ME 113

ENGINEERING DRAWING I

CHAPTER 3

GEOMETRICAL CONSTRUCTIONS

3.0. INTRODUCTION

Engineering drawing is the Universal Language in all phases of industrial and engineering work, therefore, all engineering and technical personnel must have a good knowledge of drawing techniques.

Engineering-technical drawing has two vital functions:

A: It is a means to communicate ideas to others quickly and vividly.

B: It is a tool whereby intangible ideas theories may be developed into tangible goods and products by graphical methods.

In short, engineering graphics is a language that expresses and conveys ideas of shape, size and construction of parts and mechanisms.

To have optimum value, Engineering drawings must be neat, clear concise and subject to only one interpretation. Furthermore, they should conform to accepted standards, conventions and practices.

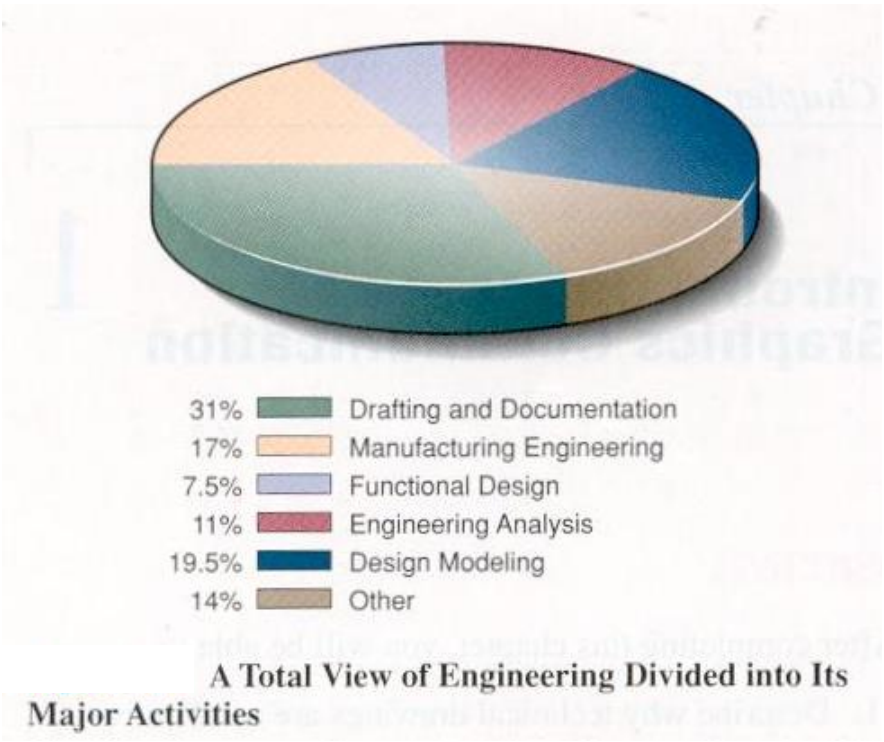
As with any Language, skill and understanding in technical drafting can be obtained only by practice. Therefore, students should not only work-out the problems assigned by the instructor but should also solve the problems provided in the textbook and the hand-out sheets in free-hand style in their free time.

Engineers use science to solve their problems if the science is available.

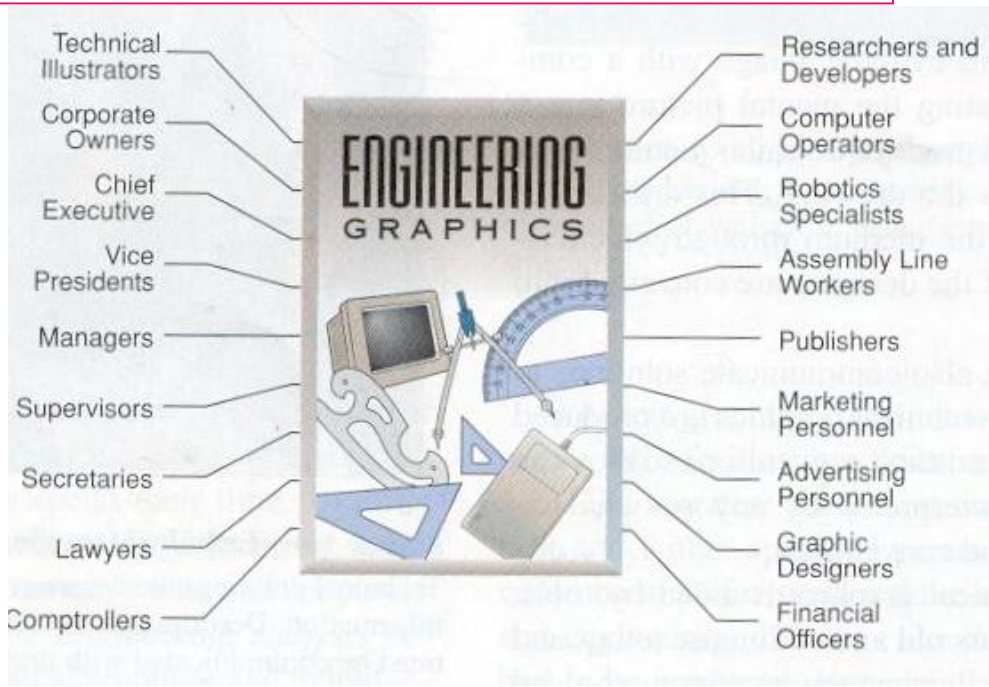
But available or not, the problem must be solved, and whatever form the solution takes under these conditions is called *engineering*.

Importance of technical graphics

- Technical drawings: A language used in the design process for communicating, solving problems, quickly and accurately visualizing objects, and conducting analysis
- A graphical representation of objects and structures and is done using freehand, mechanical, or computer methods

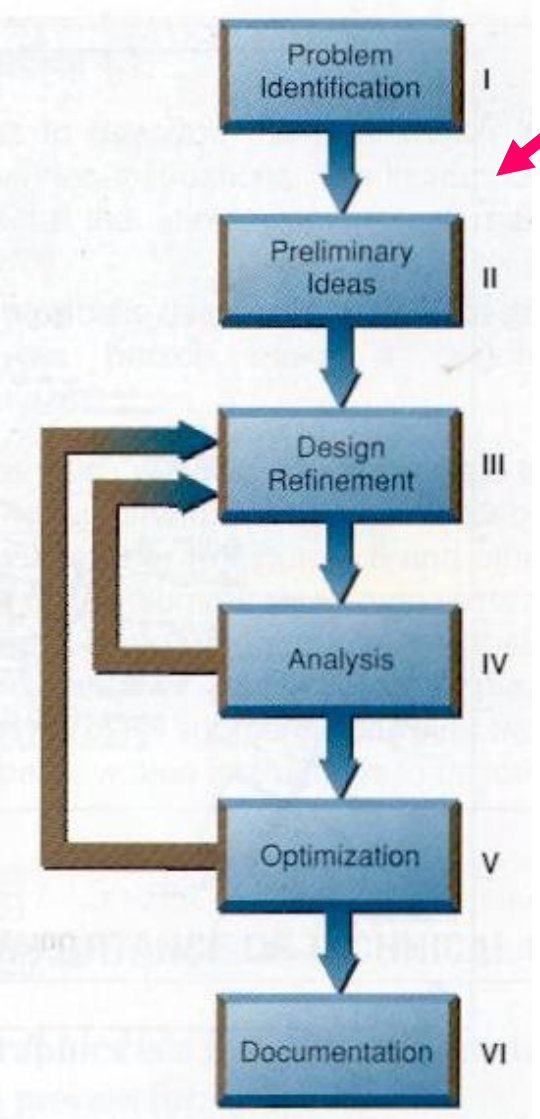


A Total View of Engineering Divided into Its Major Activities

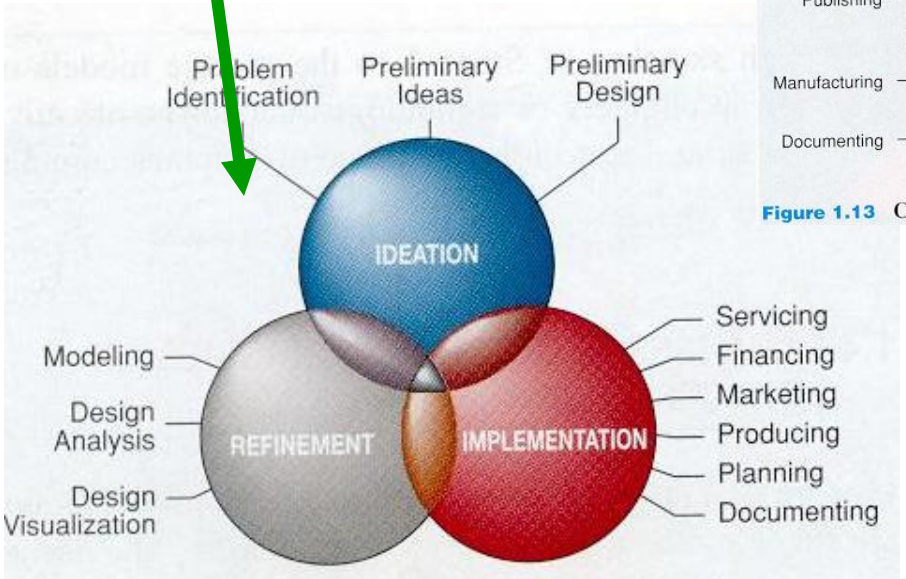


Users of engineering and technical graphics in industry

From traditional "linear" design process to new"concurrent" design process



- Traditional: A linear, segmented activity involving problem identification, preliminary ideas, design refinements, analysis, optimization, and documentation
- Concurrent: A team activity involving coordination of the technical and non-technical functions of design and manufacturing within a business



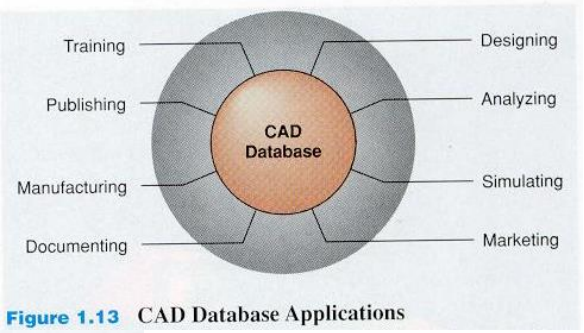
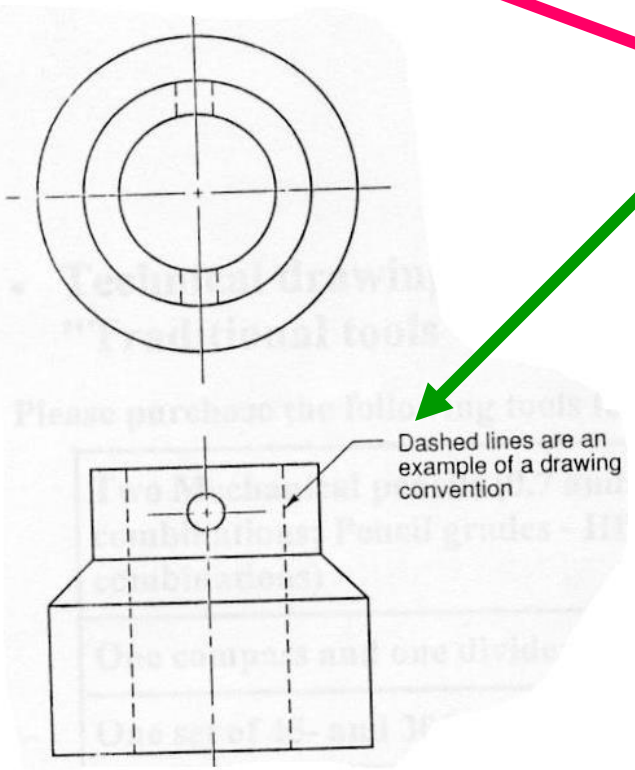
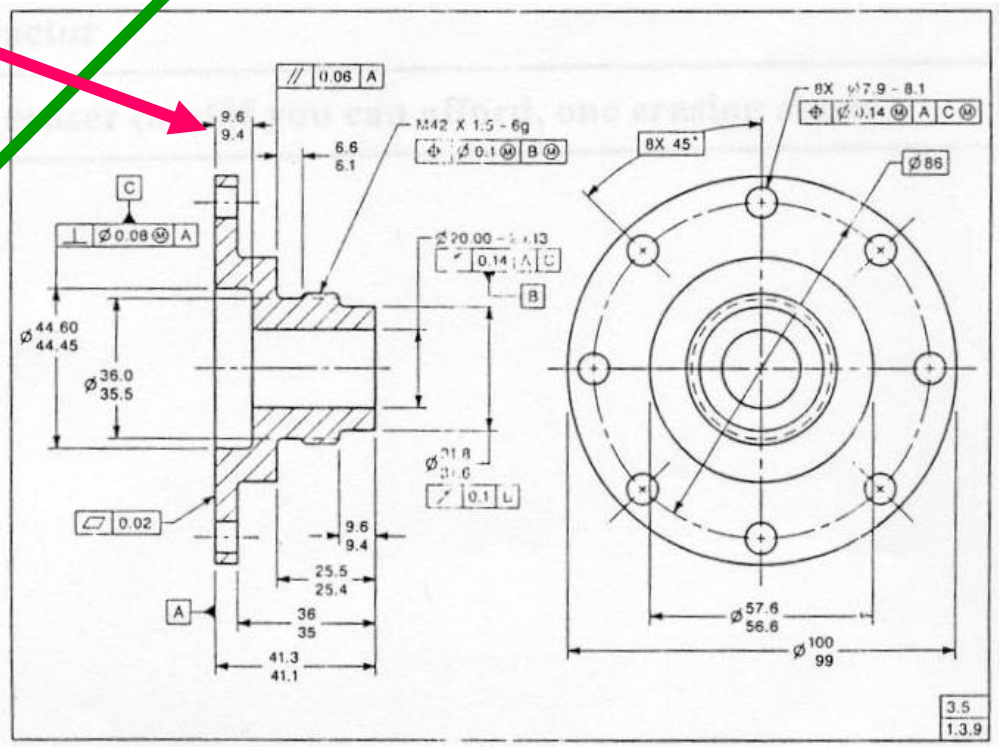


Figure 1.13 CAD Database Applications

The CAD database becomes a communication medium.

