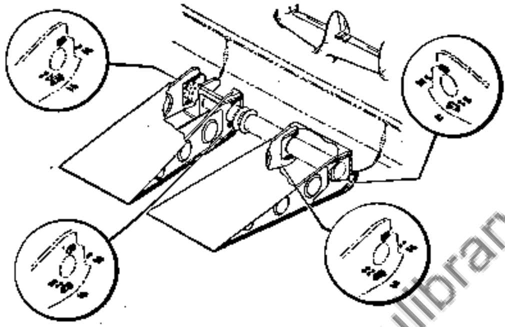


Fig. 137

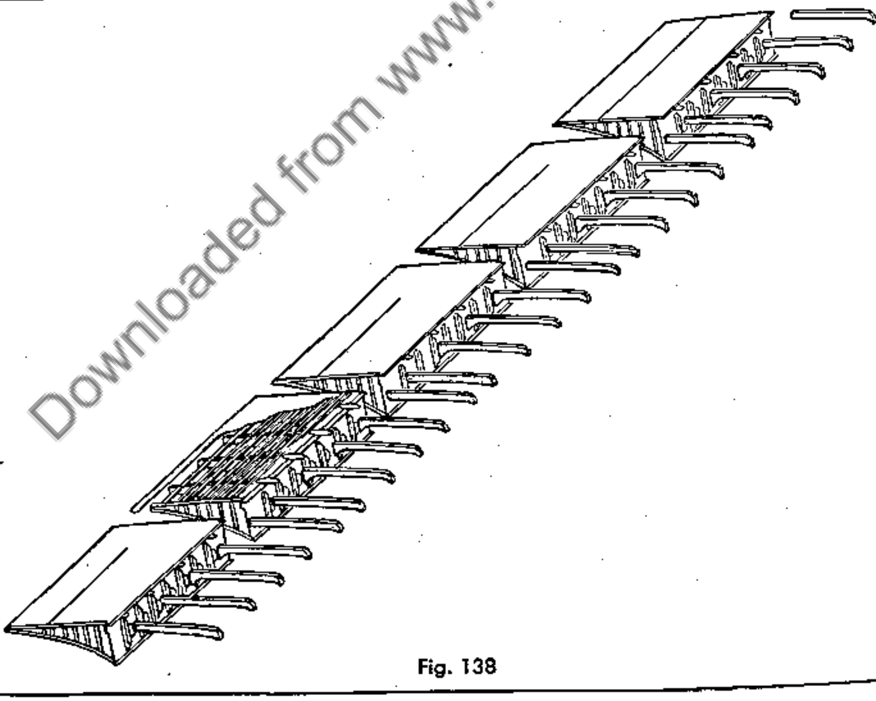


Fig. 138

