

Trade of Metal Fabrication

Module 6: Fabrication Drawing

Unit 13: Parallel Line
Development

Phase 2

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Document Release History

Date	Version	Comments
26/02/07	First draft	
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Module 6 – Fabrication Drawing

Unit 13 – Parallel Line Development

Duration – 12 Hours

Learning Outcome:

By the end of this unit each apprentice will be able to:

- State the three main methods of development
- Draw and determine the lines of intersections and true shapes of joints between (i) square and rectangular pipes and (ii) cylinders of equal and unequal diameter
- Produce full size paper templates

Key Learning Points:

Rk	Methods of development - parallel line, radial line, triangulation.
Rk Sk	The right cylinder and prism. (For more information see Module 6 Unit 11).
Rk	Revision of orthographic projection. (For more information see Module 6 Unit 8).
Rk Sk	Joint lines made between (i) equal and unequal diameter cylinders, (ii) square and rectangular pipes.
Sk	Develop patterns and true shapes in square, rectangular and cylindrical pipes. (For more information see Module 6 Unit 11).
Rk Sk	Position of joint lines. (For more information see Module 6 Unit 11).
Rk Sk	Common central sphere and its applications.
P	Presentation and neatness of drawing exercises, accuracy.

Training Resources:

- Classroom, drawing equipment instruments and paper

Key Learning Points Code:

M = Maths **D** = Drawing **RK** = Related Knowledge **Sc** = Science
P = Personal Skills **Sk** = Skill **H** = Hazards

Common Central Sphere

Problems of the Common Central Sphere

Problems of the common central sphere belong to a special class of intersections in which an imaginary sphere is the central form around which two, three, or more cones or cylinders meet or intersect.

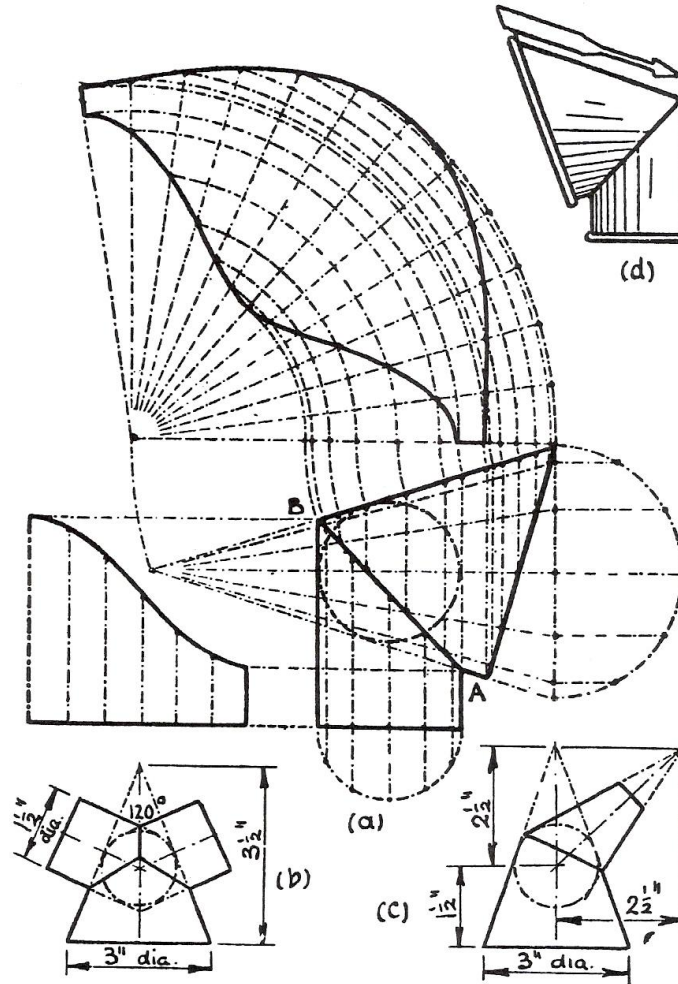


Figure 1 - Problems of the Common Sphere

The essential condition is that the intersecting bodies should be so arranged that their surfaces, if produced, would encircle the sphere. The illustration at (d), Figure 1, represents a revolving cowl for a chimney or fume pipe. It is a combination of a right cone and a cylinder. The developments are shown in the central figure at (a), and it will be seen that the sides of the cylinder just touch, or are tangential to, the central sphere. The sides of the cone also just touch the central sphere. The important point by these conditions is that the line of intersection in the elevation becomes a straight line, as from A to B. The smaller illustration at (b) shows a right cone intersected by two cylinders.