Samples of drawing conventions and standards





GEOMETRICAL CONSTRUCTIONS

3.1. INTRODUCTION

Many of the constructions used in technical drawing are based upon plane geometry, and every engineer should be sufficiently familiar to be able to apply them to the solutions of problems.

Pure geometry problems may be solved only with the compass and a straight edge.

However the draftsman has at his disposal the T square, triangles, dividers, and other equipment, such as drafting machines, which in many cases, enable him to obtain accurate results more quickly by machines by what we may term “draftsmen's methods”. Therefore way of solutions are draftsmen's adaptations of the principles of pure geometry.

3.2. POINTS

A point represents a location in space or drawing, and has no width, height or depth. A point is represented by the intersection of two lines:

a) By a short cross-bar on a line
b) By a small cross.

Never represent a point by a simple dot on the paper.

3.3.LINES ON A DRAWING

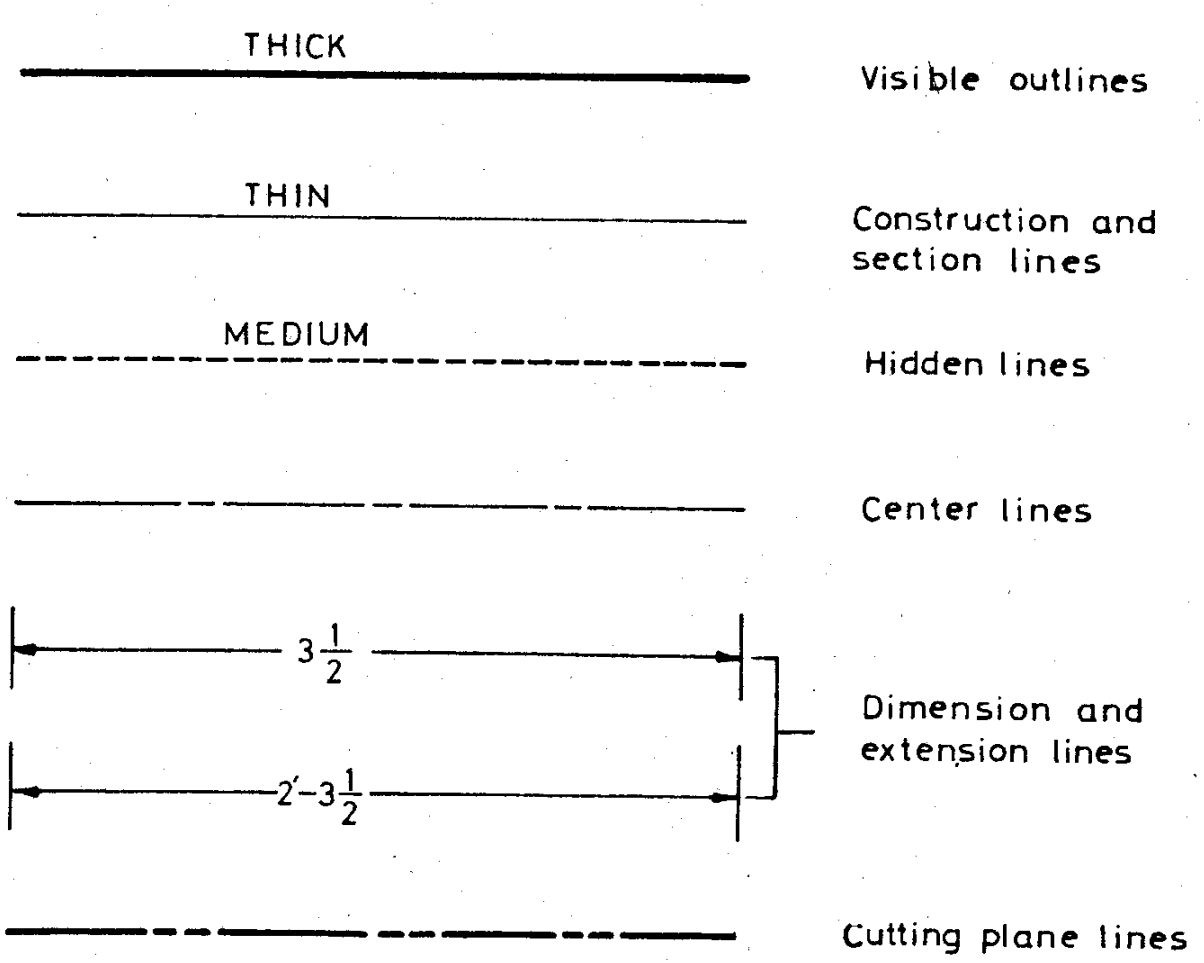
A line on a drawing indicates,

- a) edge view of a surface
- b) intersection of two surfaces
- c) surface limit

Because a line on a view may mean any one of these three conditions.

3.3.1 THE ALPHABET OF LINES

As the basis of drawing is the line, a set of conventional symbols covering all the lines needed for different purposes are given in Figs. 1.24, and 25.



THICKNESSES

	I	II	III
Visible outlines	0.5	0.7	1.0
Construction and section lines	0.25	0.35	0.5
Hidden lines	0.35	0.5	0.7
Center lines	0.25	0.35	0.5
Dimension and extension lines	0.25	0.35	0.5

Fig.1.24 Width and character of lines (ASA)

Lines:

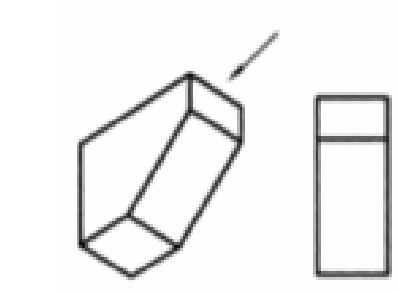
❑ Generally, technical drawing is the expression of bodies (or matters) by lines.

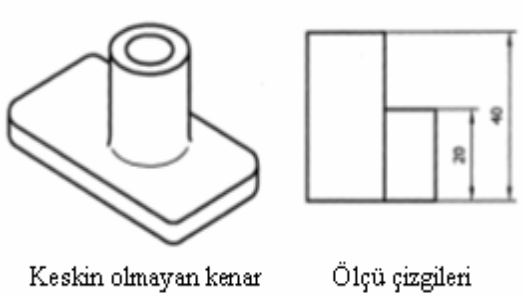
❑ Pieces are composed of variable geometric component.
Sides and surfaces of these components are visible but some of them can not be seen because they are behind the back sides.

❑ To obtain full and precise info about the piece, drawing should be done by using variable lines (instead of using same lines). Moreover, these lines should be drawn at same thickness and shape by everyone.

The shapes and thicknesses of lines are given in TS88.

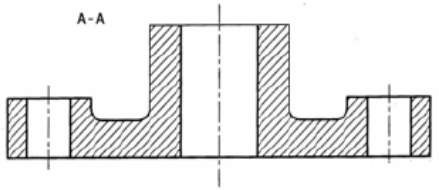
Type of lines:



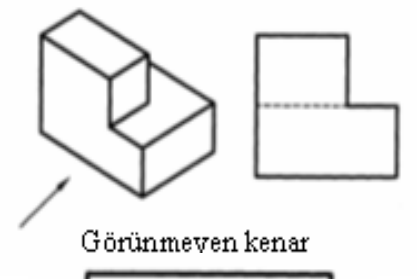


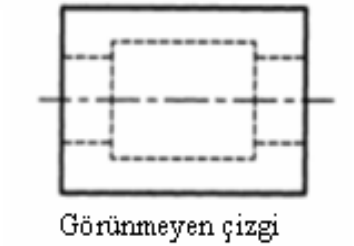
Keskin olmayan kenar

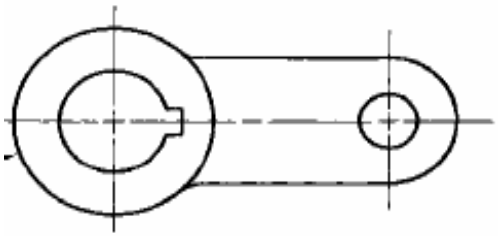
Ölçü çizgileri

Type of lines		Application places
A	Continuous line (thick)	A1- Surroundings and sides of the matters. A2- End of the screw
B	Continuous line (thin)	B1- Backside section line B2- Measure lines, guide lines B3- Simplified axis lines B4- At diagonal lines which are used to state plane surface B5- To state the code of the places 
C1 C2	Free hand lines Zigzag line (thin)	C1-To state the place that limit section and appearance of matter or to state the place teared off. C2- It is used when free hand lines are drawn by tool.

Type of lines:



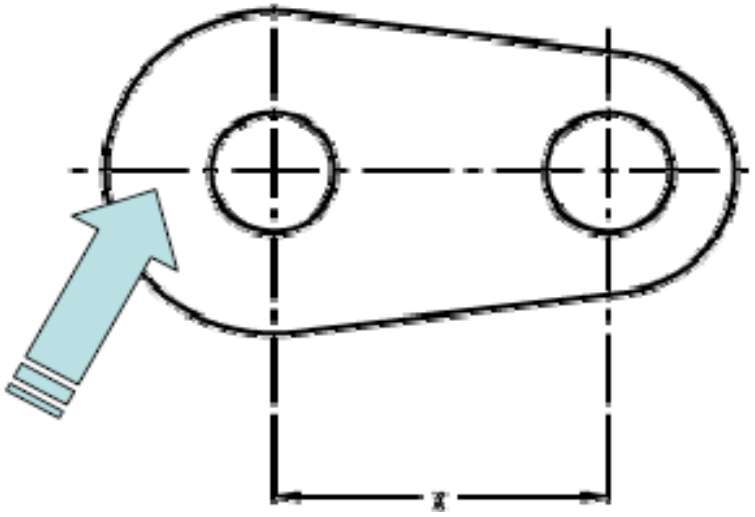


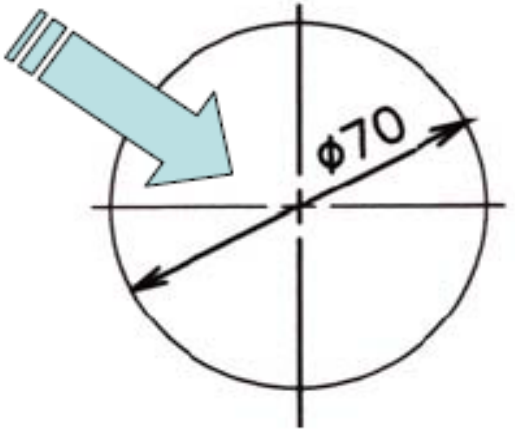


D	Dash line (thin)*	D1- Invisible surrounding and sides of the matter.
E	Dash line with point (thin)	E1- Axis lines of symmetrical drawing E2- In front of section planes
F	Section plane with thick ends and thin mid points.	F1- To draw the traces at section plane
G	Dash line with point (thick)	G- To state the place which will processed additionally. (to coat, to harden, etc.)
H	Dash line with two points (thin)	H1- To show the surroundings of neighbor pieces H2- To state the secondary situation of moving pieces. To state the center of gravity