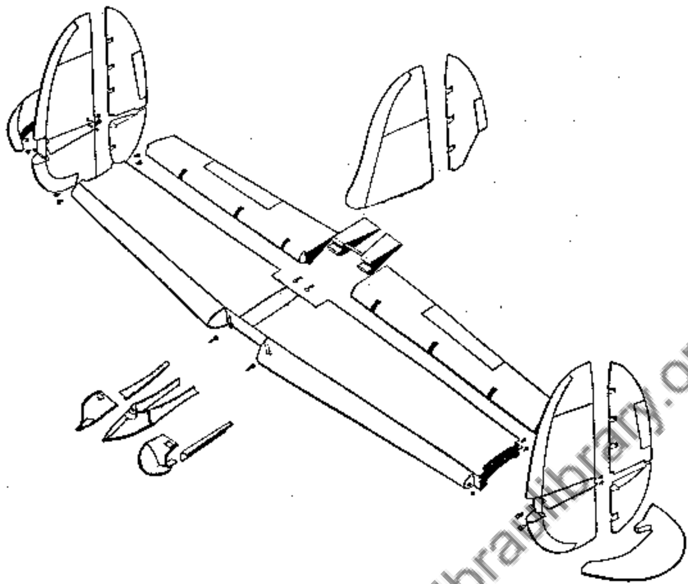


Fig. 139

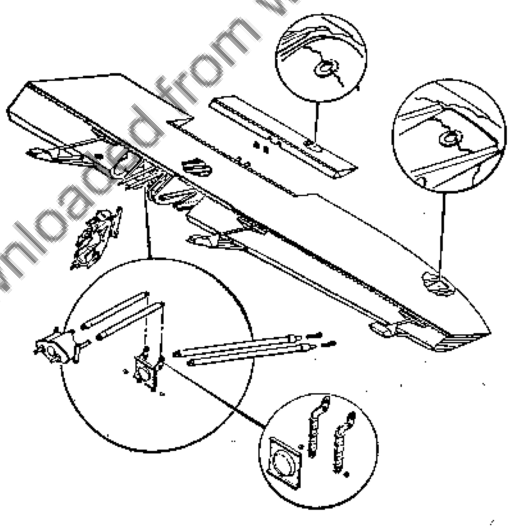
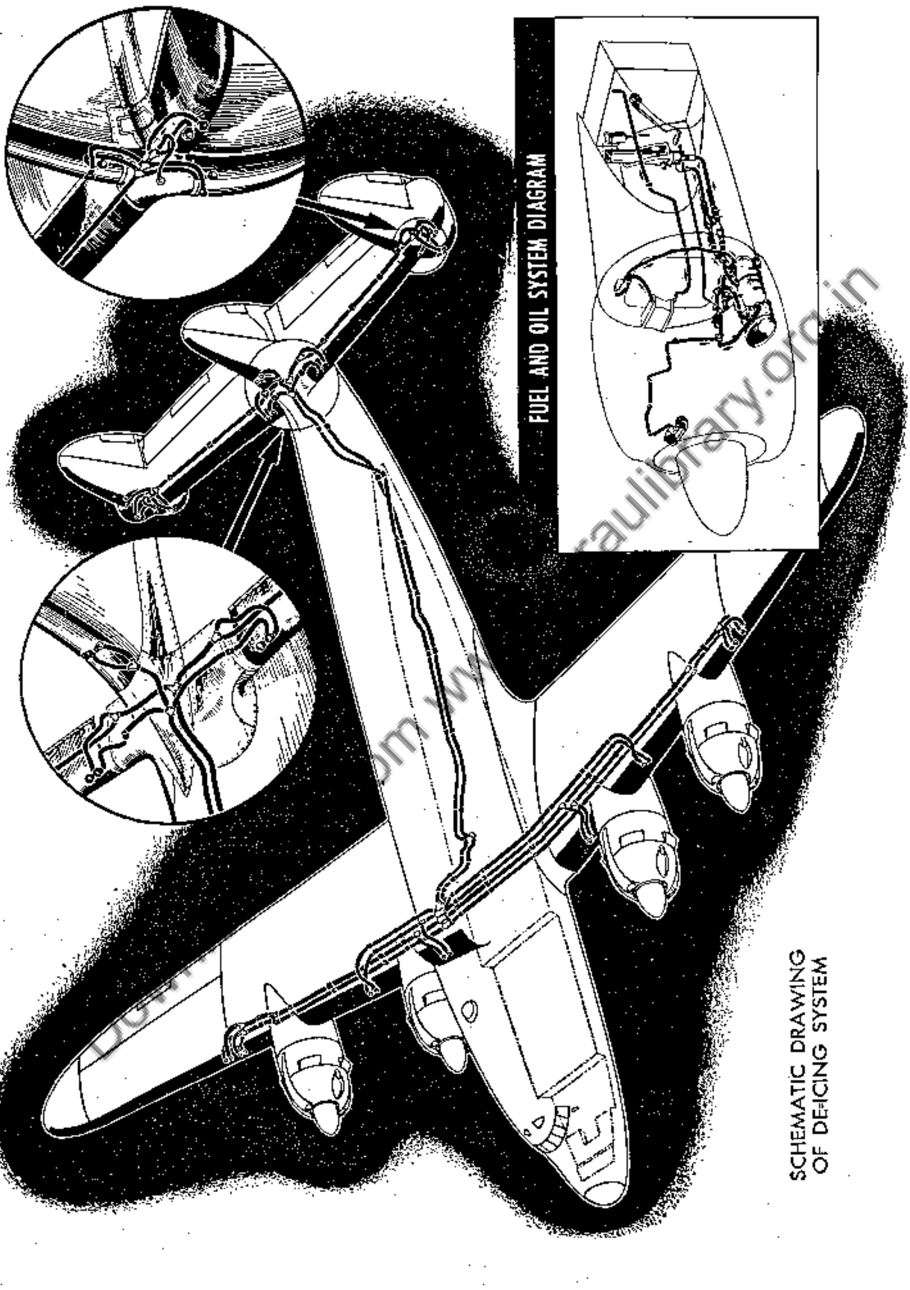