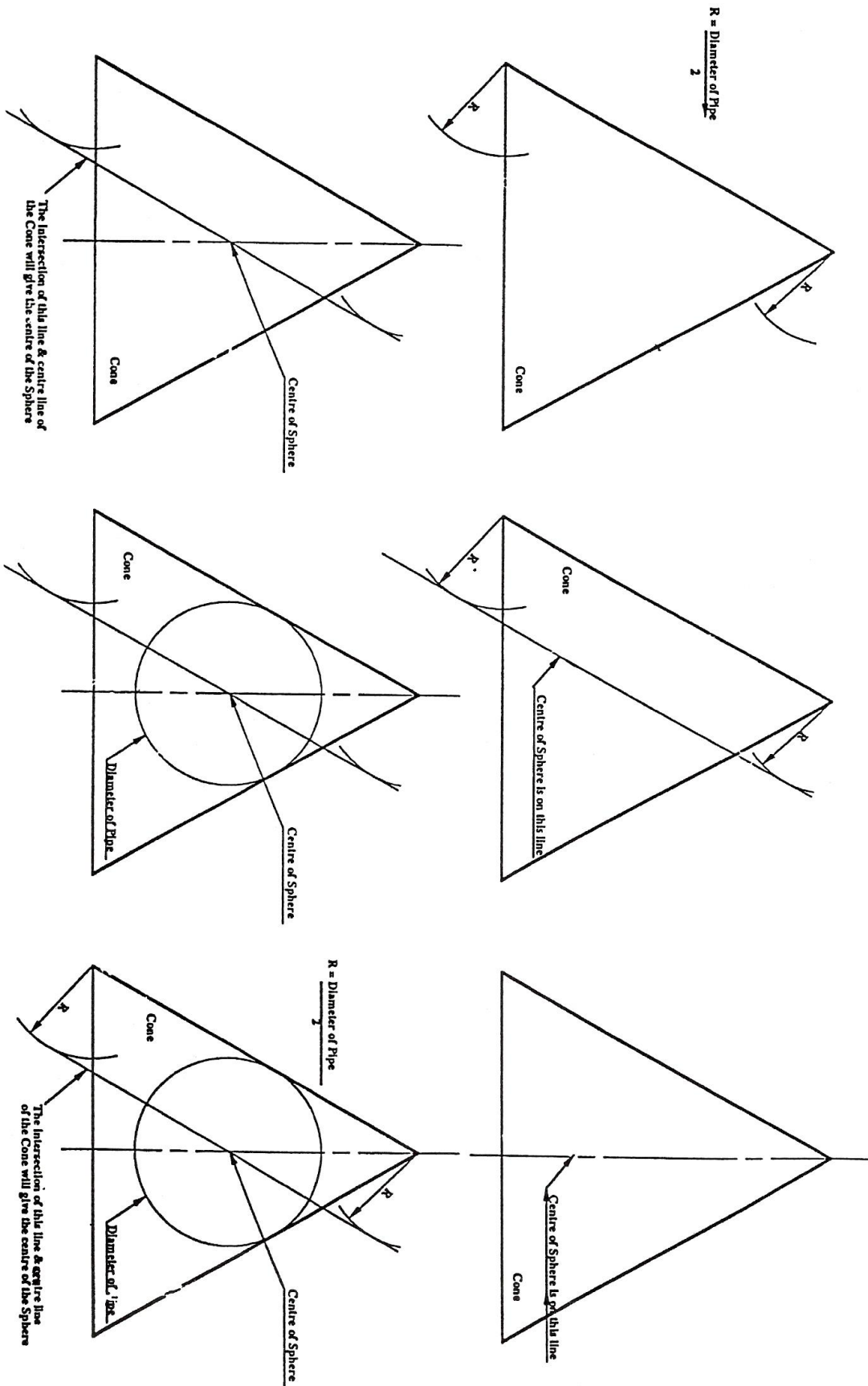


Figure 2 - Common Sphere Method 1

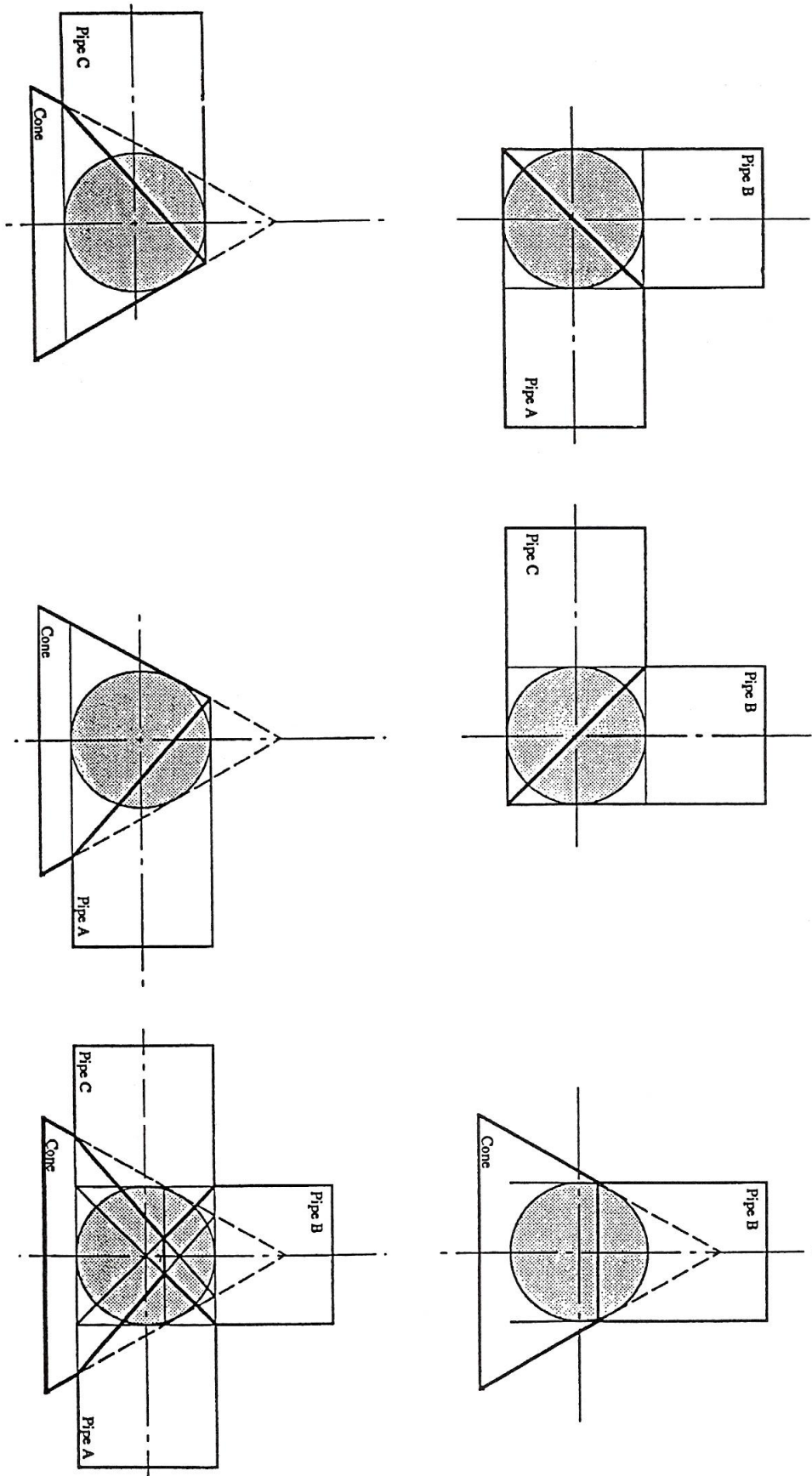


Figure 3 - Common Sphere Method 2

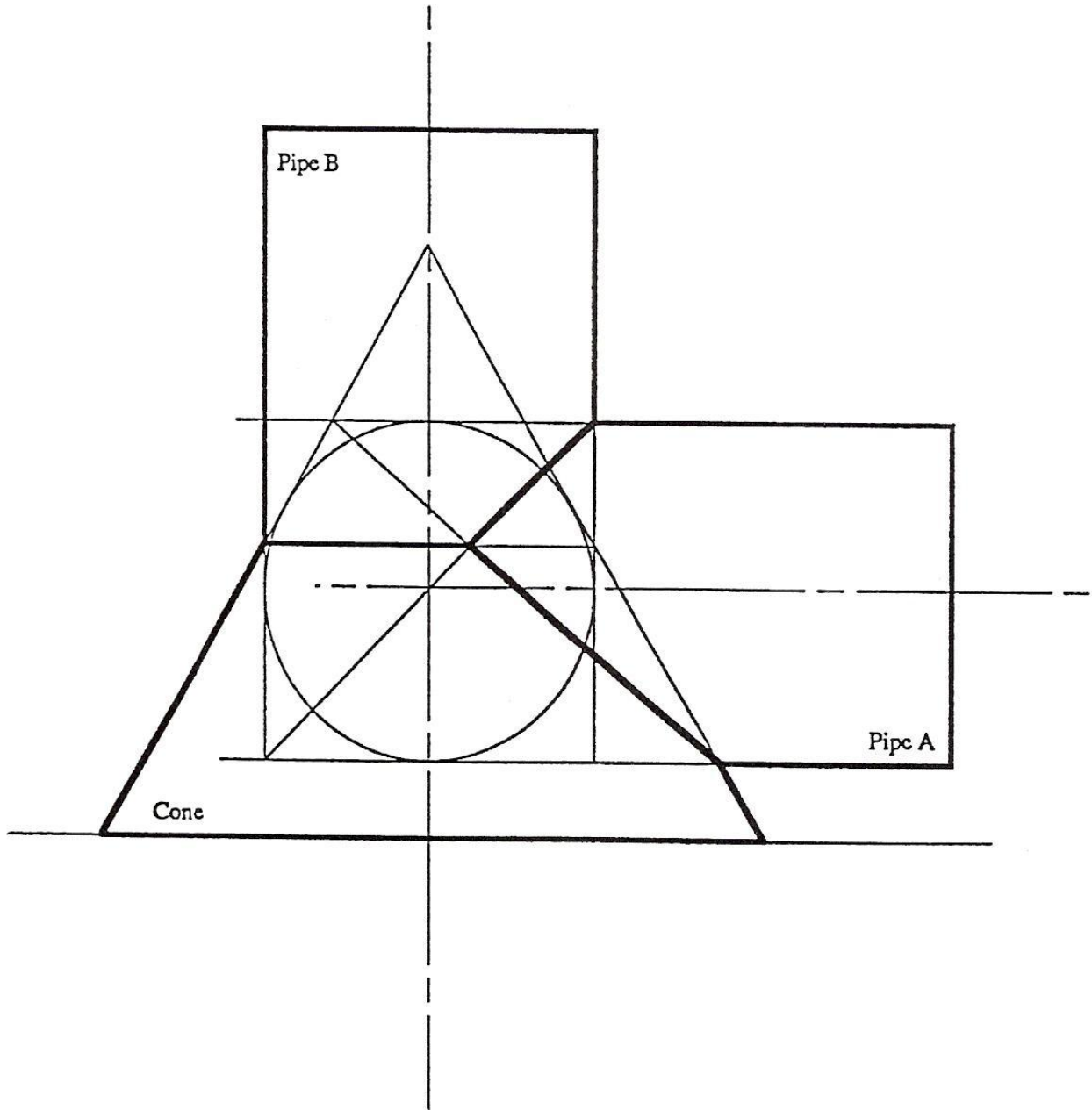


Figure 4 - Common Sphere Method 3

The drawing below shows the elevation of a right cone intersected by two right cylinders; each component has sides tangential to a common central sphere.

Scale – Full size.