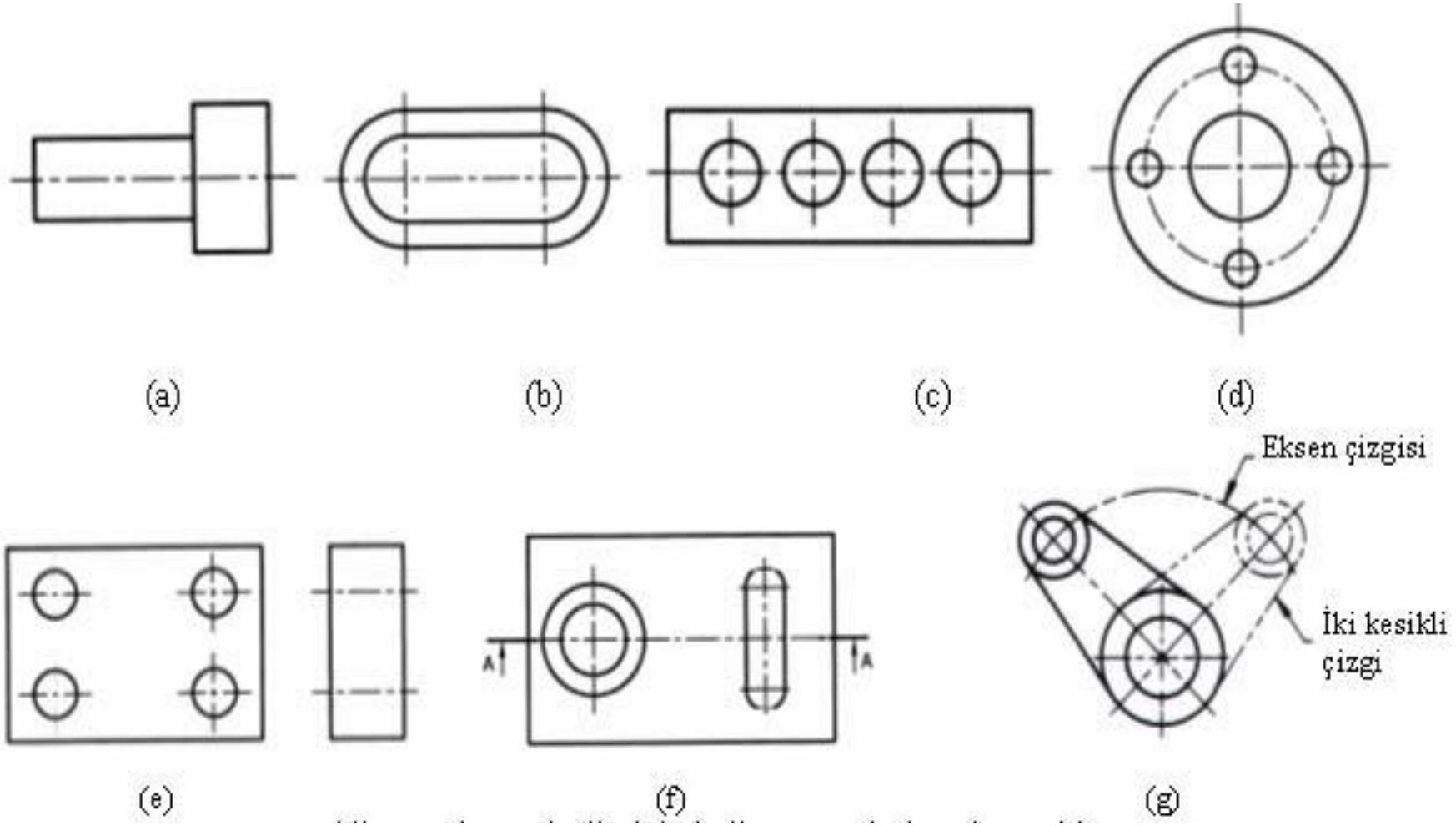
Center Lines:

You will draw the centerlines for the circle. Center lines for holes must be included in all views. A centermark and four lines extending beyond the four quadrant points are used to define the center point of a hole in its circular view.

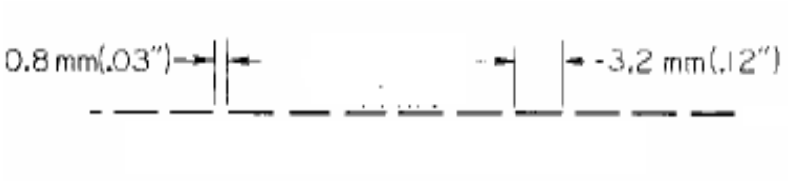


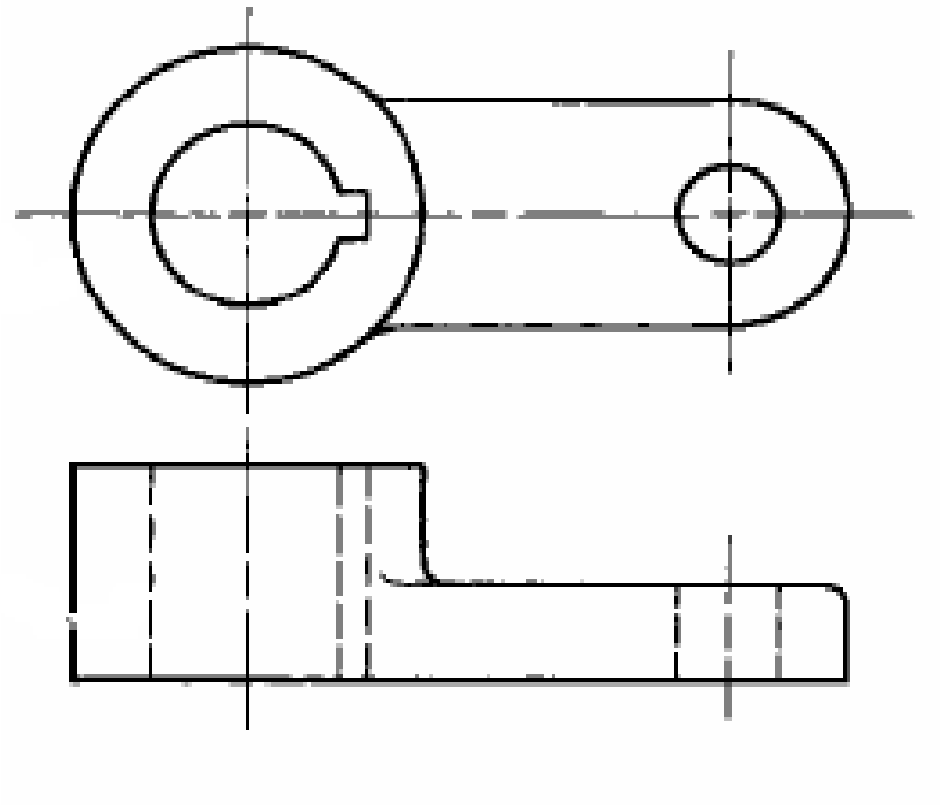


Axis lines:



Hidden Lines:

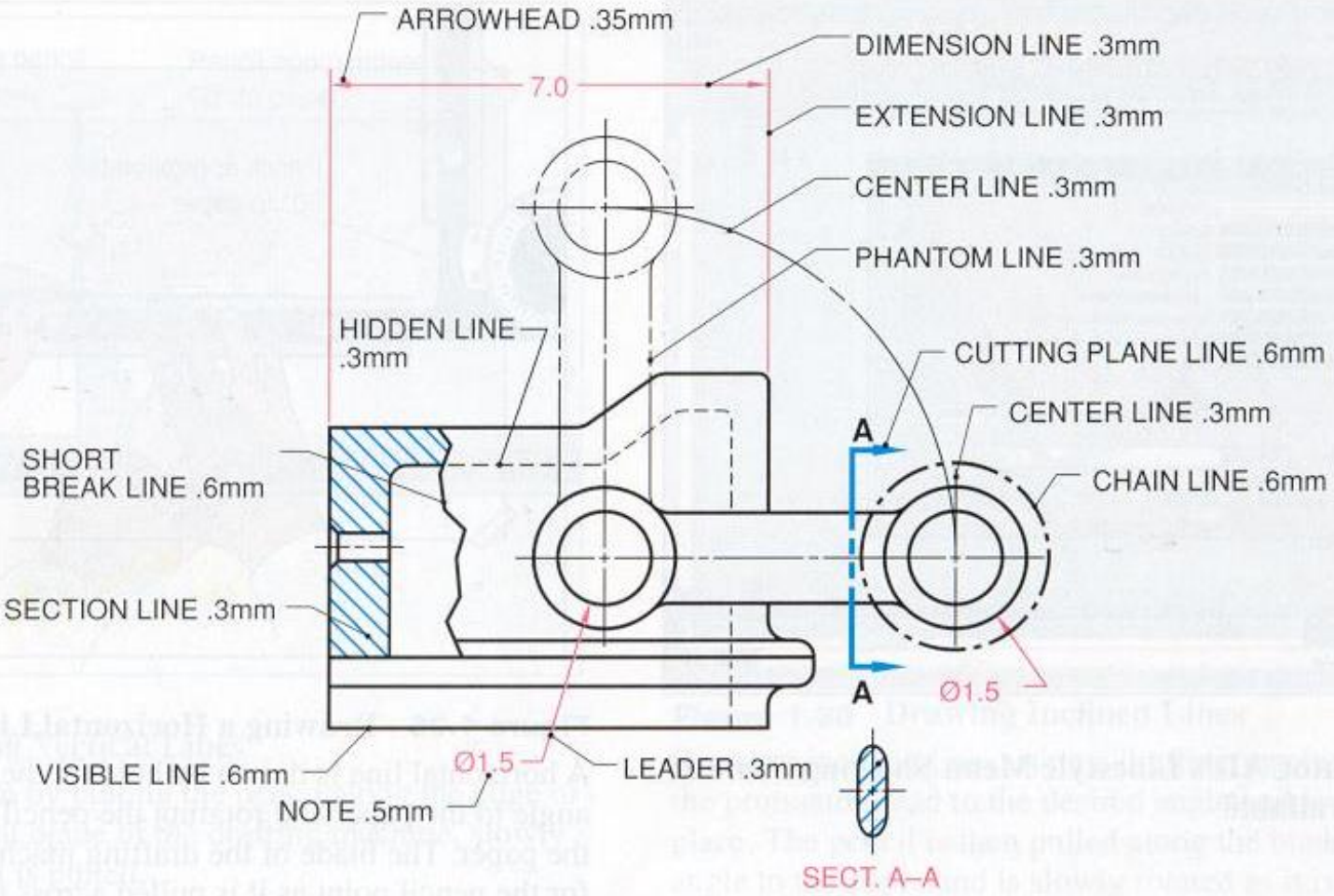




Three widths of lines for finished drawing are recommended. Thick for visible outlines, and cutting plane lines. Medium for hidden outlines, and thin for section, centre, extension, dimension and construction lines. Lighter construction lines can be used as guide lines, especially in lettering practice (Fig.1.26).

In pencil drawing try to have all straight and curved lines uniform in width and colour or thickness and density.

Alphabet of lines



3.3.2 DIVIDING LINES

A line has indefinite length without breadth. A straight line is the shortest distance between two points. Since the line is indefinite in extent, the length is a matter of convenience, and the end points are not fixed. If the end points of the line are significant, they must be marked by means o small mechanically drawn cross-bars. To divide a given line into given number of equal parts, see Fig.3.1 and 3.2.

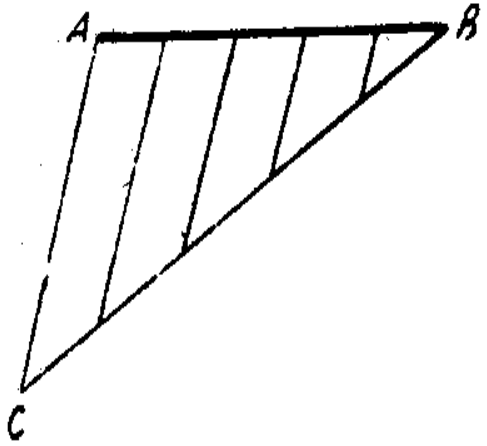


Fig.3.1 To divide a line. Equal divisions on any line BC are transferred to AB by parallels to AC.

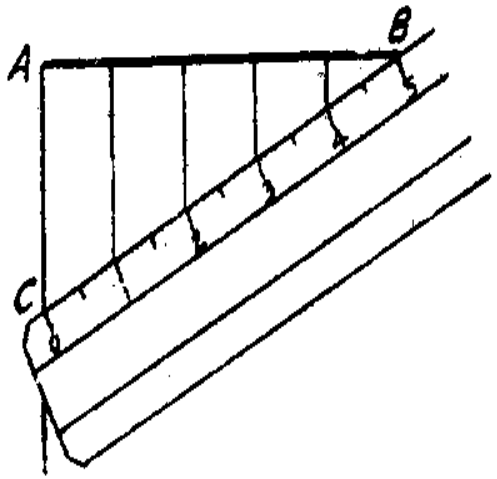


Fig.3.2 To divide a line. Scale divisions are transferred to given line AB.