Fig. 140



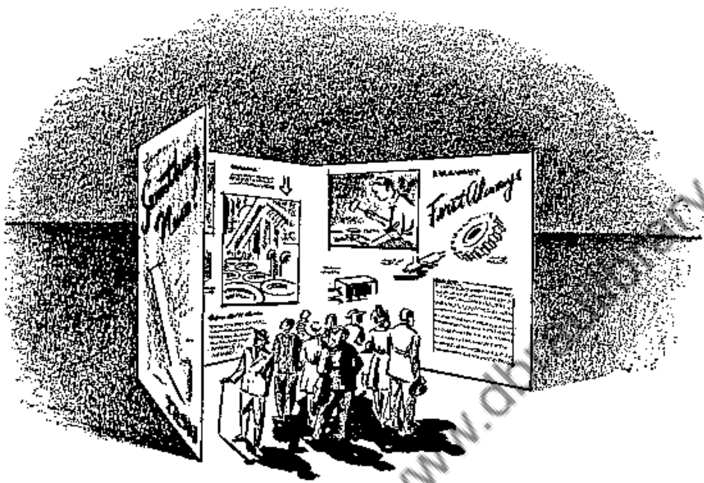
SCHEMATIC DRAWING OF DE-ICING SYSTEM

PART FOUR

The Production Illustrator in Advertising and Industrial Design

Chapter 15

THE PRODUCTION ILLUSTRATOR'S CONTRIBUTION TO INDUSTRIAL ADVERTISING



INDUSTRIAL ADVERTISING, as a specialized field, is too large a subject to cover in detail in one small chapter; however, the contributions which the production illustrator makes to the industrial advertising program of a manufacturer are of such importance that they deserve to be mentioned in this book. But first, what is industrial advertising? It might be said that industrial advertising is the art of turning the attention of others to productive business, labor, and manufacturing for the purpose of acquainting them with the purchasable services or articles produced by a business or manufacturer.

There are two ways in which industrial advertising programs are conducted. These are the same methods by which all advertisers reach their potential customers—the **direct** method and the **indirect** method.

Direct advertising is conducted by mail or personal contact, as depicted by Fig. 142. In the direct advertising method the customer is reached by one of two means: first, by a letter which includes a hand-book, folder, or pamphlet, and second, by a sales representative who calls upon the customer and explains the product of the manufacturer.