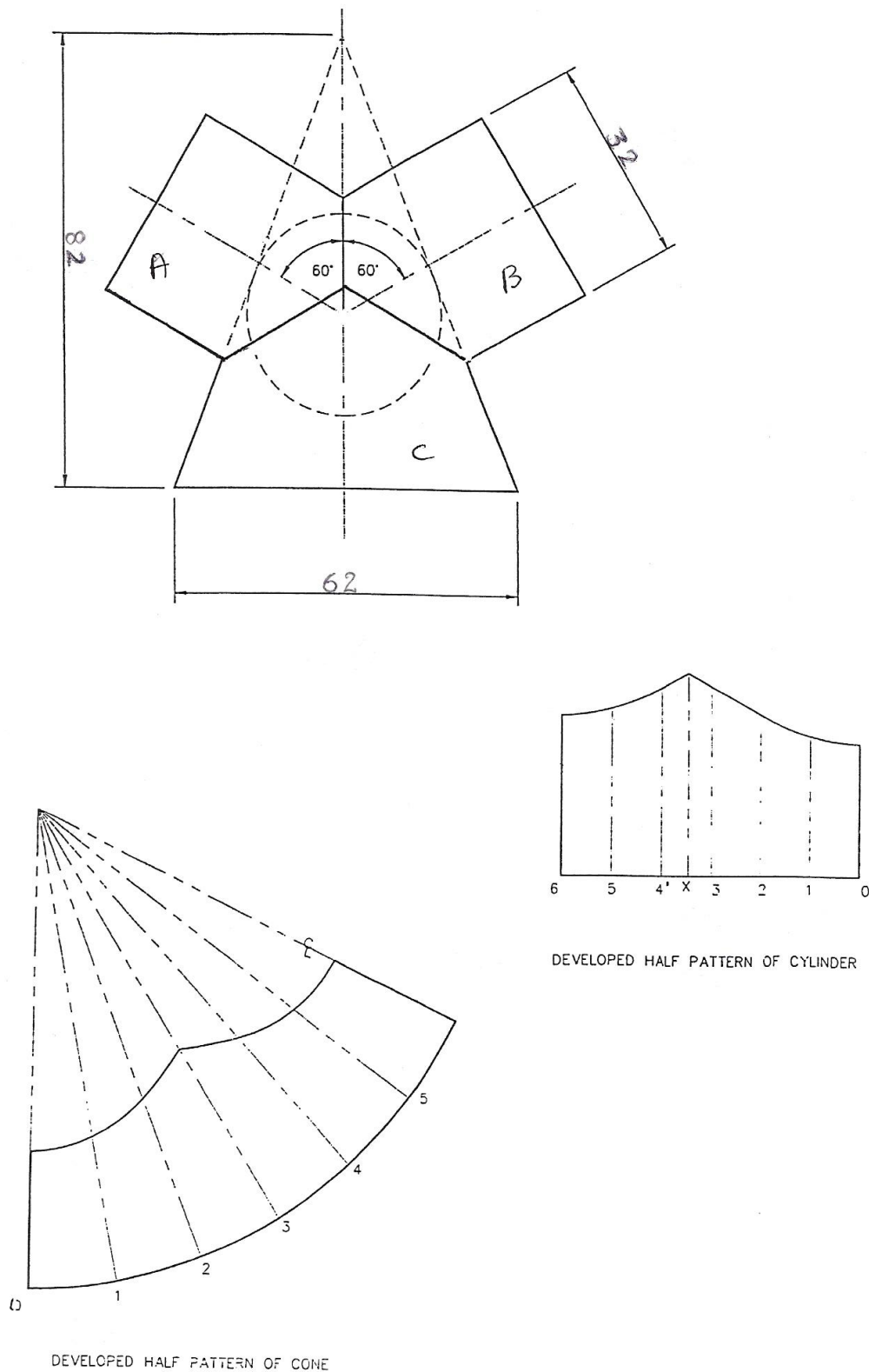


Figure 5 - Elevation of Right Cone Intersected by Two Right Cylinders

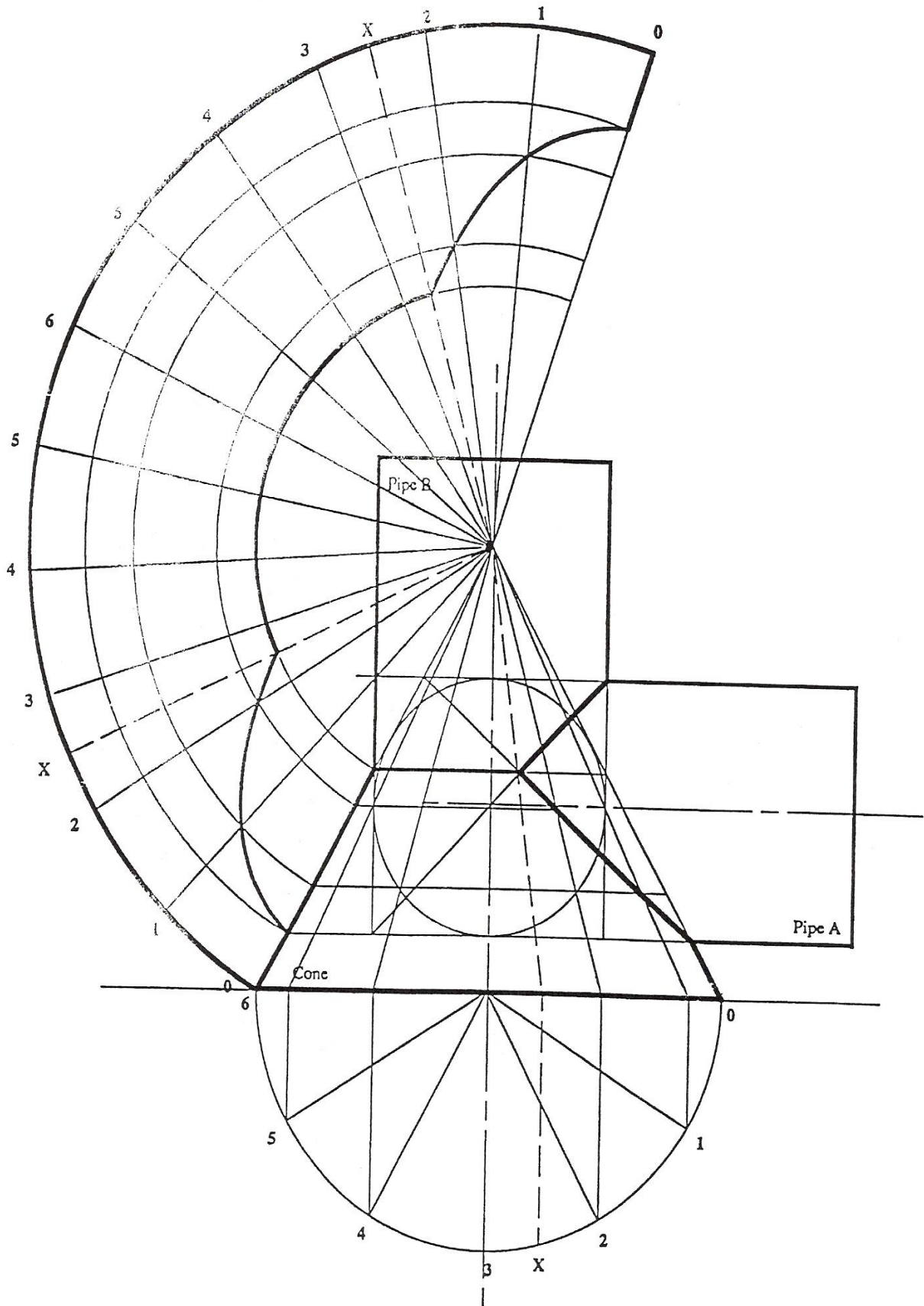


Figure 6 - Right Cone Development

Triangulation

Transformers between Two Parallel Planes

The broad principles of triangulation may be explained in a few words, but skill in the application of those principles cannot be gained in a few moments. The field of application is so broad and the variety of problems so great that fresh posers are continually being encountered.

However, in the early stages, the principles can best be grasped and understood by applying them to a few familiar problems, which, nevertheless, might well be turned round and viewed from slightly different angles. The problems dealt with in the First Course of triangulation are transformers between two parallel planes. The planes, for convenience, will be taken as horizontal.

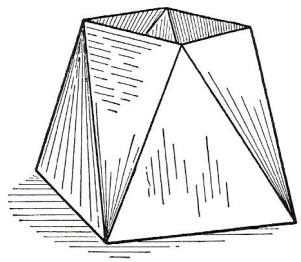


Figure 7 - Transformer

Therefore the top and bottom edges of the transformers will be level or horizontal. The vertical height will be the perpendicular distance between the two planes, and will be represented by a line drawn at right angles to the base from the top of the body (see Figure 8).

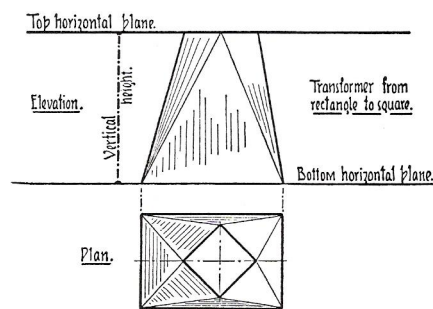


Figure 8 - Transformer Elevation and Plan

It will be observed that, by these conditions, every line drawn on the surface of the body from the top to the bottom will have the same vertical height. This, in the early stages, has the advantage of simplifying the work, since only one vertical height is needed in the elevation to serve for all the lines on the surface of the transformers. The plan will give all other details necessary for obtaining the pattern.

Twisted Square Transformer

One of the simplest and best examples to illustrate the principles of triangulation is afforded by the square-to-square transformer, in which the square at one end is placed diagonally to that at the other. In practice this occurs as a twisted connecting piece between two square pipes or portions of a duct, as shown in Figure 7 and Figure 9. Its surface is made up of flat triangles, with corners bent along the edges.

To develop the pattern, first draw the plan, showing the two squares placed in the correct positions in relation to each other, as in the plan above the pattern at (a), Figure 9. A full elevation may be drawn if desired, but only the vertical height line will be needed, and should be set off, with the horizontal base line extended to any convenient length, as shown in the elevation at (a), Figure 9. The corner points in the plan should now be numbered, beginning at the seam, as at 1,2,3,4,5,6,7,8,9. As already stated, every line forming the triangles in the pattern must be a true length. It will be observed that, in Figure 9, the distances round the bottom square, 1,3; 3,5; 5,7; 7,9; 9,1; and also the distances round the top square, 2,4; 4,6; 6,8; 8,2; are already true lengths in the plan, because they are horizontal, and possess no vertical height. On the other hand, the distances 1,2; 2,3; 3,4...8,9; 9,2; which pass up and down between the top and bottom, do not represent true lengths. In order to obtain the true lengths of these lines, the distances from the plan must be triangulated against the vertical height.

Thus, for the first triangle in the pattern, take 1,2 from the plan and mark it off along the base line from the foot B of the vertical height. Then take the diagonal from the point 2 on the base line to the top T of the vertical height, and mark off this distance on the line 1',2' in the pattern. Next take 2,3 from the plan and mark it off along the base line at right angles to the vertical height; take the diagonal from the point 3 on the base line to the top T of the vertical height, and from the point 2' in the pattern swing off an arc through the point 3'. Now take the true length line 1,3 direct from the plan, and from the point I' in the pattern describe an arc cutting the previous arc in 3'. Join 1',3' and 2',W. For the second triangle, place the plan length 3,4 at right angles to the vertical height, take the diagonal, and from point 3' in the pattern, swing off an arc through the point 4'. Take the true length 2,4 from the plan and describe an arc cutting the previous arc in point 4'. Join 2',4' and 3',4'.

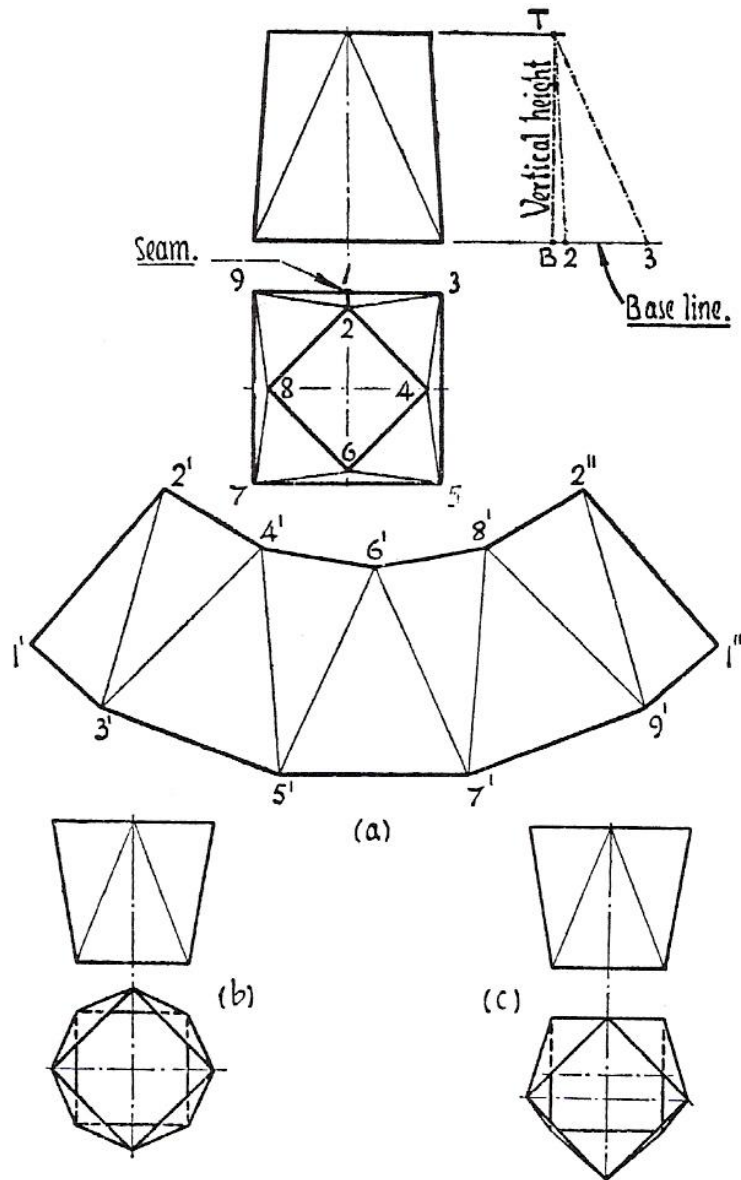


Figure 9 - Transformer

For the third triangle, repeat this process with lines 4,5 and 3,5. For the fourth, and remaining triangles, the process is repeated until the final triangle is completed.

It will be seen that the plan lengths of 2,3; 3,4;... 8,9; 9,2; are all equal. Therefore the distance B,3 on the base line serves for all of them. The true lengths also are all the same. This condition occurs when the top square is placed concentrically over the bottom, but in a case such as that shown at (c), Figure 9, where the top square is off-centre with the bottom square, the plan lengths will vary, as also will the true length. The example shown at (b), Figure 9, represents the top and bottom squares of the same size. The development of this transformer is carried out in a similar manner to that of (a), although it is interesting to note that the pattern is actually a simple rectangle, having a length equal to the perimeter of one of the squares.

Triangulation

This method is used to develop patterns of components, which would be difficult or impossible to develop, using either the parallel line or radial line methods.

TRANSITION pieces, which join together ducts that have different cross-sections, may be developed using triangulation as shown in the following examples.

The pictorial view below shows a transition piece that connects two square sections between parallel planes.

The vertical line V is the height of line 1 as seen in the front view below.

The horizontal line H is the length of line 1 as seen in the plan view below.

The angle between V and H must be 90° .

Method: The surface area of the component is divided into a series of triangles.

Line 3 is a true length because it is parallel to the horizontal plane.

Line 1 is not a true length in either the front view or plan because it is not parallel to the vertical plane in either the front view or the plan view.

Line 2 is not a true length in either the front view or plan for the same reason.

To find the true length of line 1.

Project the vertical height of line 1 (V) from the front view to the right.

Step off the length of line 1 from the plan (H) along the base line.

The hypotenuse of the triangle thus formed is the true length (1T) of line 1. In this example it is also the true length (4T) of line 4.

Using the same construction, verify the true length (2T) of line 2.