To draw a line through two points

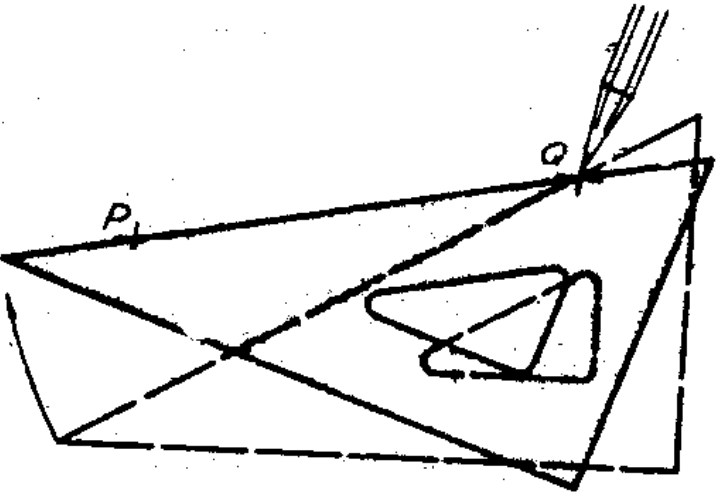


Fig.3.3 To draw a line through two points. Use the pencil as a pivot and align the triangle or T square with the second point.

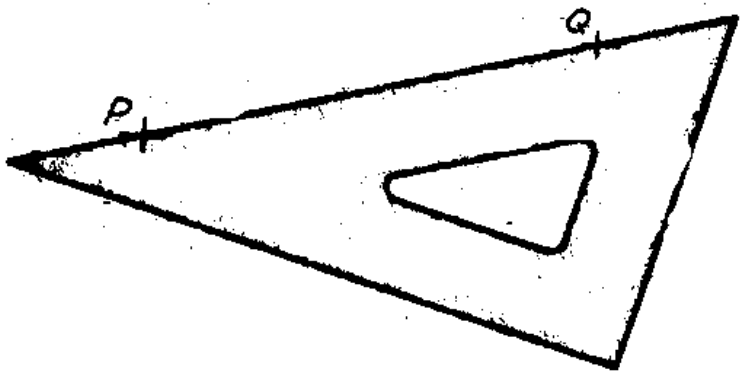


Fig 3.4 To draw a line through two points (alternate method). Carefully align the triangle or T-square with the points, and draw the required line.

To draw a line through two points

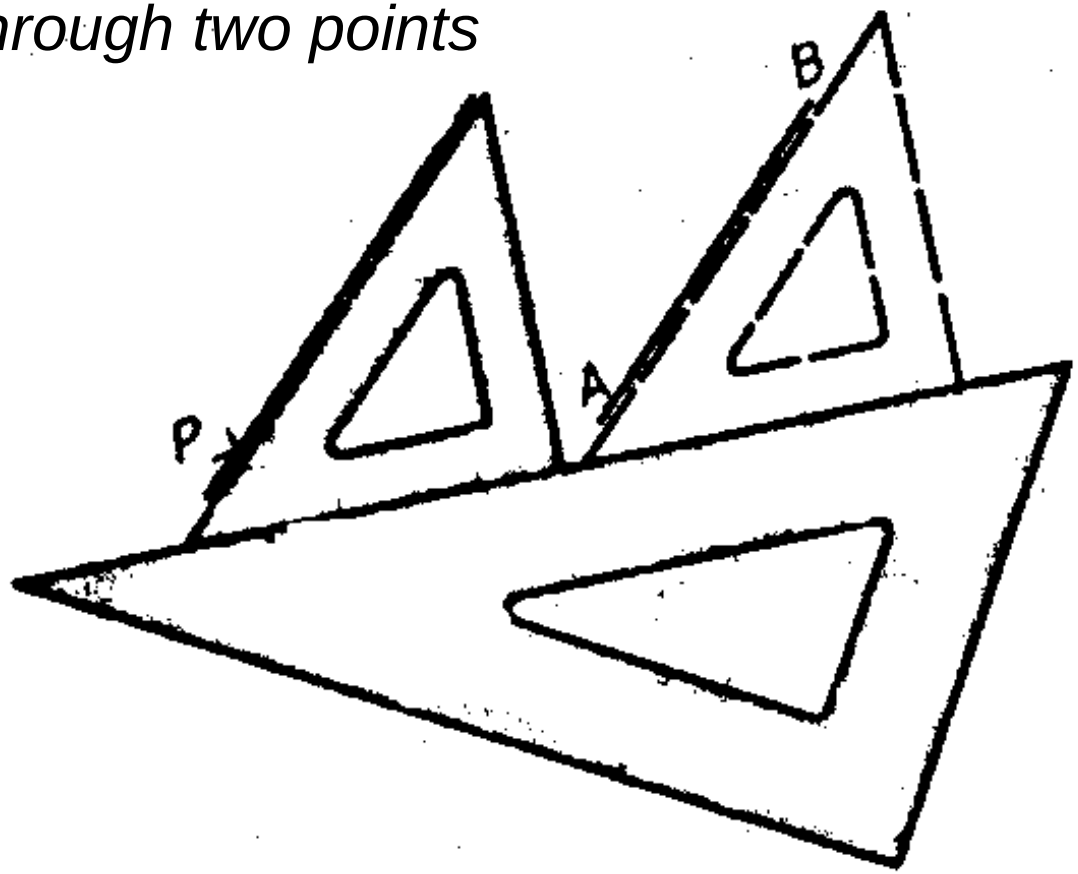


Fig.3.5 To draw a line parallel to another. Align a triangle with the given line AB using a base as shown; move it to position through the given point p and draw the required line.

To draw a line perpendicular to another

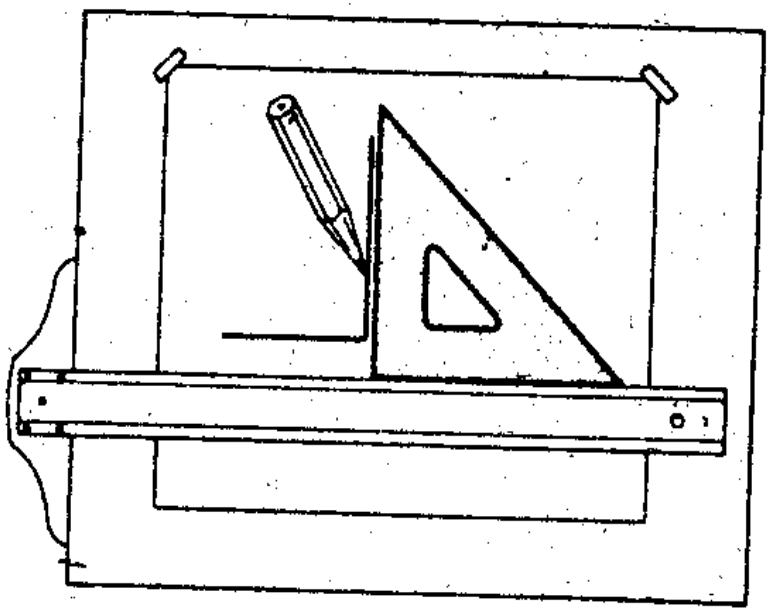


Fig.3.7 To draw a line perpendicular To another (when the given line is horizontal). Place the triangle on the T-square and draw the required line

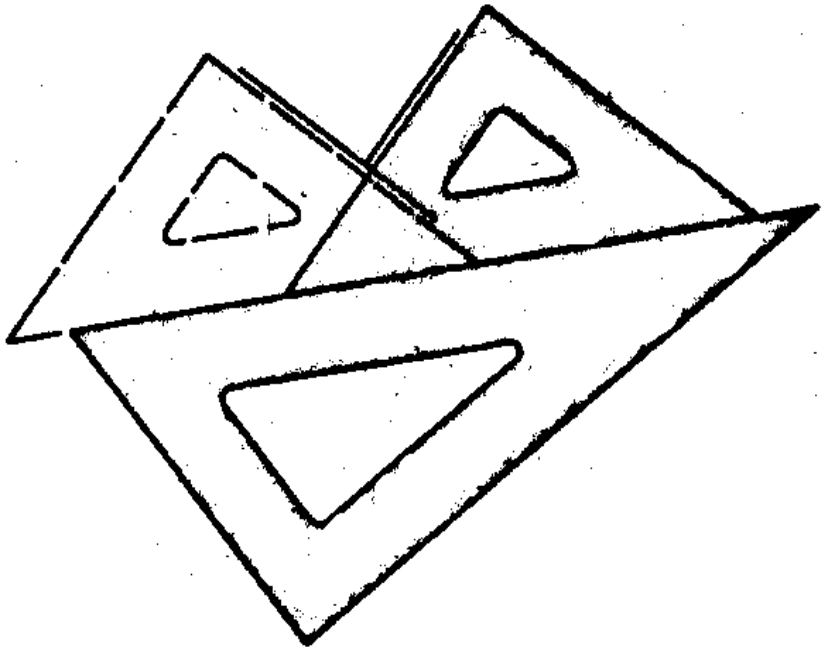


Fig.3.8 To draw a line perpendicular to another (general position). Align a triangle with the given line as shown; slide it (on another triangle as a base) to position of perpendicular and draw the required line.

3.4. TANGENTS

A tangent to a curve is a line, either straight or curved, that passes through two points on the curve infinitely close together.
The method of finding these points is indicated in the following constructions. The location of tangent points is based on one of these geometric facts:

(1) the tangent point of a straight line and a circle will lie at the intersection of a perpendicular to the straight line that passes through the circle centre, and

(2) the tangent point of two circles will lie on the circumferences of both circles and on a straight line connecting the circle centers (Fig.3.9).

All tangent points must be marked with a short dash (3 mm) across the outline of the figure with a hard pencil.

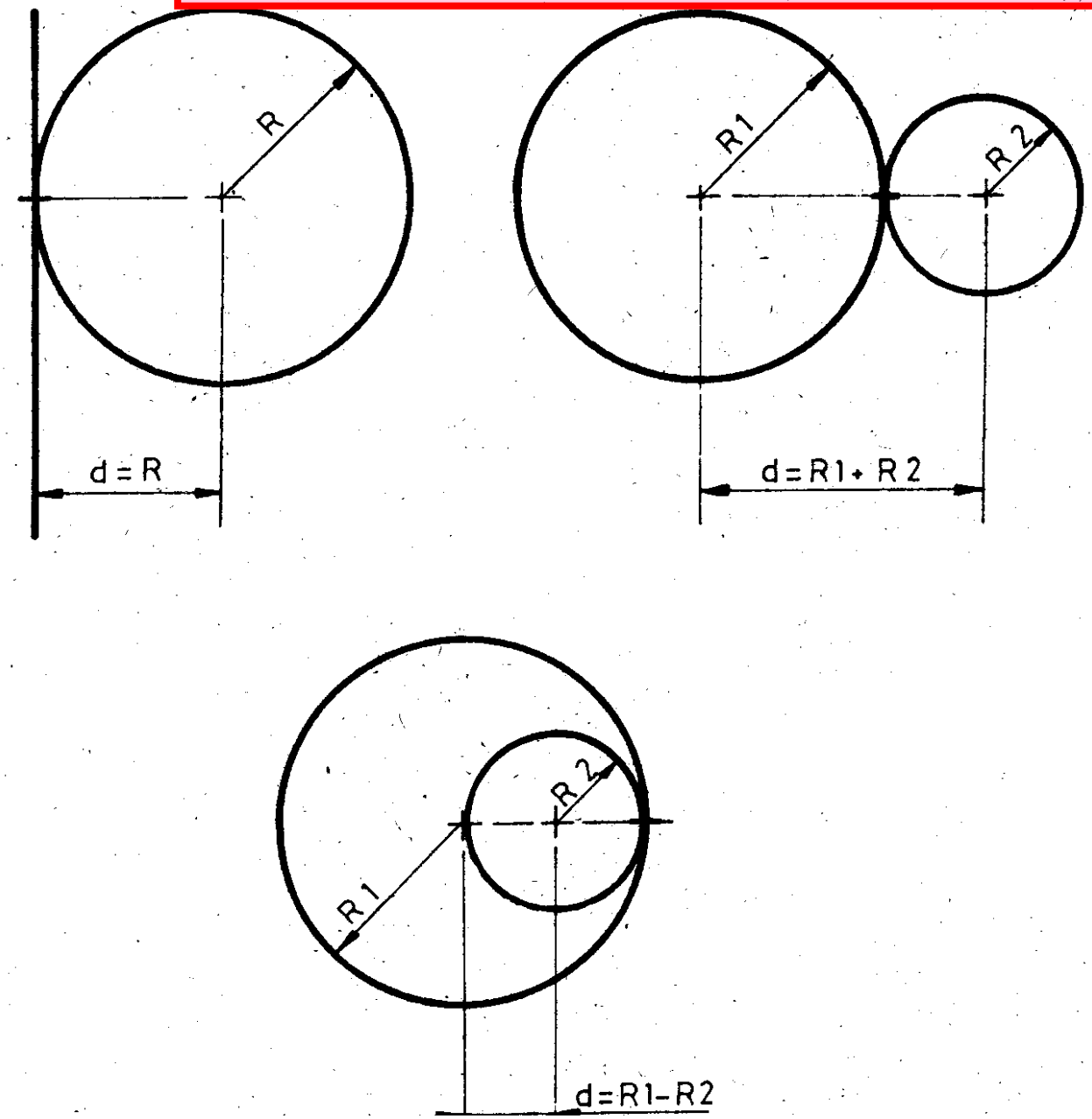


Fig.3-9 Tangent points

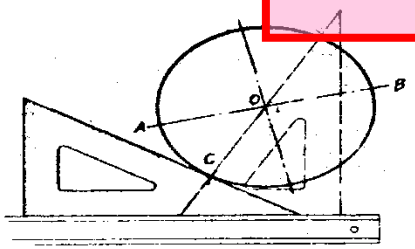


Fig 3.10 A tangent at a point on a circle. The tangent line must be perpendicular to the line from the point to the centre of the circlet.