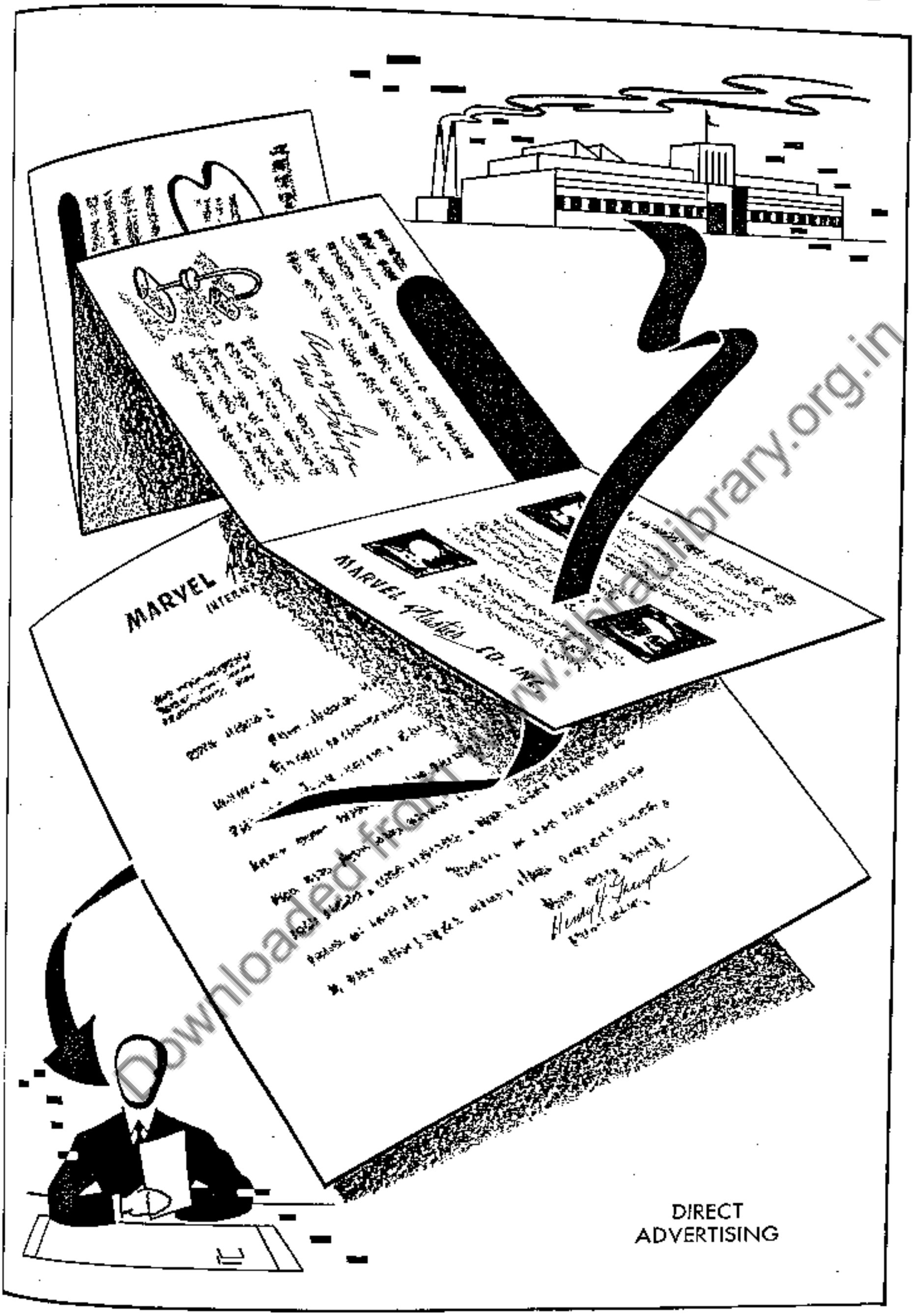
Indirect advertising is conducted through the use of magazines, newspapers, billboards, and radio, as depicted by Fig. 143. This is a means which acquaints the public in general with the product of the manufacturer. In all these direct and indirect methods, such as magazines, newspapers, folders, etc., there appear illustrations of the latest model that the manufacturer is endeavoring to promote. However, besides the illustrations, each of these folders, pamphlets, newspapers, and magazines contains specific printed information which explains all the details of the product.

How does the production illustrator fit into this advertising scheme? His first responsibility is to make third-dimensional illustrations which will show the product in an attractive manner. Nevertheless, the production illustrator is frequently called upon to make an illustration of the manufactured product for use in the advertising material.

For example, if the manufacturer were producing a folder as shown in Fig. 144, the production illustrator would supply the principal illustrations as in parts A, B, C, of Fig. 144. These illustrations as well as descriptive information concerning the product are submitted to the organization or individual responsible for the advertising and promotion of the product. Here the manufacturer's material is fitted into the advertising campaign. Notice in part A of Fig. 144 that the illustrator's drawing of the assembled unit is combined with the headline "An Amazing Innovation in Fans" to make up the outside cover of the folder. In parts B and C of Fig. 144, descriptive copy is added to the illustrator's drawing. Since such advertising material is made at the request of the manufacturer, the studio usually employs several production illustrators to do this type of art work.

A few of the duties of a production illustrator in an advertising studio are to make various illustrations that explain the selling points of the manufactured product, to make illustrations that explain the operation and function of the manufactured product, and to make illustrations that show the advantages and maintenance of the product.

Industrial advertising material generally makes use of many various types of art work. The studio employs a staff of illustrators who are