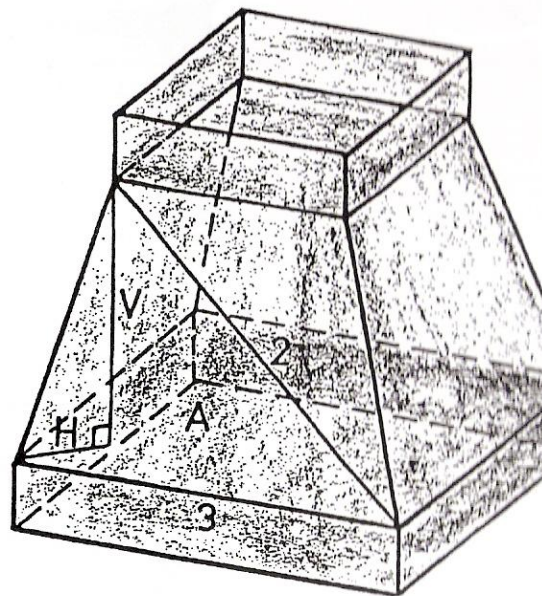


Figure 10 - Triangulation

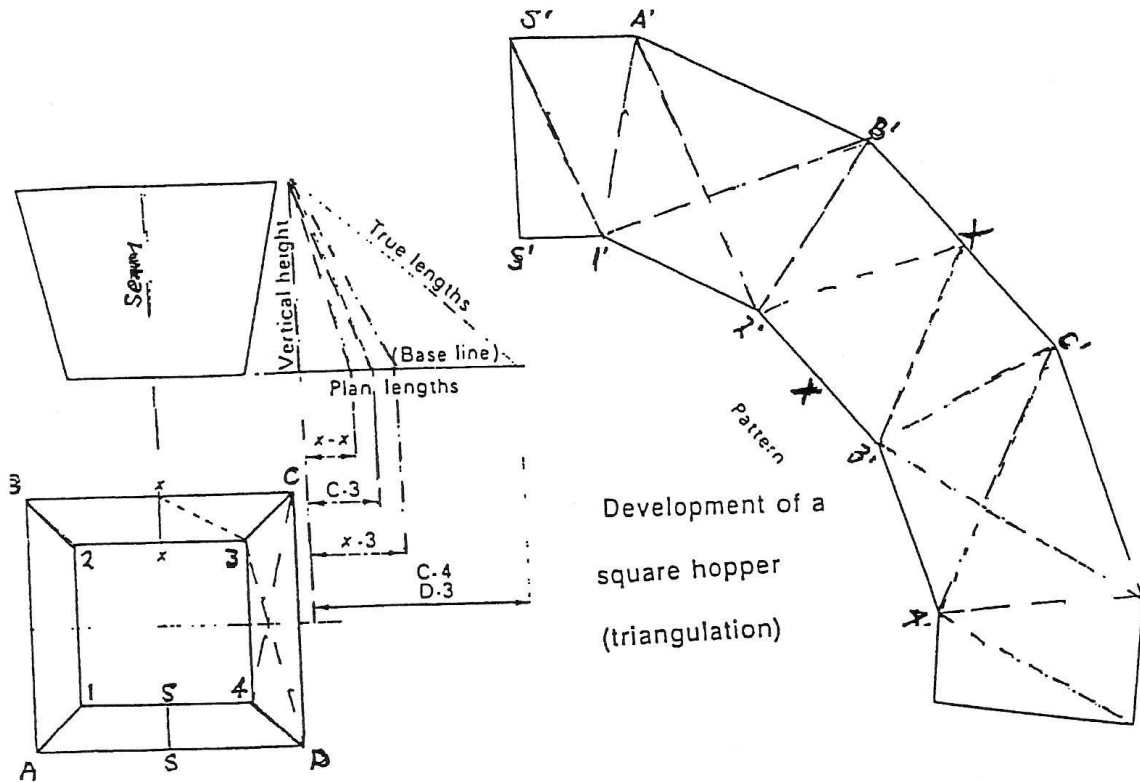


Figure 11 - Development of a Square Hopper

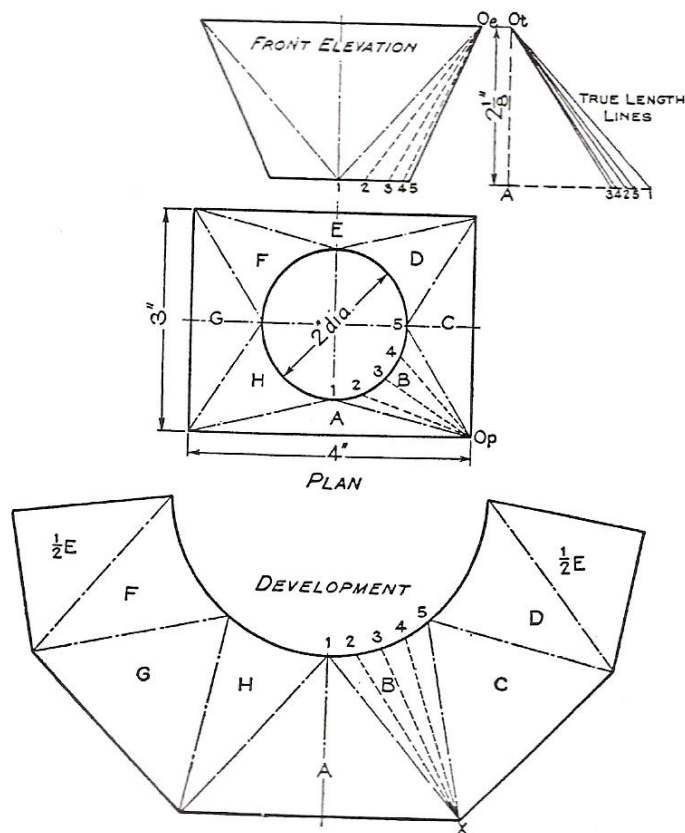


Figure 12 - Transition Piece Development

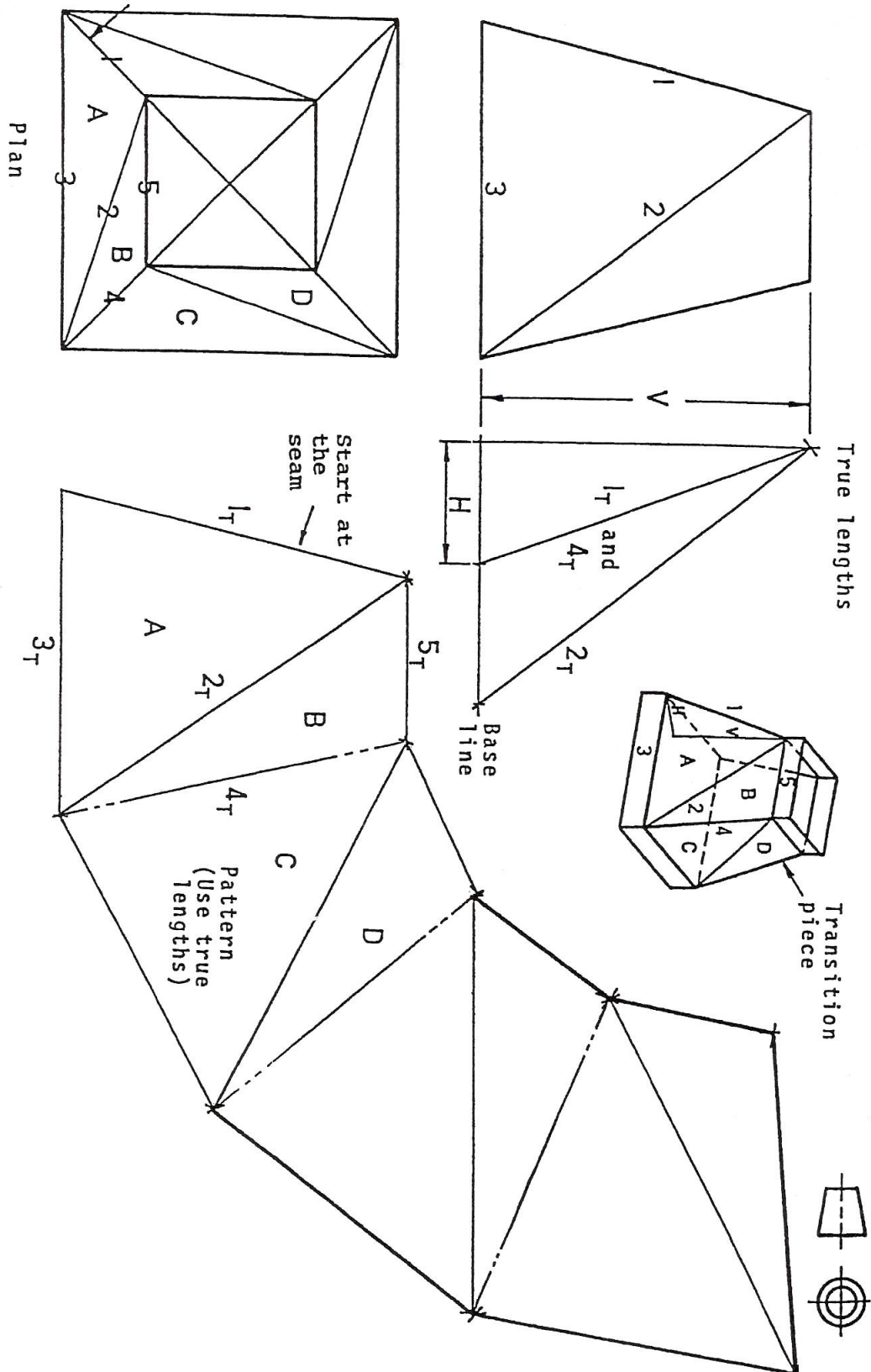


Figure 13 - Square to Square between Parallel Planes

Always number the lines on the line or near to the line. Of the lines numbered only 3 and 5 are true lengths in the plan view.