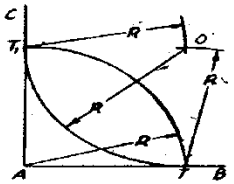


Fig 3.12 An arc tangent at right angle corner. The arc center must be equidistant from both lines.

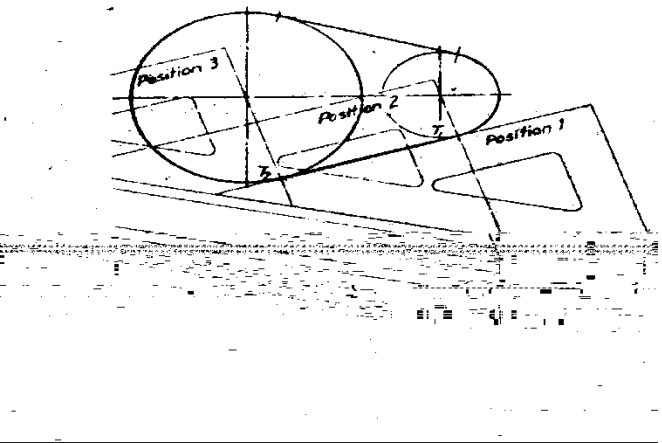


Fig.3.14 Tangents to two circles (open belt).Tangent lines are drawn by alignment with both circles. Tangent points lie on perpendicular lines from circle centers.

3.5 JOINING OF ARCS

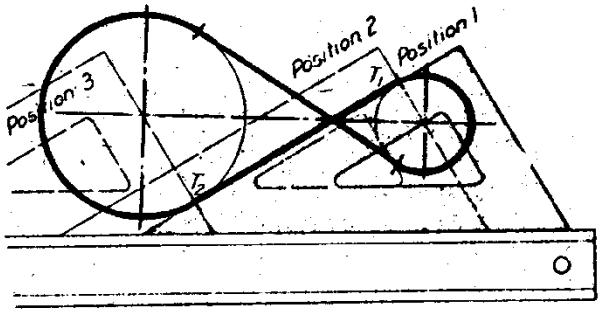


Fig.3.15 Tangents to two circles (crossed belt).Tangent lines are drawn by alignment with both circles tangent points lie on perpendicular lines from circle centers.

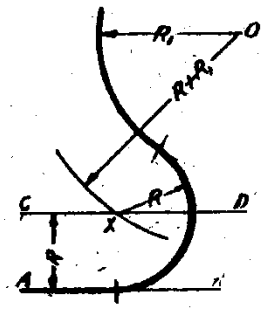
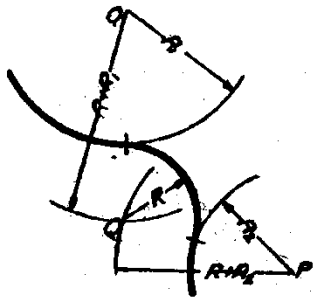


Fig.3.16 An arc tangent to a straight line and a circle. The arc must be equidistant from the line and the



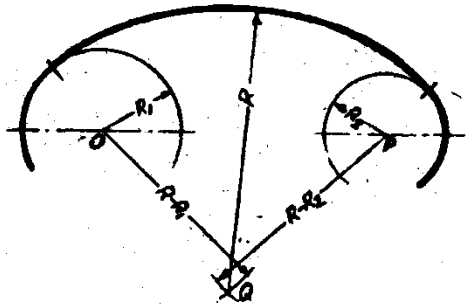
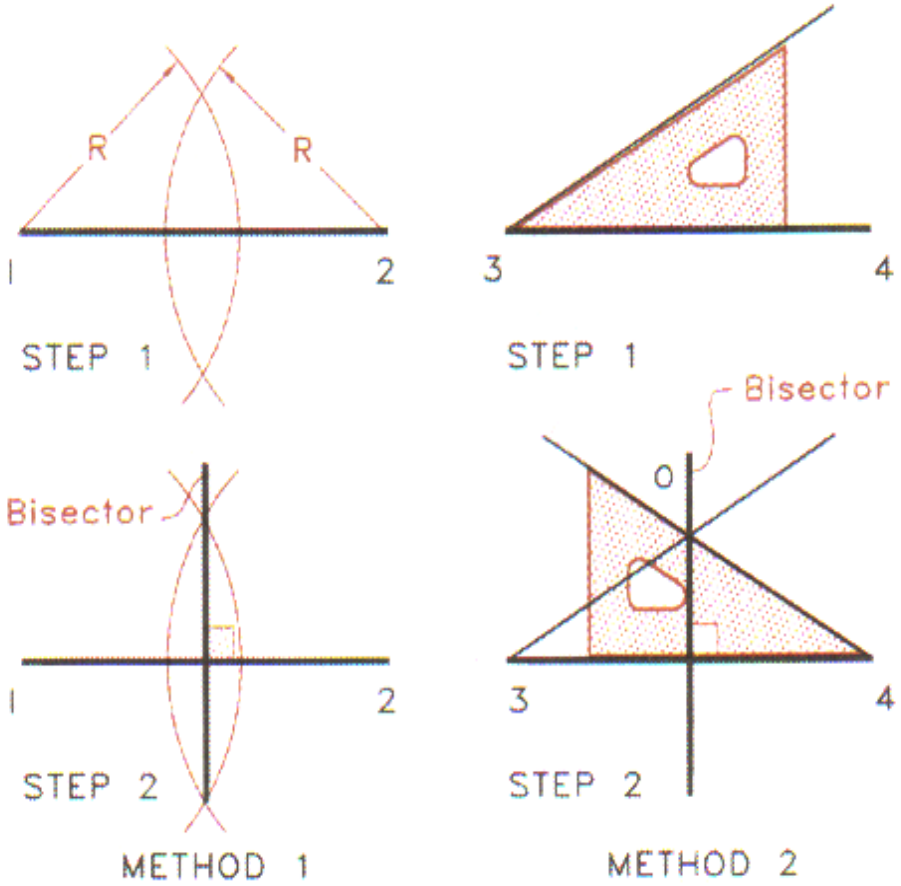


Fig.3.17 An arc tangent to two circles. The arc centre must be equidistant from both circles.

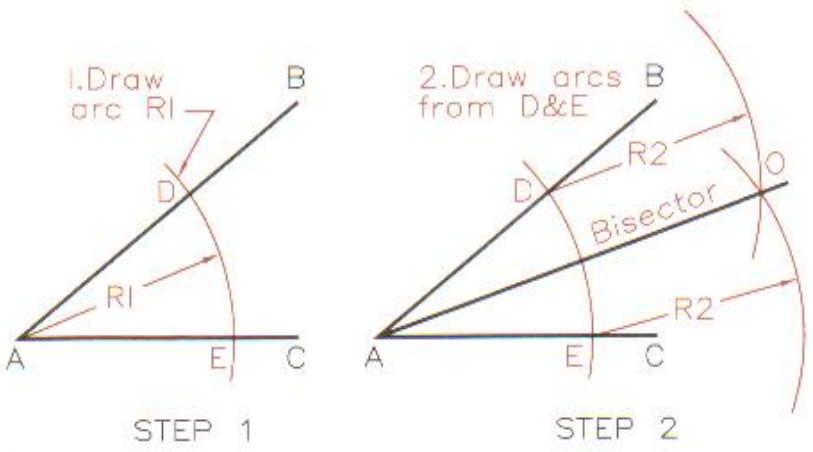
Geometric Construction: Bisecting a line & angle



12.7 Bisecting a line:

Method 1 Use a compass and any radius.

Method 2 Use a triangle and a straightedge.

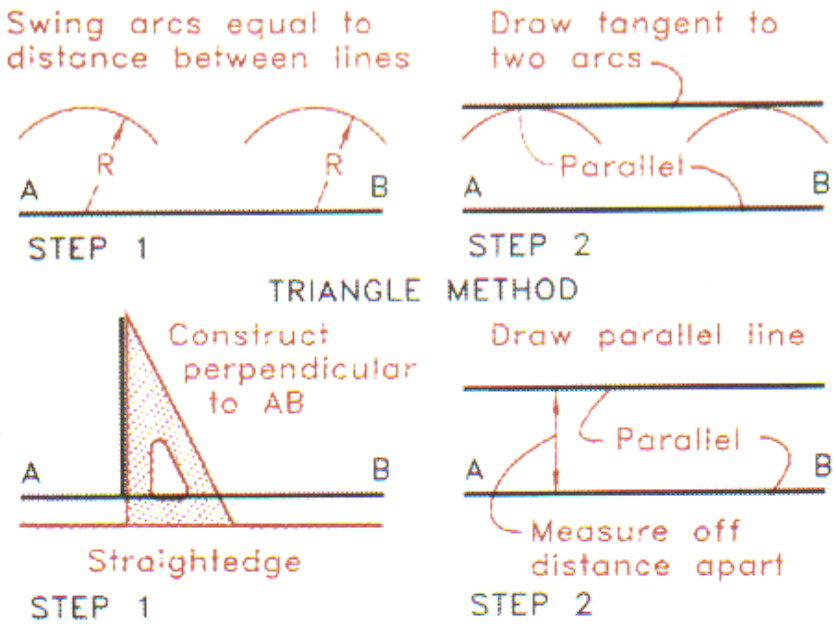


12.8 Bisecting an angle:

Step 1 Swing arc R1 to locate points D and E.

Step 2 Draw equal arcs from D and E to locate point O. Line AO is the bisector of the angle.

Geometric Construction: Dividing a line & drawing parallel lines



12.13 Drawing parallel lines

Compass Method

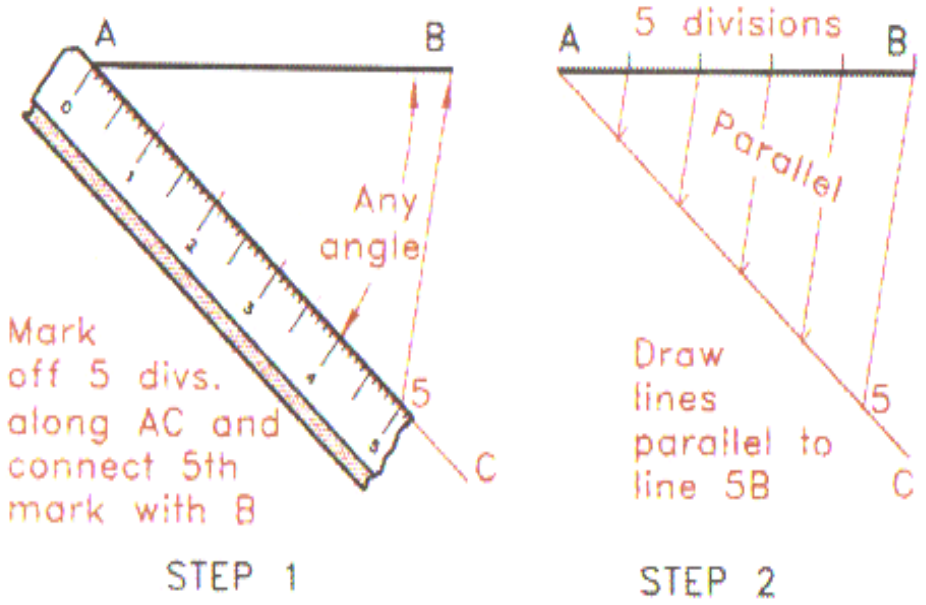
Step 1 Swing two equal arcs from line AB.