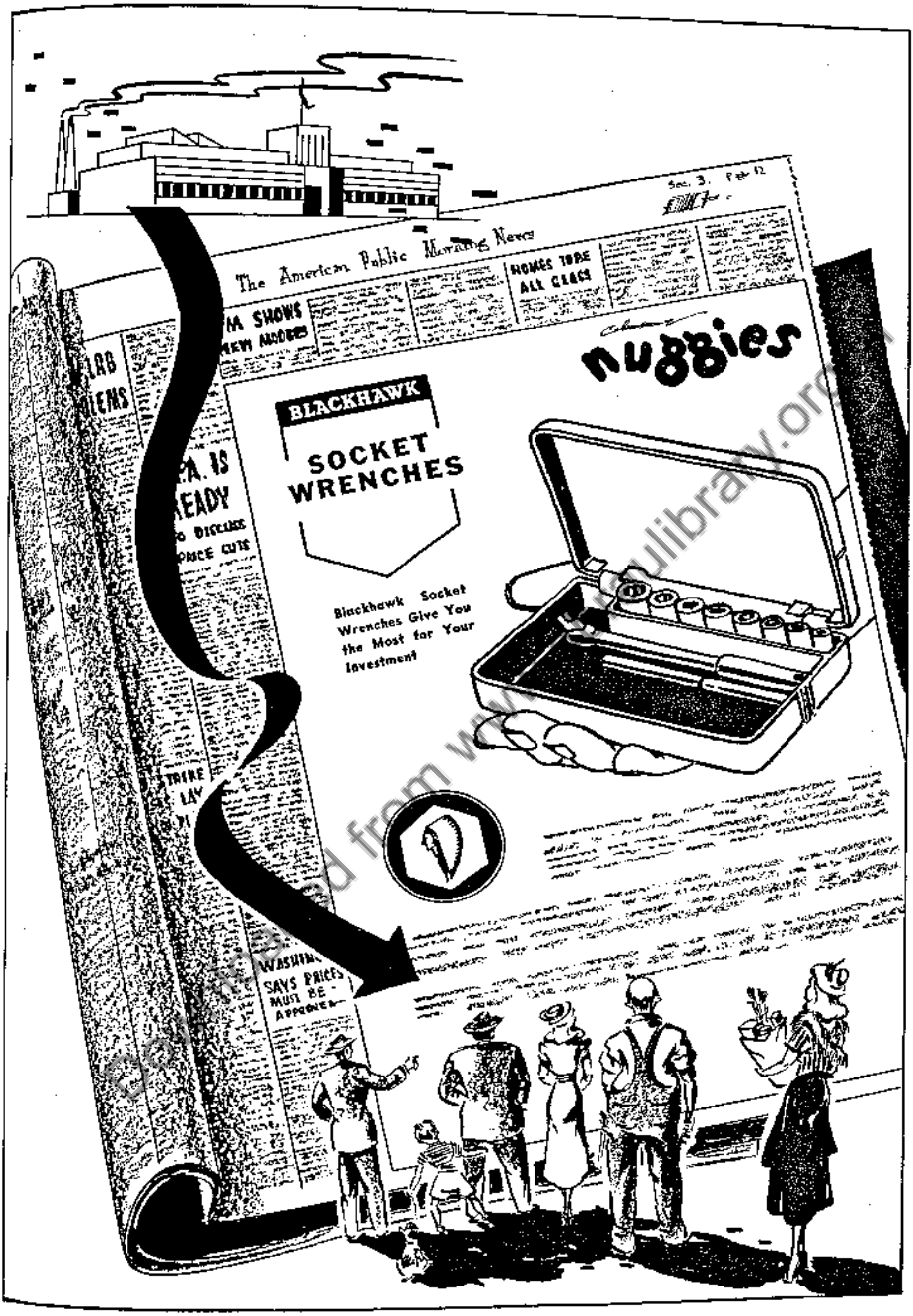


DIRECT
ADVERTISING

specialists in retouching photographs and rendering in different mediums, in order to control the cost of the advertising requested by the manufacturer.

The industrial advertising field, as related to the talents and abilities of the production illustrator, is one that holds unlimited opportunities. It is true that advertising for industry is not a brand-new idea, but because of the new developments in industry the industrial advertising field will become ever-expanding so as to meet the requirements of the manufacturer whose competition is continually increasing. Therefore, the production illustrator who has the ability and experience to satisfy the demands made upon him by the new and expanding industrial advertising field of tomorrow will find himself contributing to a rapidly growing profession of which he will well be proud.