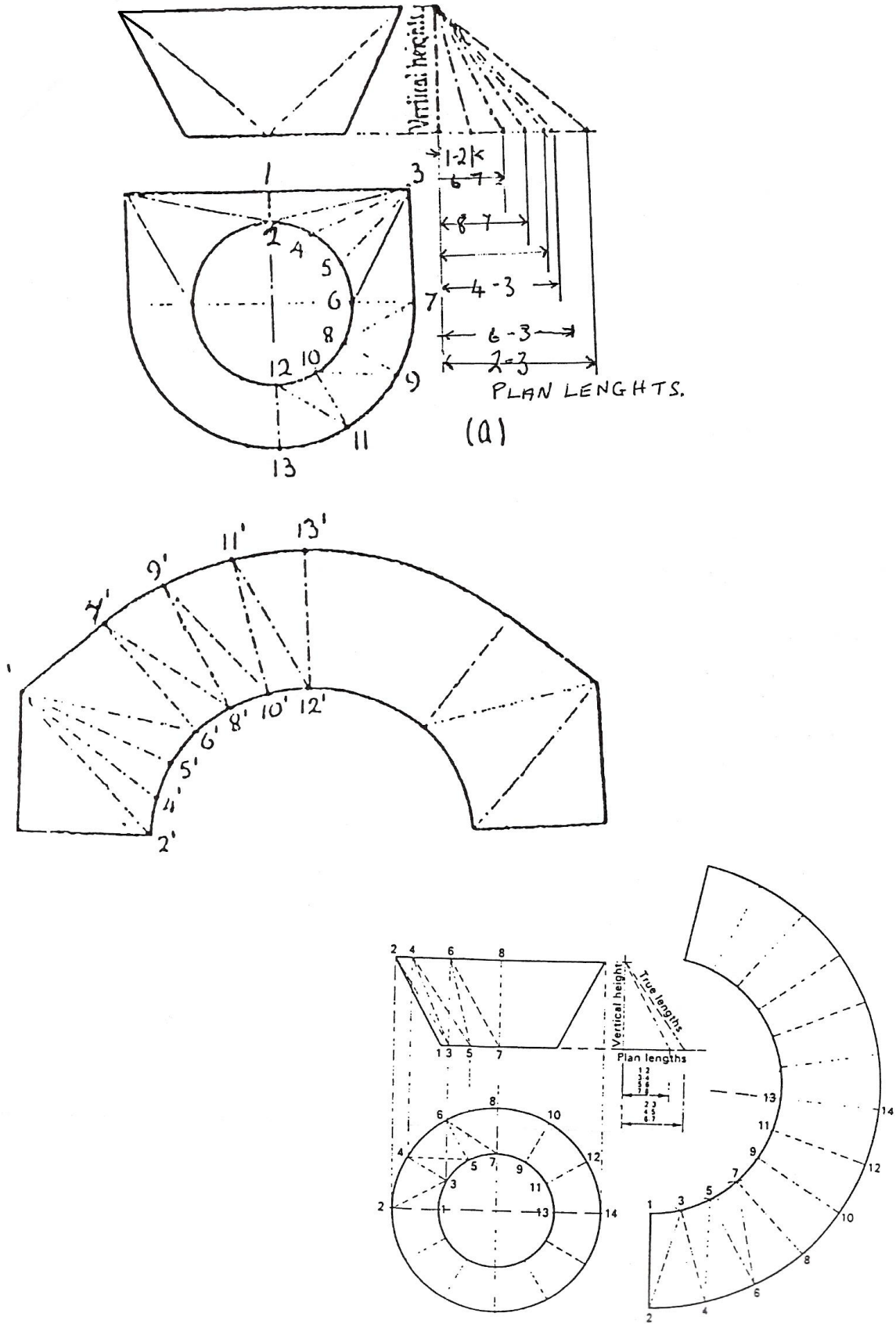


Figure 14 - Triangulation

Radial-Line Development

Development by Radial Lines

The sides, or the sides produced, of any object belonging to the class of pyramids, and the cone in particular must converge to an apex. Given that condition, it is possible to define a series of lines radiating from the apex down the sides of the pyramid to the base. It is further possible to unfold the surface so that it lies in a flat plant with the lines all radiating from one point, which was the apex.

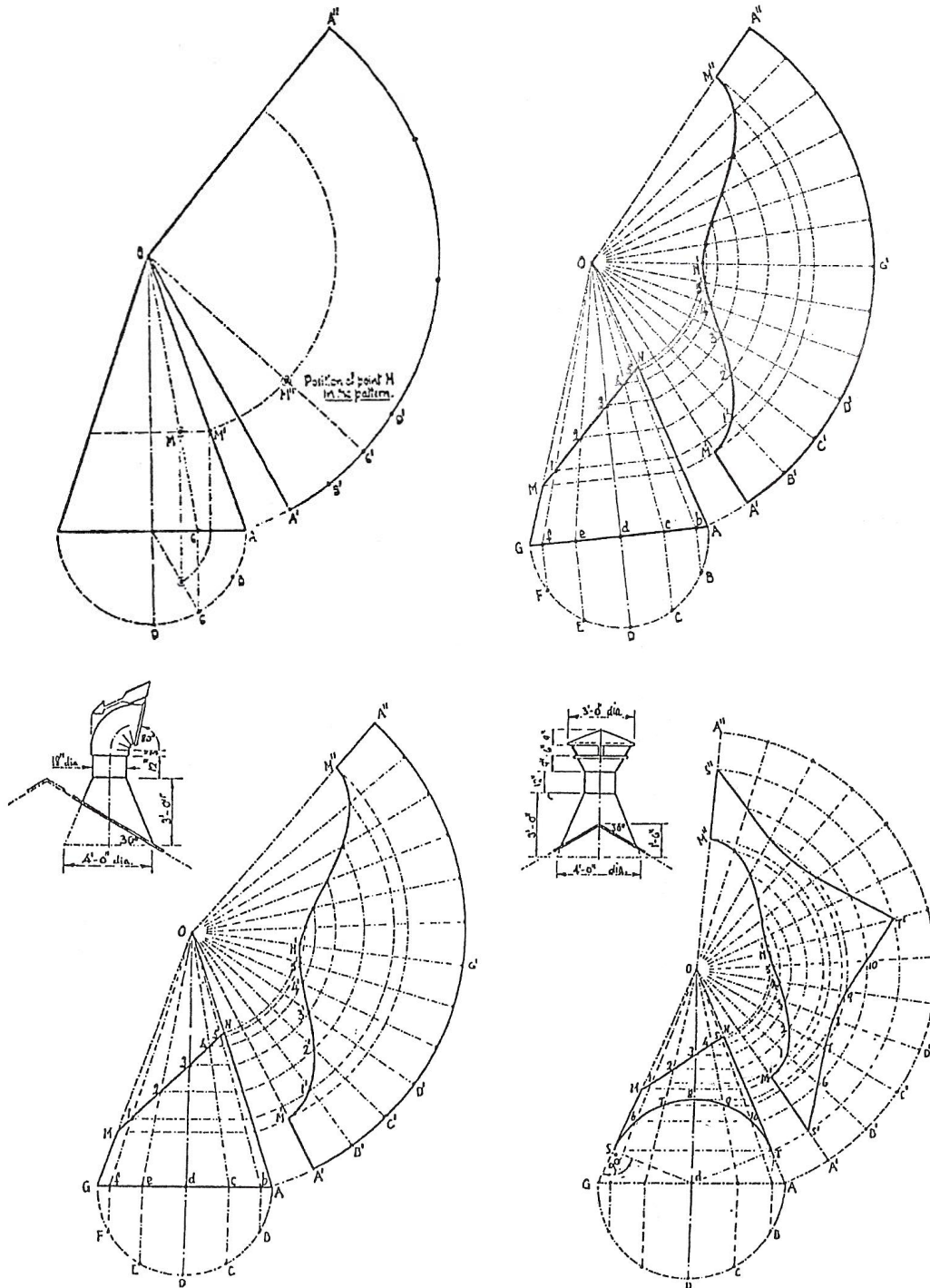


Figure 15 - Development by Radial Lines

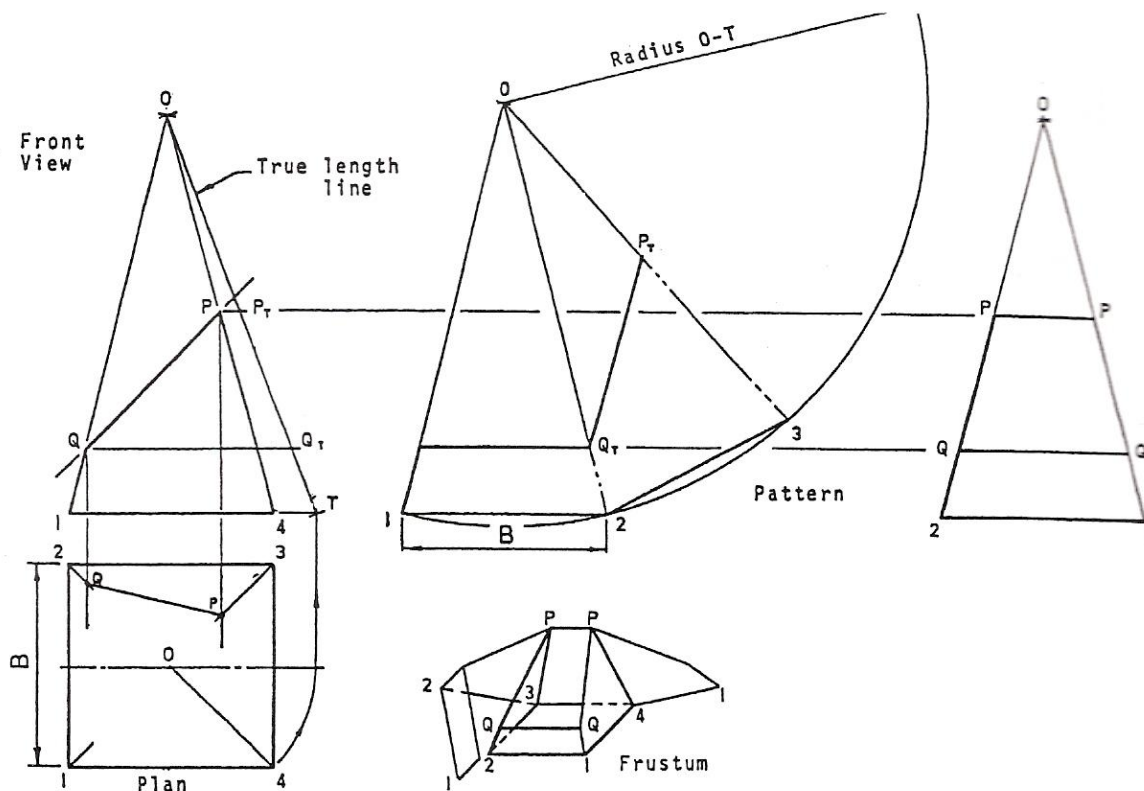


Figure 16 - Pyramid

When a pyramid is positioned as shown above, length 0-1 is not the true length of the sloping edges of the pyramid.

The true length of the sloping edge is found by swinging the plan view of one of the edges, 0-4, to the horizontal and projecting to the front view as shown. 0-T is the true length of all four sloping edges.

As an aid to visualising the shape of frustum of the pyramid the construction of the side and plan views is illustrated. The side view and plan view are drawn projecting from the front view as shown.

FRUSTUM of a right square-based pyramid.

RADIAL line development.