Step 2 Draw the parallel line tangent to the arcs.

Triangle Method

Step 1 Draw a line perpendicular to AB.

Step 2 Measure the desired distance, R, along the perpendicular and draw the parallel line through it.

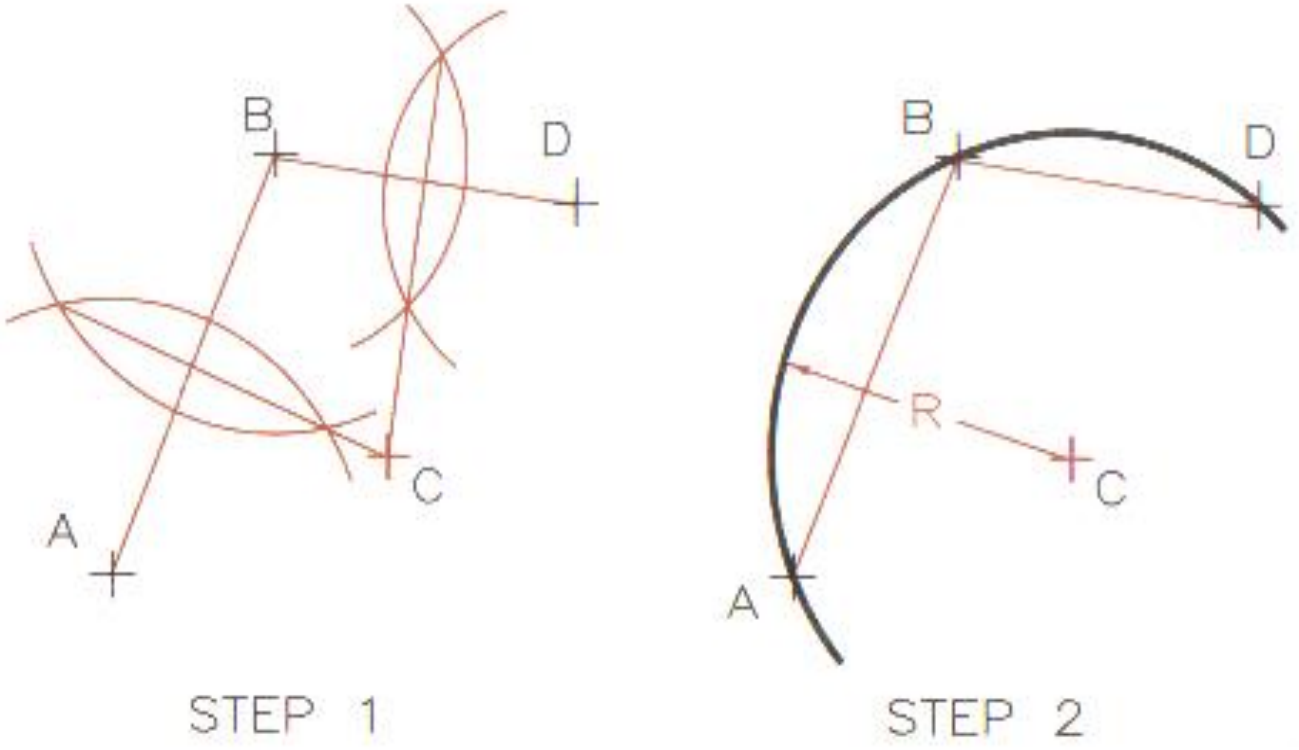


12.10 Dividing a line

Step 1 To divide line AB into five equal lengths, lay off five equal divisions along line AC, and connect point 5 to end B with a construction line.

Step 2 Draw a series of five construction lines parallel to 5B to divide line AB into five equal parts.

Geometric Construction: Construct an arc through three points



12.12 An arc through three points

Step 1 Connect points A, B, and D with two lines and construct their perpendicular bisectors, which intersect at center C.

Step 2 Use center C and the distance to the points as the radius, R, to draw the arc through the points.

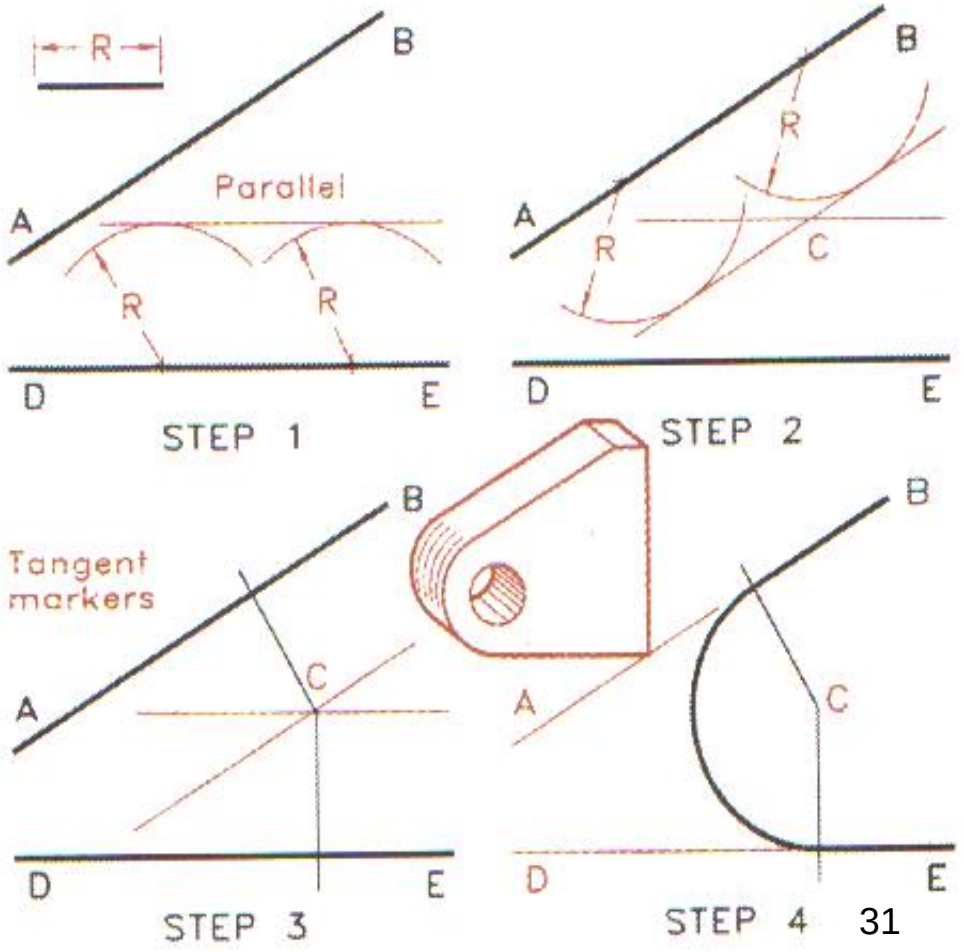
Geometric Construction: Construct an arc tangent to two nonparallel lines

Step 1: Draw a light line parallel to DE with radius R.

Step 2: Draw a second light line parallel to and R distant from line AB to locate center C.

Step 3: Draw thin, dark lines from center C perpendicular to AB and DE to locate the tangency points.

Step 4: Draw the arc and darken lines.



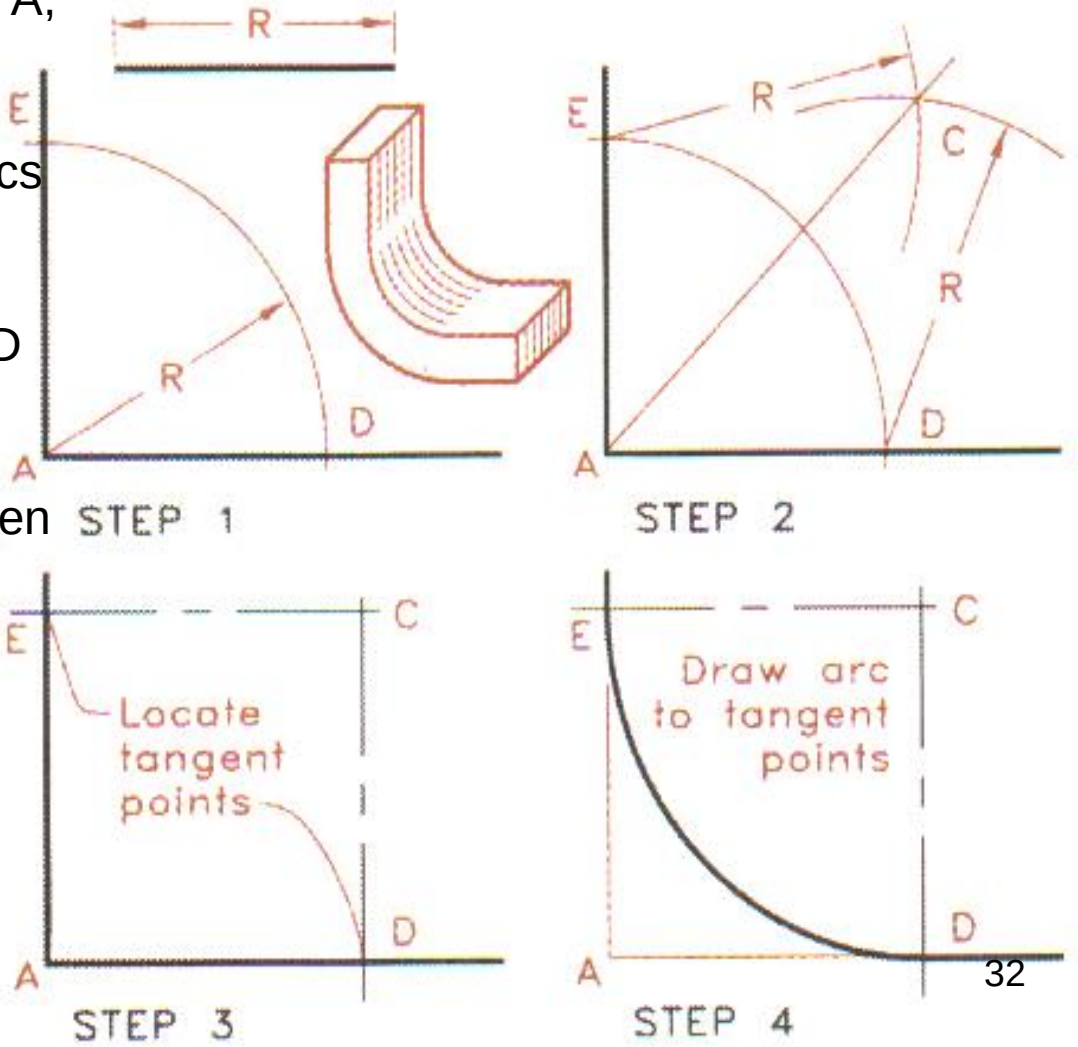
Geometric Construction: Draw an arc tangent to two perpendicular lines

Step 1: Using radius R and center A, locate D and E.

Step 2: Find C by swinging two arcs with radius R.

Step 3: Perpendiculars CE and CD locate tangent points.

Step 4: Draw the tangent arc darken your lines.



Geometric Construction:

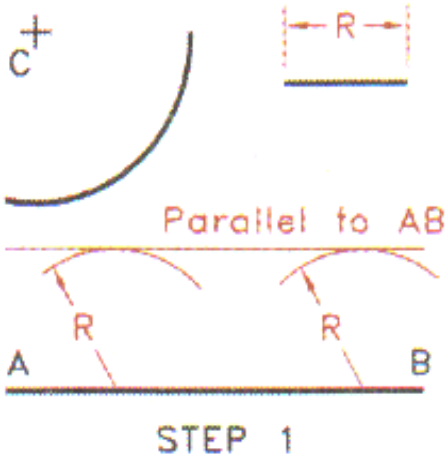
Construct an arc tangent to an arc and a line

Step 1: Draw a line parallel to AB that is R distance from it.

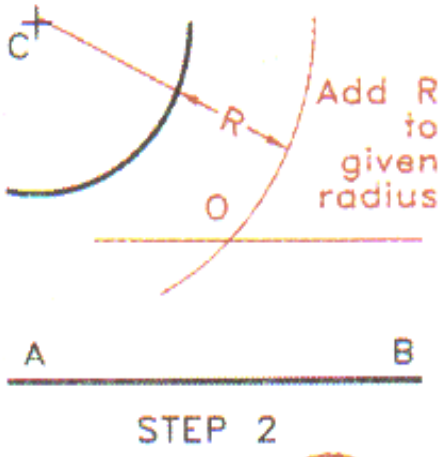
Step 2: Add radius R to the radius from center C. Swing the extended radius to find the center O.