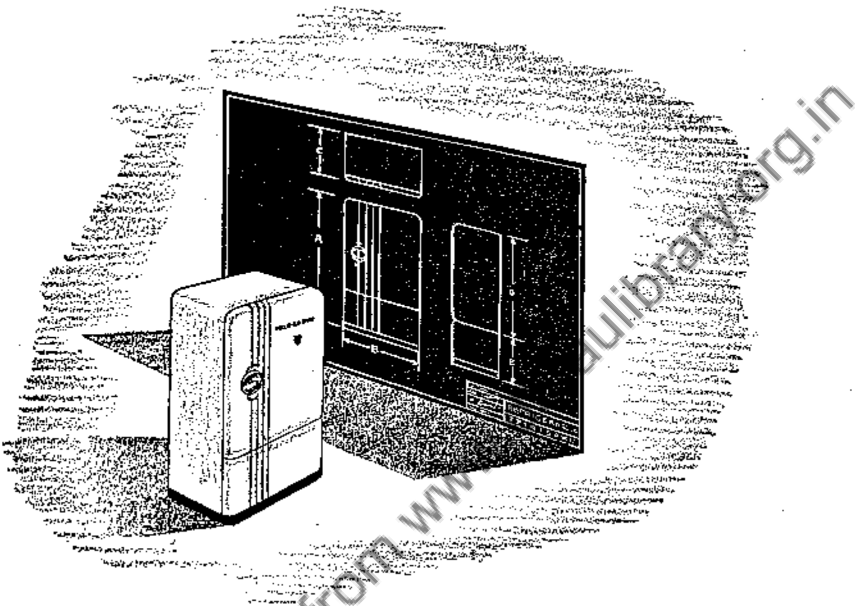
The production illustrator in the strictest sense of the word is a trained commercial artist. An artist who has been schooled in the fundamentals if perspective, light and shade, and layout may then enter the specialized field of production illustration, or illustrating for industrial advertising.


The American Public Morning News
Sec. 3. Feb 12
HOMES TO BE ALL CLASS
SHOWS NEW MODELS
SAYS PRICES MUST BE APPROVED
nuggies
BLACKHAWK
SOCKET WRENCHES
Blackhawk Socket Wrenches Give You the Most for Your Investment