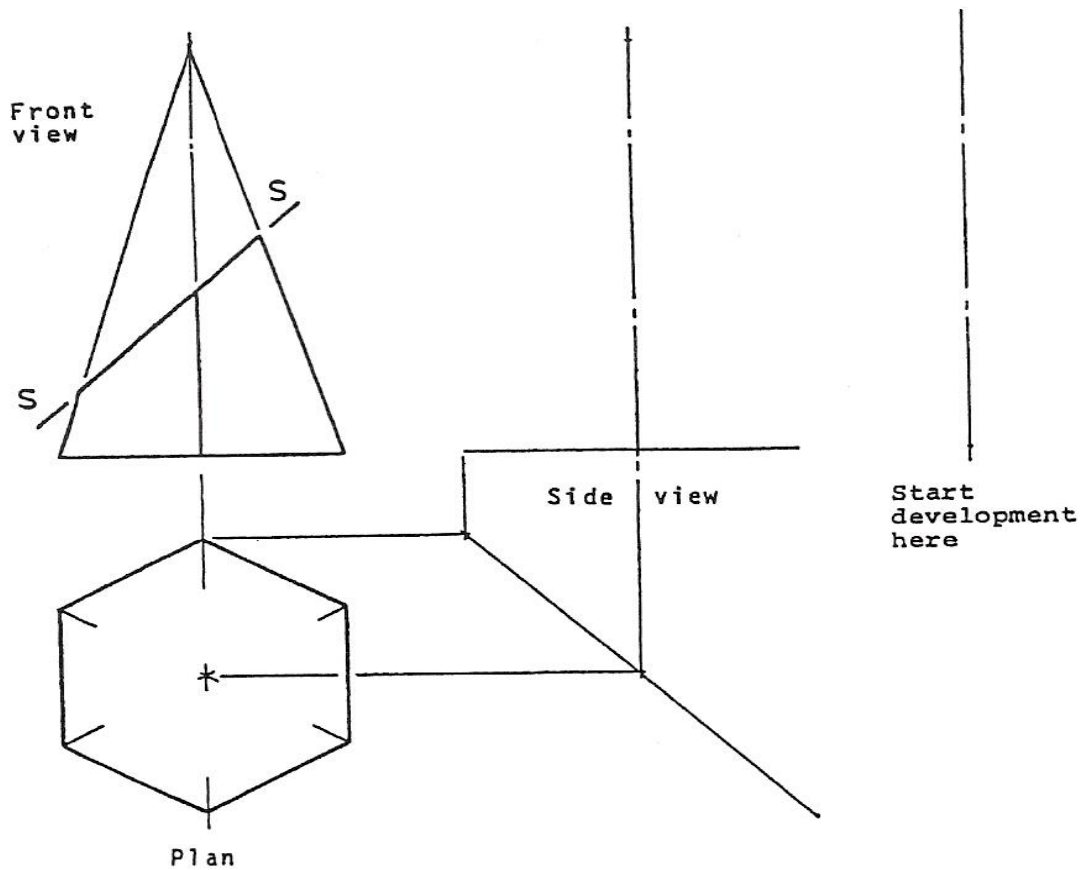


Figure 17 - Frustum of a Pyramid

1. Draw the left-hand side view of the frustum in the space provided and complete the plan.
2. Construct the pattern for the surface of the frustum below section plane SS. Omit the base.

FRUSTUM OF A PYRAMID
 WITH A HEXAGONAL BASE
 RADIAL LINE DEVELOPMENT

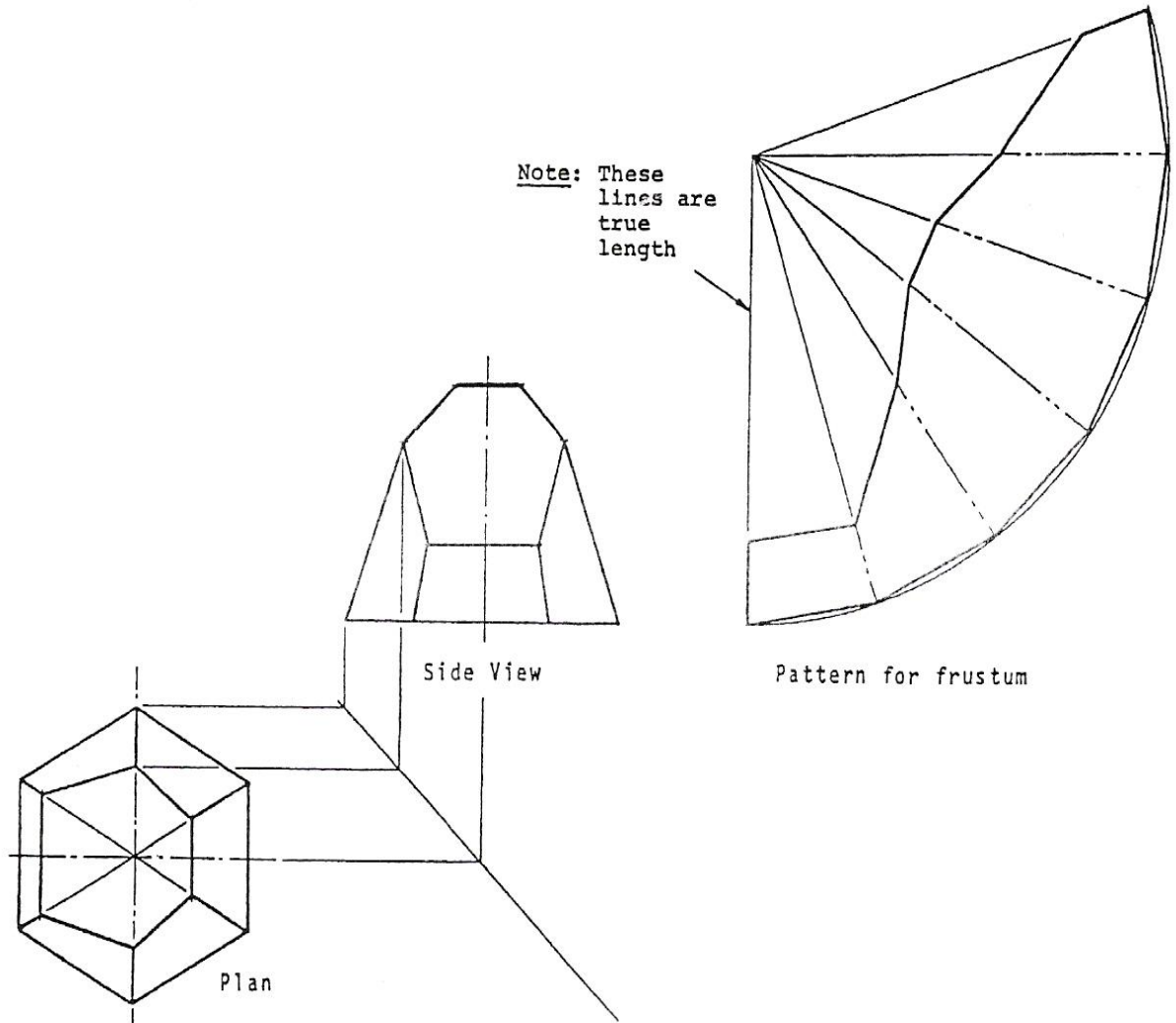


Figure 18 - Pattern for Frustum

Parallel-Line Development

Parallel line development and also joint lines made between: equal and unequal diameter pipes.

Note: Joint lines are almost always on the shortest side. (A shorter seam to weld).

Interpenetration

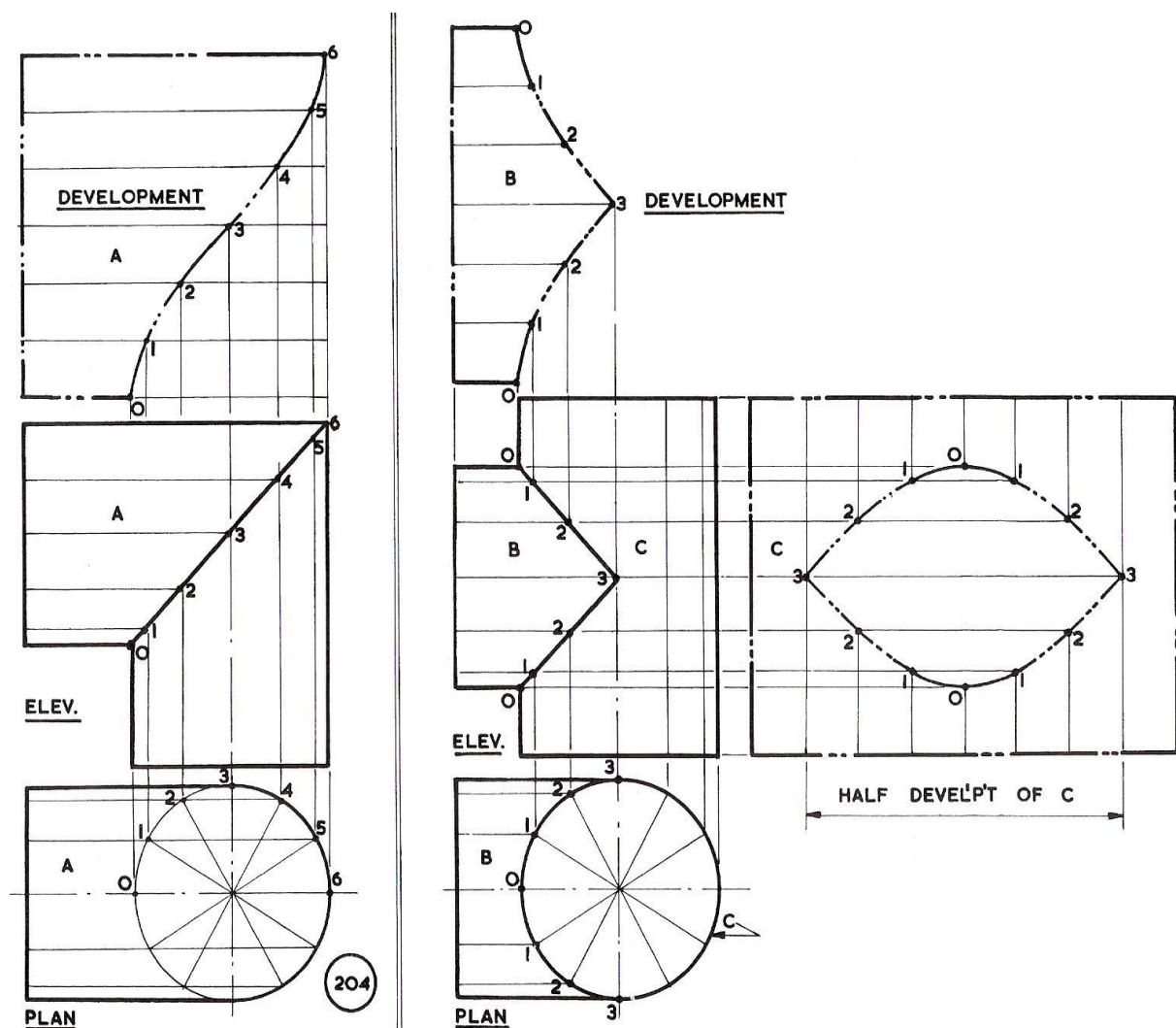


Figure 19 - Cylinder Interpenetration

204. Elbow Two cylinders of equal diameter meeting at right angles. First angle projections are given. The circle of the cylinder is divided into twelve parts by setsquare, and the generators projected into the elevation. Since the two cylinders are of equal diameter, the same projectors will do for both cylinders. The line of intersection will be a straight line.

The development of A piece is best projected in line with its cylinder as shown. The divisions of the opened out cylinder may be chordal, from the cylinder circle; or may be calculated $3\frac{1}{7} \times D$. The labelled points of intersection 0, 1, 2, 3, 4, 5, 6, are projected to the cylinder development, to cut the respective generators. A fair curve through the points completes the development, which is symmetrical and only half is shown.

205. Tee Junction of two equal diameter cylinders. First angle plan and elevation are given. Proceed as above, dividing the circle into 12 parts for projecting generators whose intersections give the line of the interpenetration. Part B is developed in line as before. Part C is developed also in line with its cylinder; the points on the intersection line being projected to the respective division. Note the shape of the hole in cylinder C.

206. Equal Cylinders at Right Angles First angle views of the interpenetration are given; note the crossed straight line of the intersection. Draw the construction circle and the generators. Develop the one piece only, as all the four portions are equal. Only a half portion is shown.