Step 3: Lines OC and OT locate the tangency points.

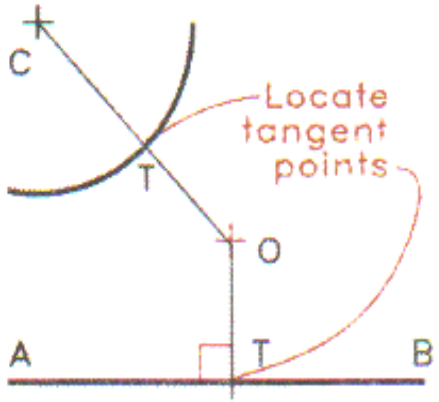
Step 4: Draw the tangent arc between the points of tangency with radius R and center O.



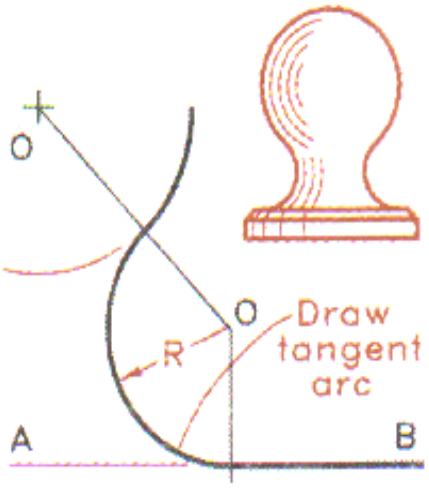
STEP 1



STEP 2



STEP 1



STEP 2

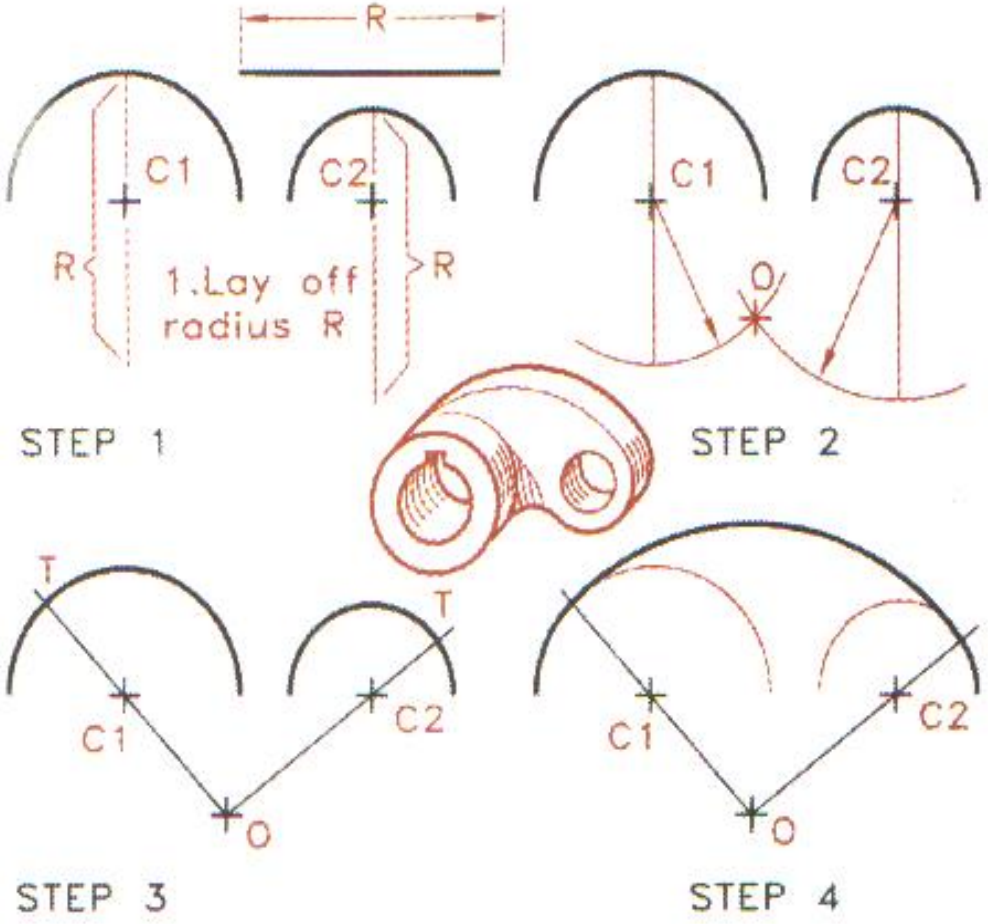
Geometric Construction: Construct a concave arc and a convex arc tangent to two arcs

Step 1: Extend each radius from the arc past its center by a distance of radius R along these radii.

Step 2: Use the distances from C1 and C2 to the ends of the radii and swing arcs to locate center O.

Step 3: Draw thin, dark lines from center O through centers C1 and locate C2 to locate the points of tangency.

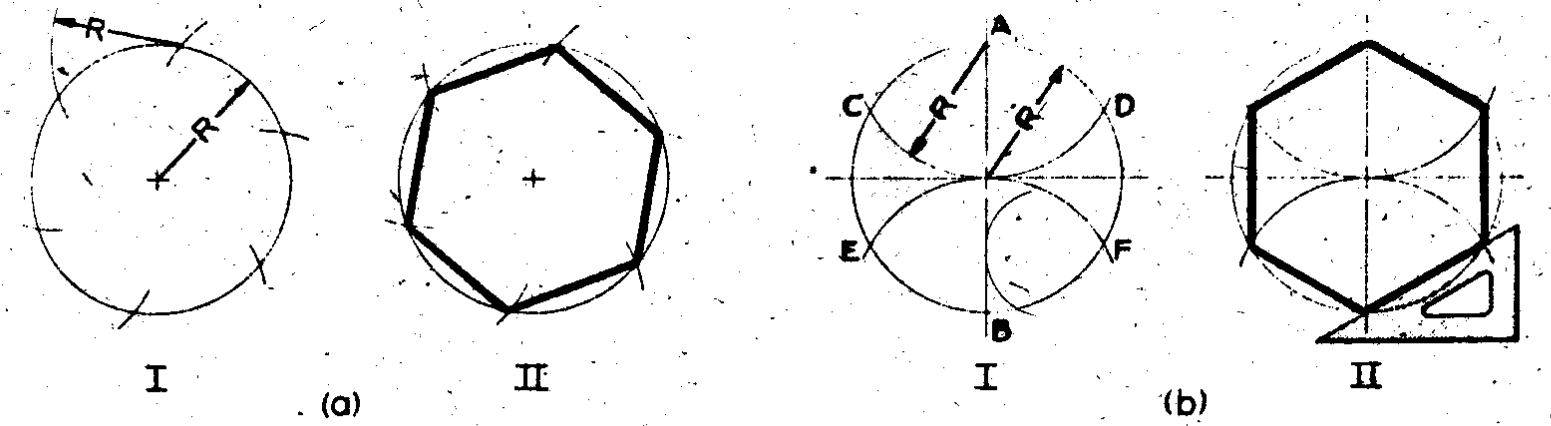
Step 4: Draw the arc between the tangent points using radius R and center O.



3.6. HEXAGON CONSTRUCTIONS

Each side of a hexagon is equal to the radius of the circumscribed circle. Therefore, using the compass and the radius of the circle set off the six sides of the hexagon around the circle, and connect the points with straight lines. As a check on the accuracy of the construction, make sure that opposite sides of the hexagon are parallel.

Fig.3.18. Drawing a hexagon



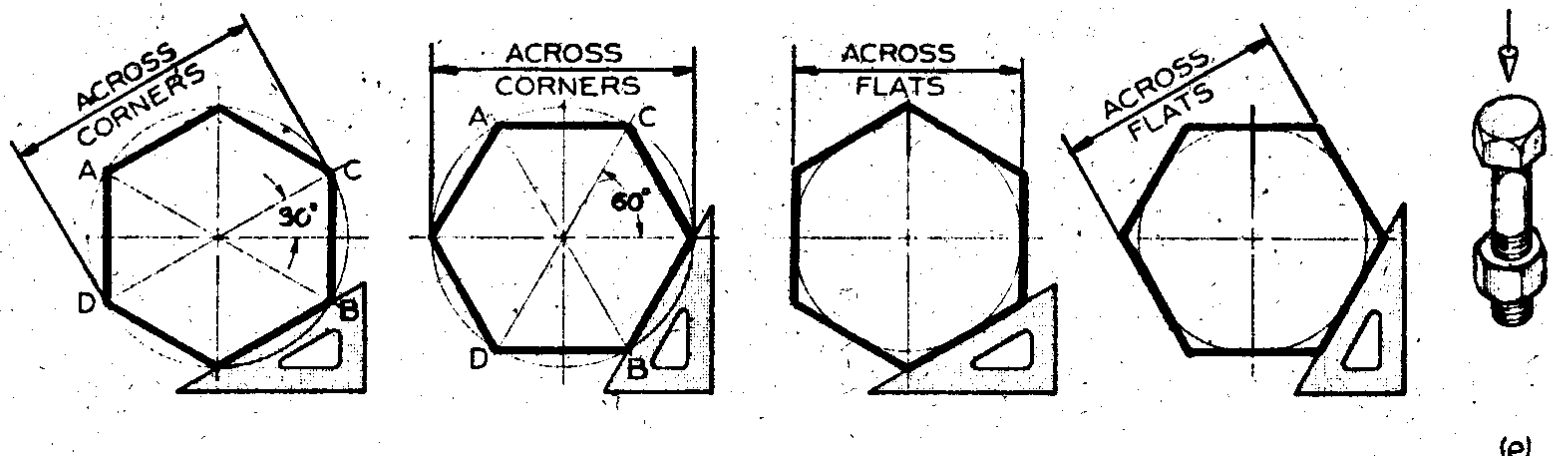
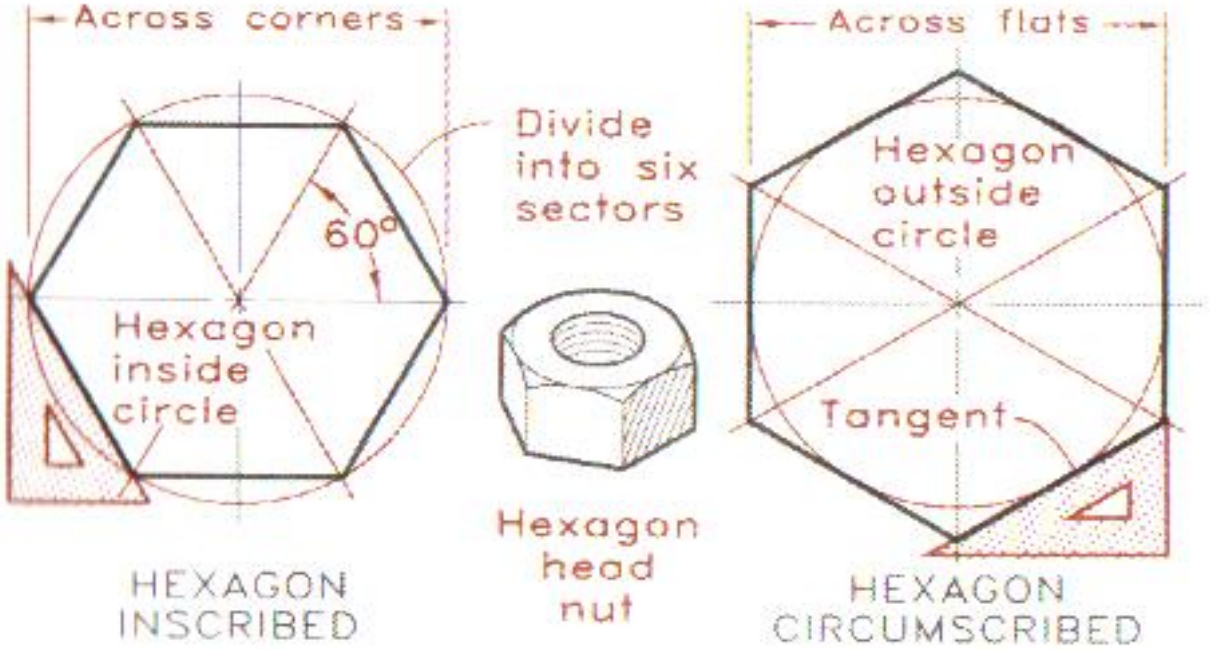