FOLDER LAYOUTS

Chapter 16

THE PRODUCTION ILLUSTRATOR'S CONTRIBUTION TO INDUSTRIAL DESIGN

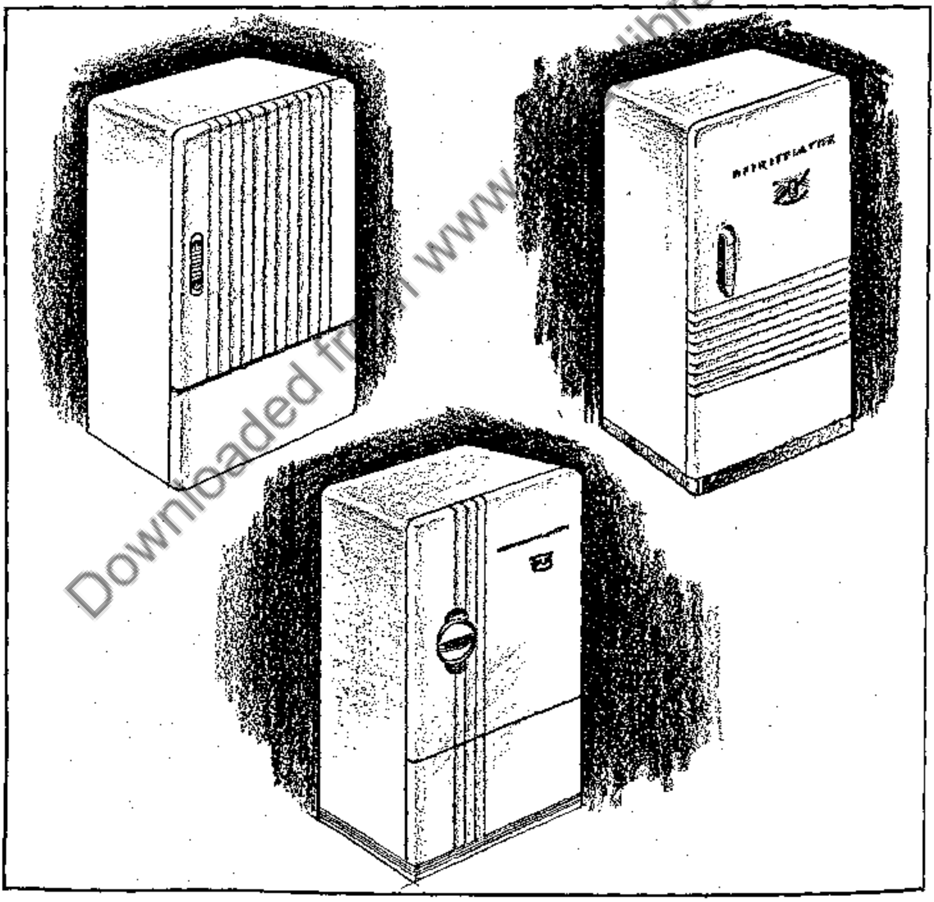


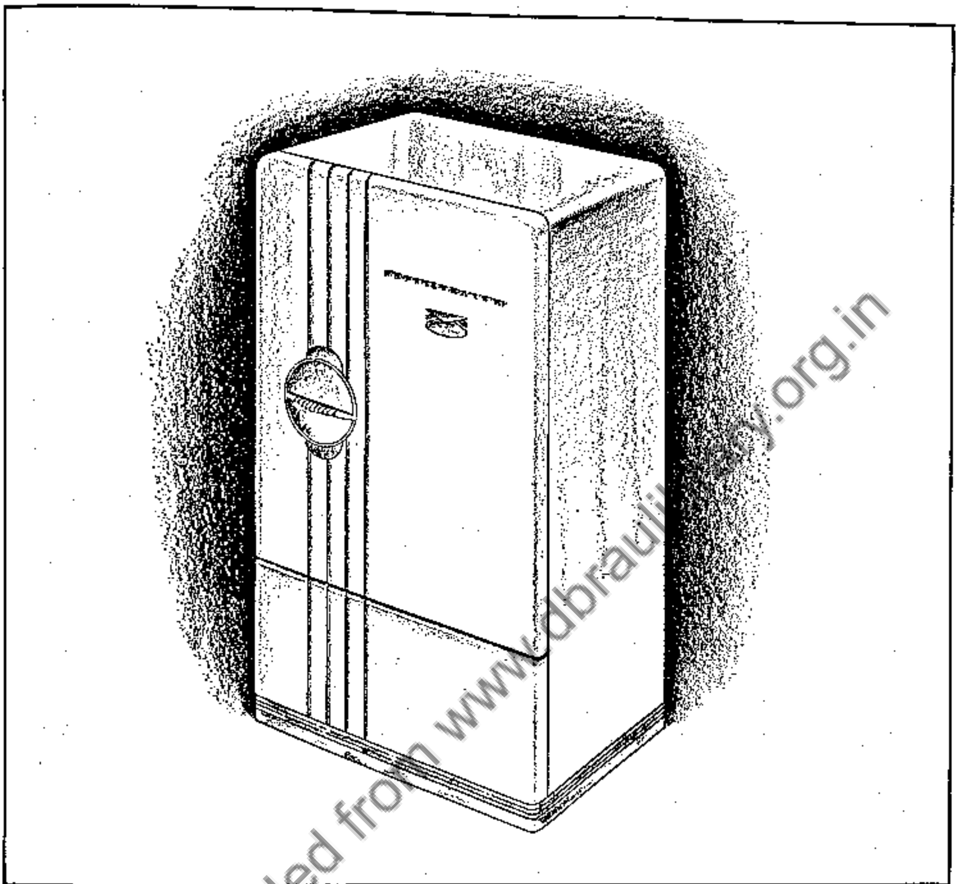
INDUSTRIAL DESIGNING is a relatively new profession which originates, for manufacturers, new designs for products which have eye appeal and which stimulate within the customer an irresistable desire to buy. Although industrial designing is now a highly specialized profession, the production illustrator can enter this field with some additional training. As a production illustrator he has already gained much experience in gathering data, making rough visualizations, and making renderings. Therefore, with some understanding of design, he is ready to begin making his contributions to industrial styling; but before the production illustrator can be of service to the industrial designer there are a number of preliminary steps which must be taken by the designer such as determining the theme, size, proportions, and limitations of the design. For example, suppose the product being designed is a new electric refrigerator; the production illustrator may make a rough visualization of the design for study and analysis as shown by Fig. 145.

When the study and analysis have been completed with desired changes in the design noted on the rough drawing, the illustrator makes the final layout as in Fig. 146, subject to the approval of the designer, before preparing the rendering which is to be presented to the client, or manufacturer.

When the rendering has been completed he may then assist in the styling of the interior and other details as shown in Fig. 147. This part