The above diagram should be drawn to any convenient size: a diameter of 50 to 80 mm would be suitable.

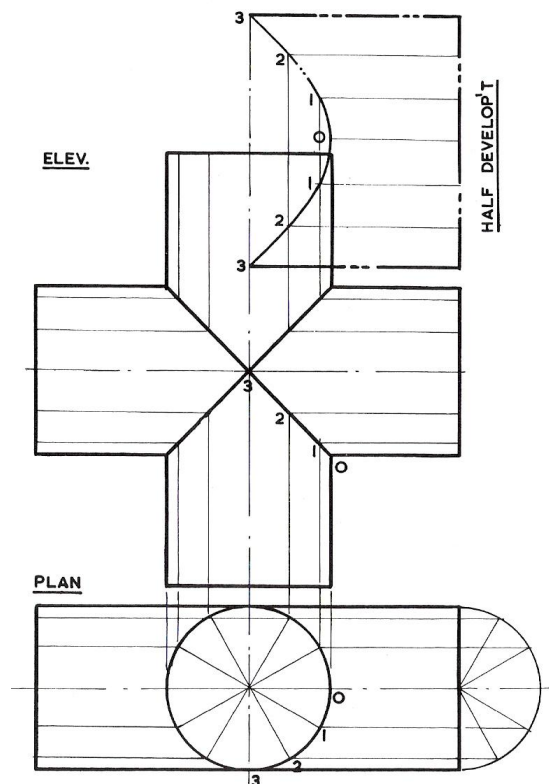


Figure 20 - Equal Cylinders at Right Angles

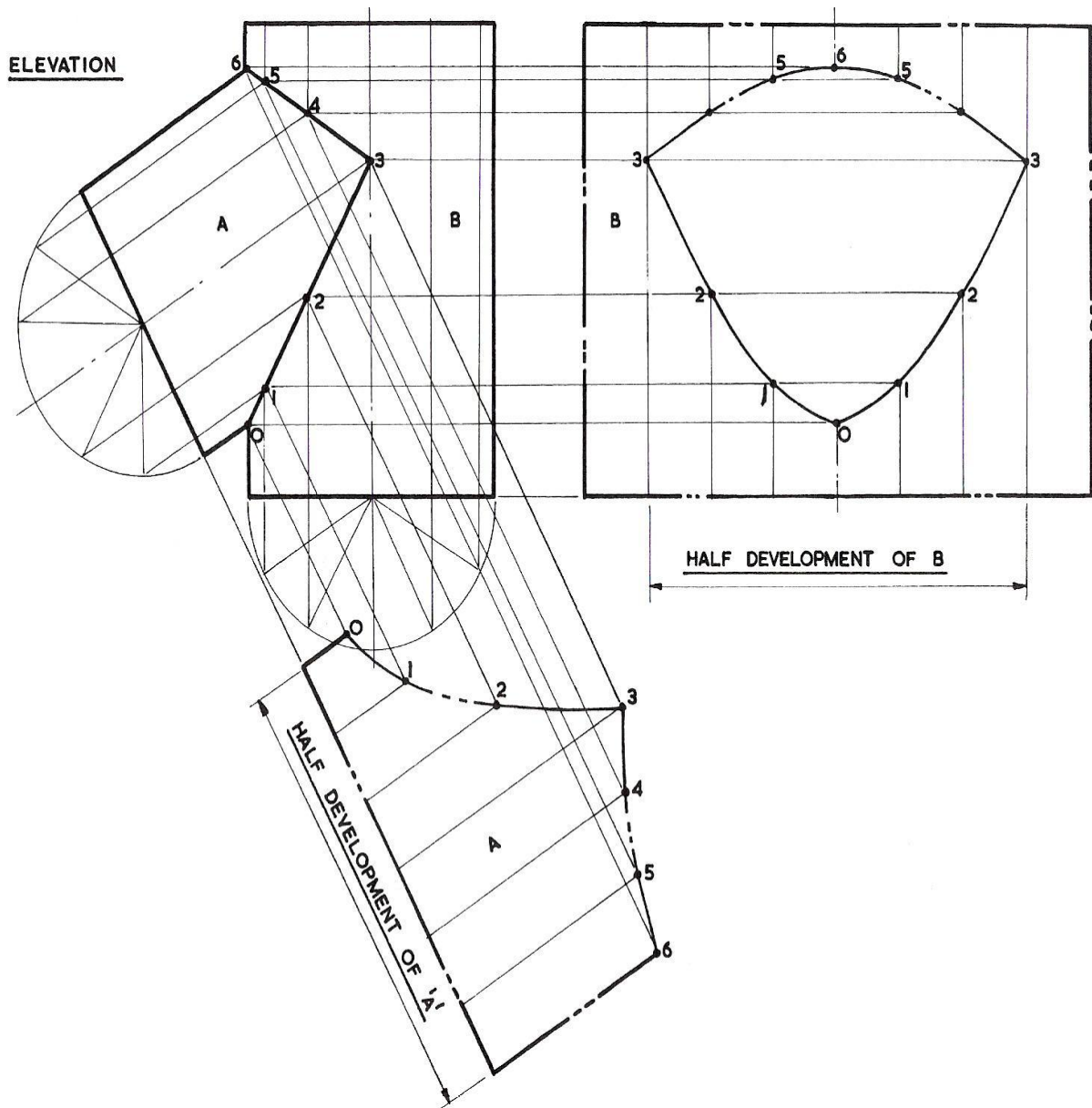


Figure 21 - Two Equal Cylinders Angle Interpenetration

207. Two Equal Cylinders at an Angle First angle views are given to two equal diameter cylinders, which interpenetrate at an angle of 60° . When the axis lines lie in the same plane, the term 'coaxial' is applied.

Draw the given views to a convenient size. Draw the constructional semicircles; project the generators to obtain the line of intersection. The development of A piece should be in line with its cylinder as shown. The development of B piece should be in line with its cylinder. Note the shape of the aperture in B.

208. Three Cylinders Interpenetrating at 120° The first angle views of the interpenetration are given. Draw the constructional circles and generators. This gives the straight-line intersection. Project the development in line with one of the cylinders. A symmetrical half-portion only is shown.

The above developments can be made using diameters of 50 mm to 80 mm, and can be constructed in thick paper and pasted together after adding pasting flaps.

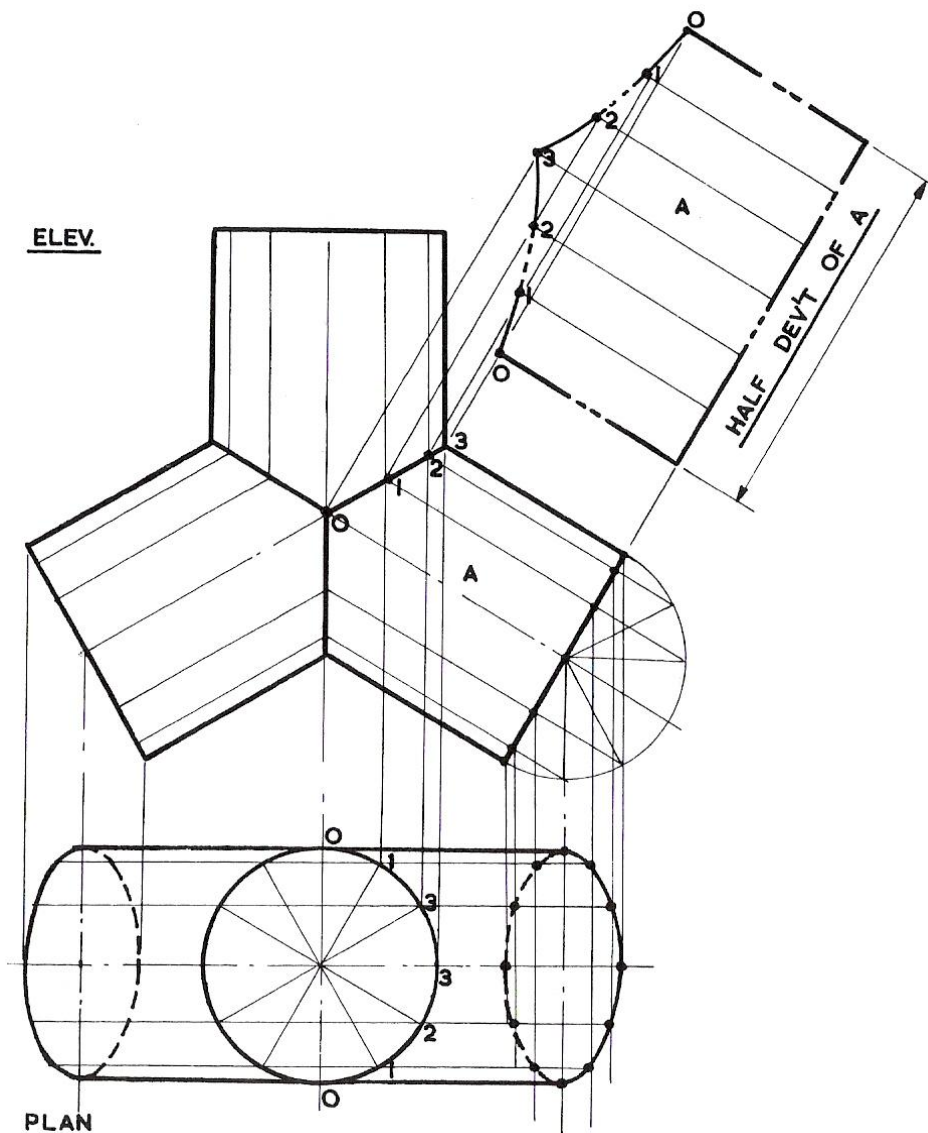


Figure 22 - Three Cylinders at 120°

209. Two Cylinders of Unequal Diameters at right angles first angle views of the interpenetration are given. Draw the given views; draw the constructional semicircles and the generators of the smaller diameter cylinder. Project the points of intersection with the larger cylinder 0, 1, 2, 3, to the elevation, meeting the respective generators there. Draw a fair curve through the points of intersection in the elevation. The development of B can now be projected in line with B cylinder.

The development of the larger cylinder should be projected in line with its cylinder. Note that chordal widths can be taken from the plan at 3, 2, 1, 0, for use on the opened out cylinder to intersect with projectors from the elevation. The penetration is co-axial.

210. Angled Coaxial Interpenetration of two unequal diameter cylinders. Plan and elevation in first angle projection are given. Draw the views, constructional semicircles, and generators of the smaller cylinders. Label the points of intersection in the plan. Project these to the elevation to give the line of intersection of the two cylinders. Project the development of B cylinder in line with its cylinder, as shown.

Project the development of the larger diameter cylinder in line; chordal widths must be taken from the plan for use on the development. Note that the two apertures are identical.