Fig.3.19. Drawing a hexagon

Geometric Construction: Construct polygons

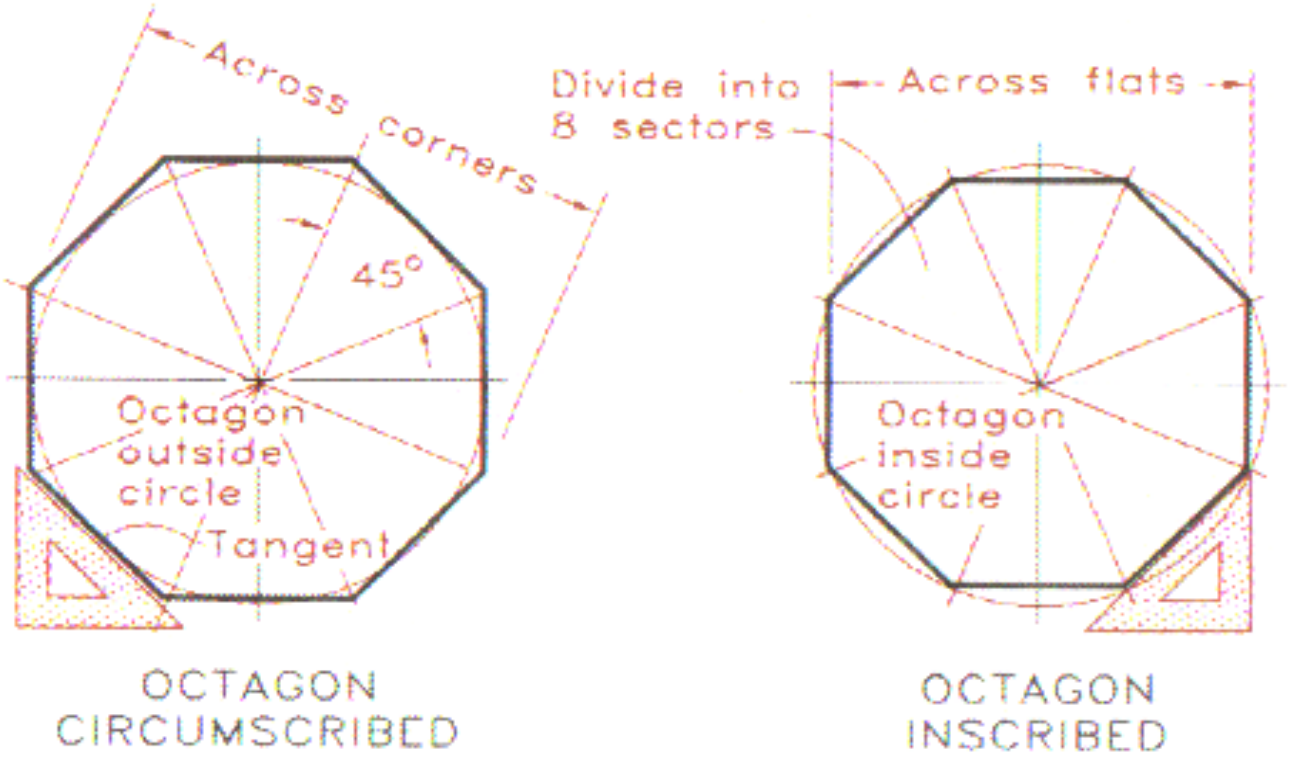
The **hexagon** can be inscribed or circumscribed about a circle. Use 30º-60º triangle to divide the circle into six sectors and draw the hexagon. The circle represents the distance from corner to corner for an inscribed hexagon, and from flat to flat for circumscribed about a circle.



12.3 A hexagon can be inscribed in or circumscribed about a circle with a 30°–60° triangle.

Geometric Construction: Construct polygons

The **octagon**, an eight-sided regular polygon, can be inscribed in or circumscribed about a circle. Use a 45º triangle to divide the circle into eight sectors. When the octagon is circumscribed, the sides are drawn tangent to the circle. When the octagon is inscribed, the corner points found on the circle are connected.



An octagon can be inscribed in or circumscribed about a circle with a 45° triangle.

3.7. TRAMMEL METHOD OF ELLIPSE CONSTRUCTIONS

Method I (Fig.3.20); On a straight edge or a strip of paper, thin cardboard or sheet of celluloid, mark the. distance (ao) equal to one-half the major diameter and (do) equal to one-half the minor diameter. The strip is moved, keeping (a) on the minor axis, and (d) on the major axis, (o) will give point on the ellipse. Then use a french-curve

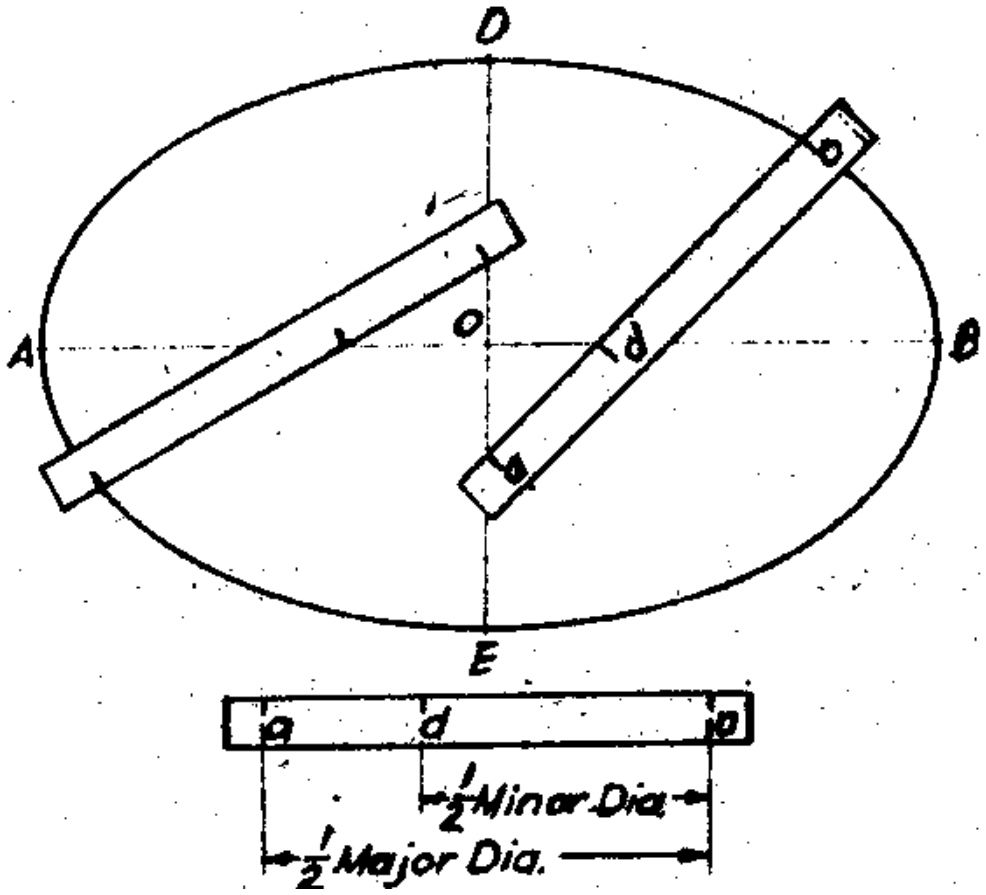


Fig 3.20. An ellipse by trammel (first method). Point on the curve are plotted.

Method II (Fig.3.21): On a strip, as above, mark the distance (do) equal to one-half the minor diameter, and (ao) equal to one-half the major diameter. The strip is moved, keeping (a) on the minor axis, and (d) on the major axis, (o) will give points on the ellipse.

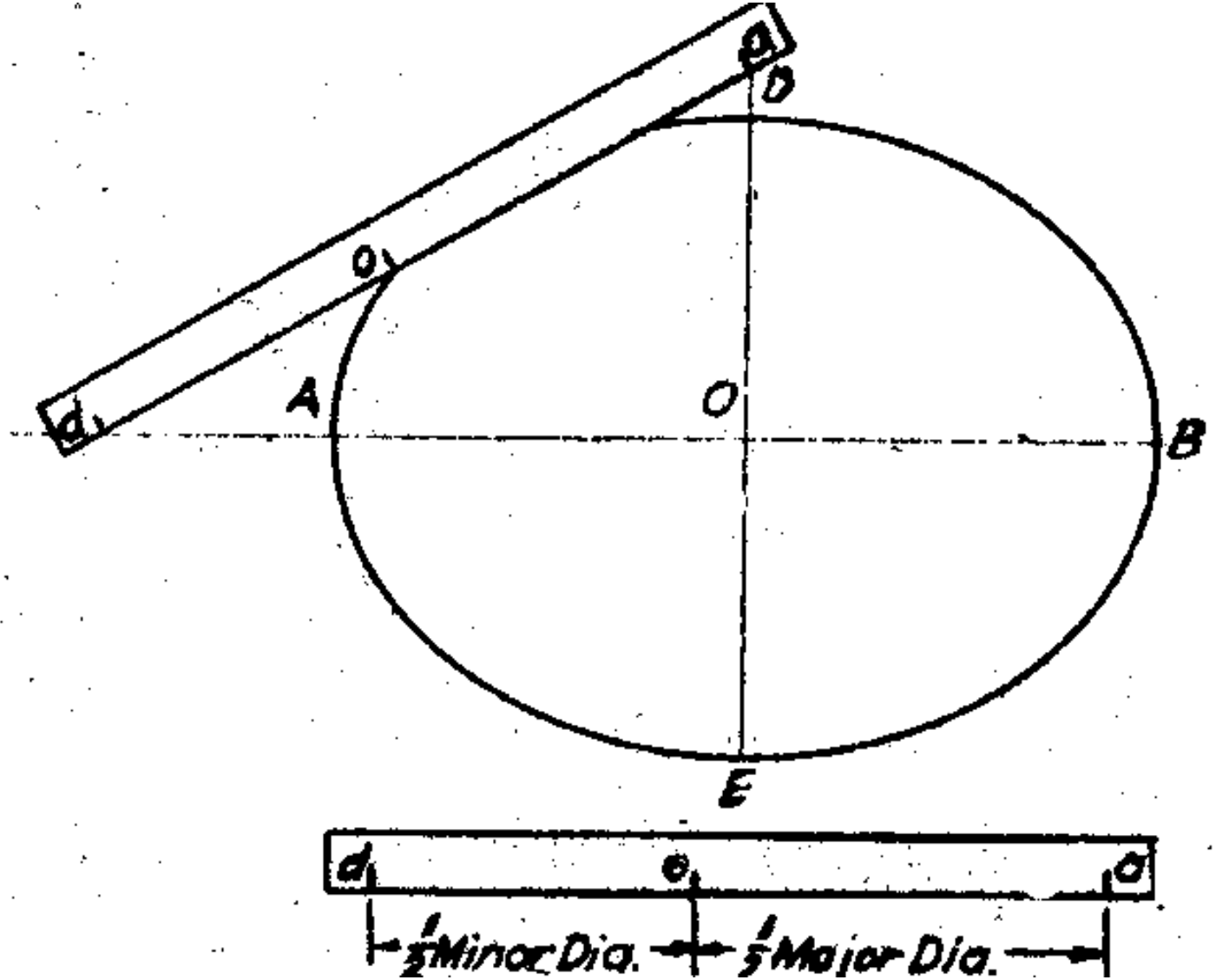


Fig. 3.21 An ellipse by trammel (second method). Points on the curve on the curve are plotted.

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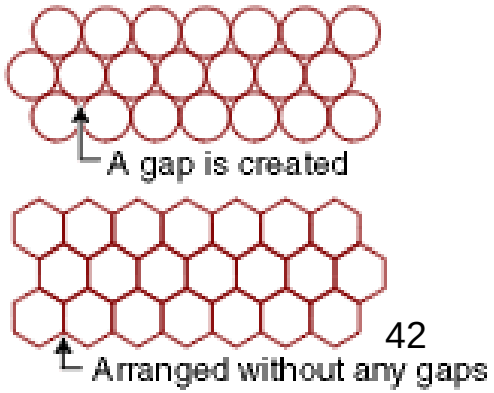
From the Bee Farm

Why Is the Beehve Hexagonal?

Bees have been designed with an inbuilt ability to build perfect hexagonal shapes which have been shown to be the most efficient use of space. It also makes the comb very strong.
Read more:
http://wiki.answers.com/Q/Why_do_bees_make_a_hexagonal_shape#ixzz1b8EPyT3b

Yamada Bee Farm
Beekeeping Division
Hiroto Fujiyoshi



Bees have been designed with an inbuilt ability to build perfect hexagonal shapes which have been shown to be the most efficient use of space. It also makes the comb very strong.
Read more:
http://wiki.answers.com/Q/Why_do_bees_make_a_hexagonal_shape#ixzz1b8EPyT3b

THE END