FIGURE 145

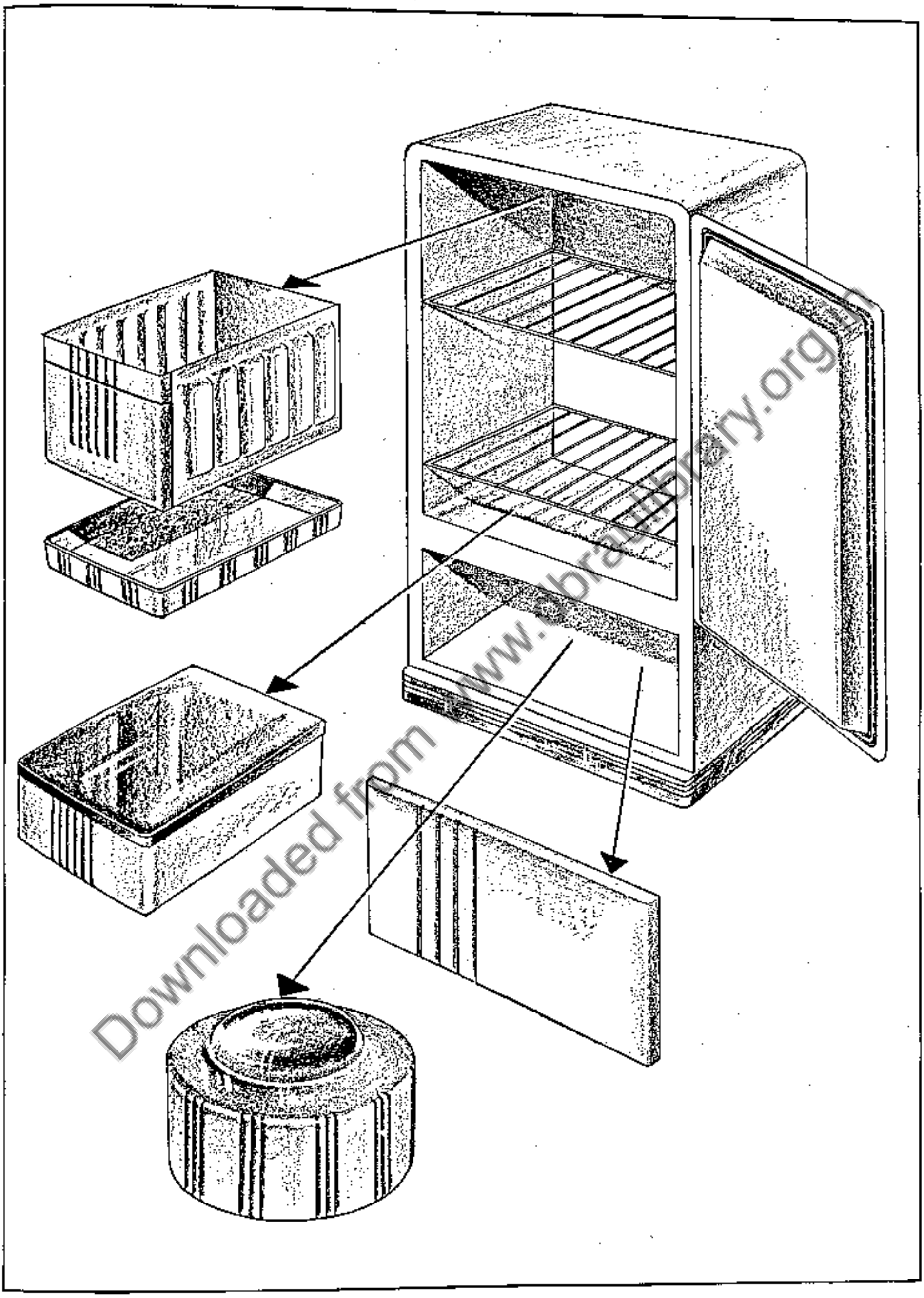




of the design is undoubtedly the most important phase of the refrigerator design since it creates in the consumer the desire to possess.

If the design is found to be satisfactory with respect to materials, function, cost, and manufacturing, the engineering and production are begun. Nevertheless, the industrial designer's work is not complete—it has only just begun, because he is often retained by the manufacturer as a consultant to advise on any design changes or modification which are found to be necessary. While the engineering department is planning and scheduling the working drawings for the shop, the industrial designer begins the design proposal for details such as the shelves, freezer, ice trays, control knobs, door hinges, door handle, lighting, and other features.

Back in the design studio the production illustrator again makes rough visualization drawings from the designer's idea sketches of the details mentioned above. These idea sketches may be in the form of notes made while in conference with the manufacturer and his engineering staff. These sketches and rough visualization drawings are made on tracing paper and then blueprinted so that both the manufacturer and the designer may have copies to be retained in their case-history file of the particular design under consideration. This procedure is valuable especially when the design studio is located in a city distant from that of the manufacturer. Under such a procedure the manufacturer and the designer are able to transact, by telephone, any business concerning minute problems which may arise in the engineering and production of the design.



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