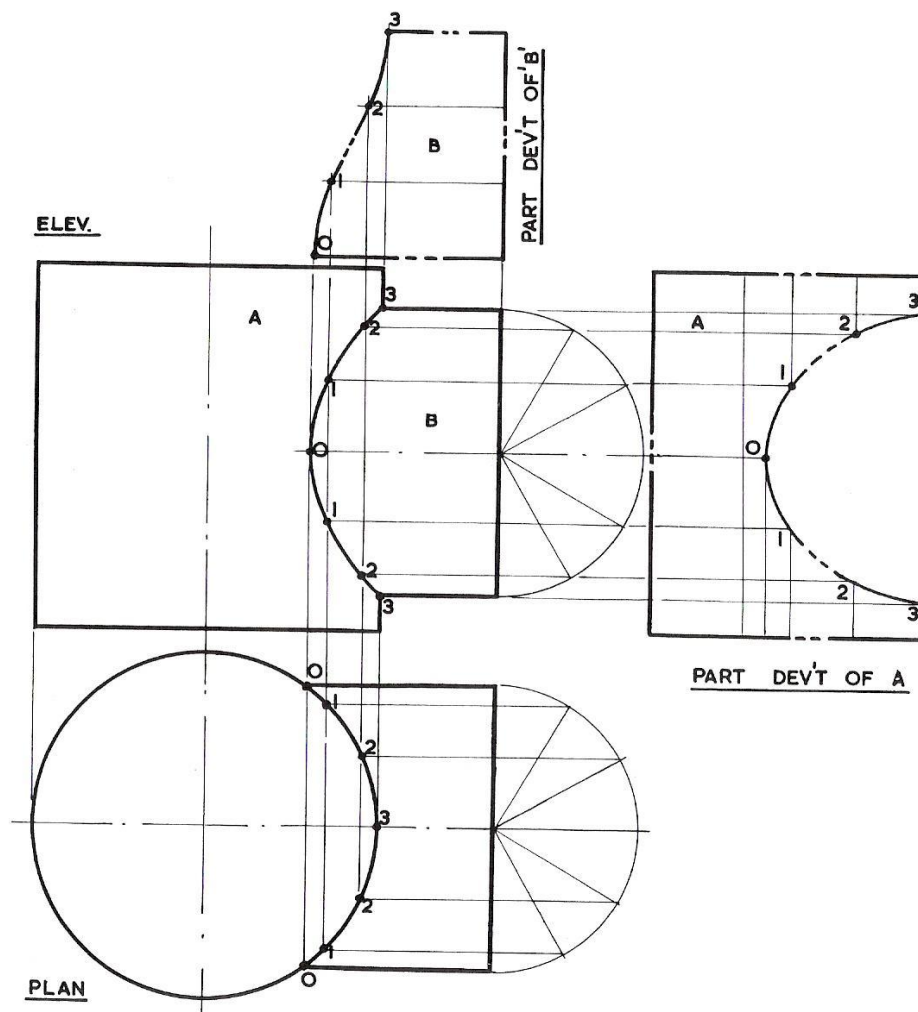


Figure 23 - Two Cylinders of Unequal Diameters

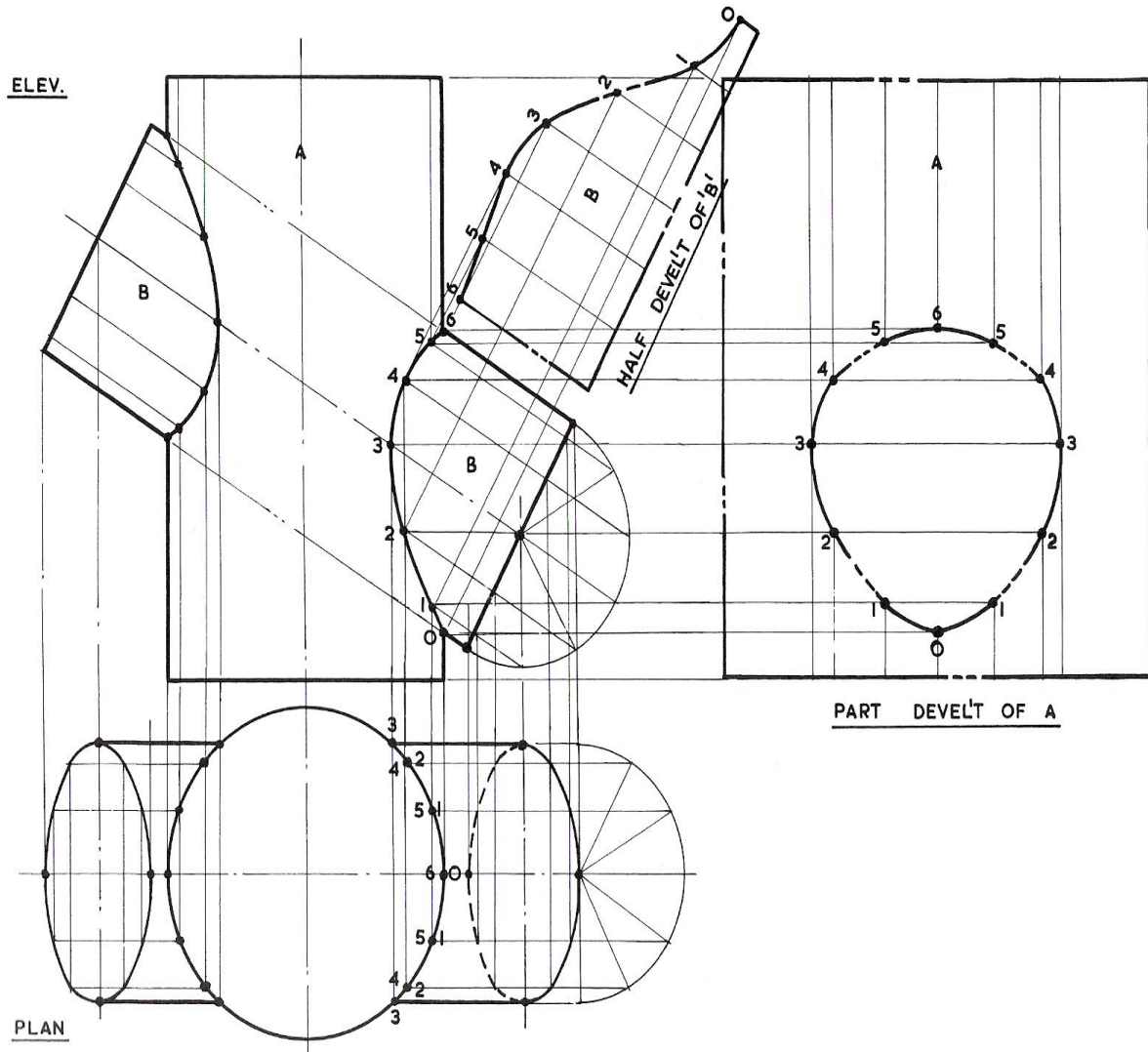


Figure 24 - Two Cylinders Unequal Diameters Angled

211. Offset Interpenetration of Two Unequal Cylinders First angle views are shown of the interpenetration of two cylinders of unequal diameters, whose axes are not in the same plane, and so are said to be 'offset'.

Draw the plan and elevation; draw the constructional semicircles and generators of the smaller cylinder. Label the points of intersection in the plan, and project to the elevation. Draw the curve of intersection. Project part B in line with its cylinder. Project the development of A in line with its cylinder. Chordal widths must be taken from the plan to be used on the development. Note the shape of the aperture.

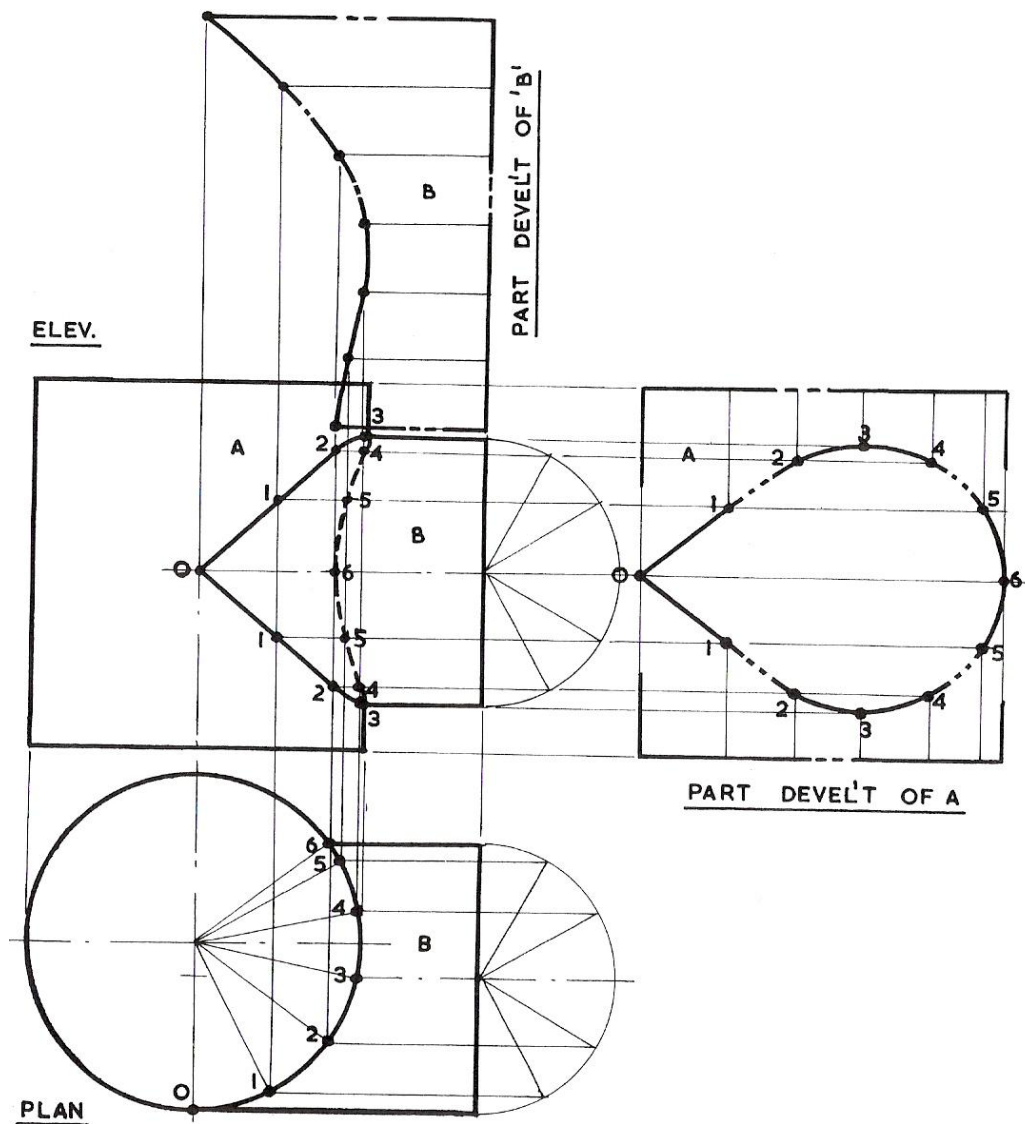


Figure 25 - two Cylinders Unequal Diameters Offset

Self Assessment

Questions on Background Notes – Module 6.Unit 13

No Suggested Questions and Answers.

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