Trade of Metal Fabrication

Module 3:	Plate Fabrication
Unit 12:	Duct Sections
	Phase 2

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Document Release History

Date	Version	Comments
22/12/06	First draft	
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Module 3 – Plate Fabrication

Unit 12 – Duct Sections

Duration – 17 Hours

Learning Outcome:

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

- Read and interpret drawing
- Mark out, shear, oxy fuel gas cut, drill, assemble and weld a section of duct

Key Learning Points:

Sk Rk	Setting out angles.
Sk	Bending brake press.
Rk	Economic use of material. *(Also see Module 3 Unit 7).*
Sk Rk	Angle iron - cutting marking.
Sk Rk	Flanges - marking, assembly, accuracy. *(Also see Module 3 Unit 11).*
Sk Rk	Assembly procedures - distortion - bracing. *(Also see Module 2 Unit 4).*
Rk	Fundamental dimensions.
Sk	M.M.A. - tacking and welding.
Rk	Interpretation of weld symbols.
Rk	Safety procedures - cutting, drilling, welding. *(Also see Module 1 Unit 10).*
P	Standard and presentation of work.

Training Resources:

- Fabrication workshop facilities
- Apprentice tool kit
- P.P.E.
- M.M.A. plant and consumables
- Materials as stated on drawings

Key Learning Points Code:

M = Maths D= Drawing RK = Related Knowledge Sc = Science

P = Personal Skills Sk = Skill H = Hazards

Constructing Angles

1. Drawing 1, Figure 1 - Construct an angle of 60 degrees. Bisect to obtain 30 degrees.

2. Drawing 2 - Construct an angle of 60 degrees.
   Bisect to obtain 30 degrees. Bisect to 15 degrees.

3. Drawing 3 - Construct an angle of 120 degrees.
   Bisect the angle between 60 degrees and 120 degrees to obtain an angle of 90 degrees.

4. Drawing 4 - Construct an angle of 90 degrees.
   Bisect it to obtain an angle of 45 degrees.

5. Drawing 5 - Construct an angle of 90 degrees.
   Bisect between 90 and 180 degrees to obtain an angle of 135 degrees.

6. Drawing 6 - Bisect the angle between 90 and 120 degrees to obtain art angle of 105 degrees.

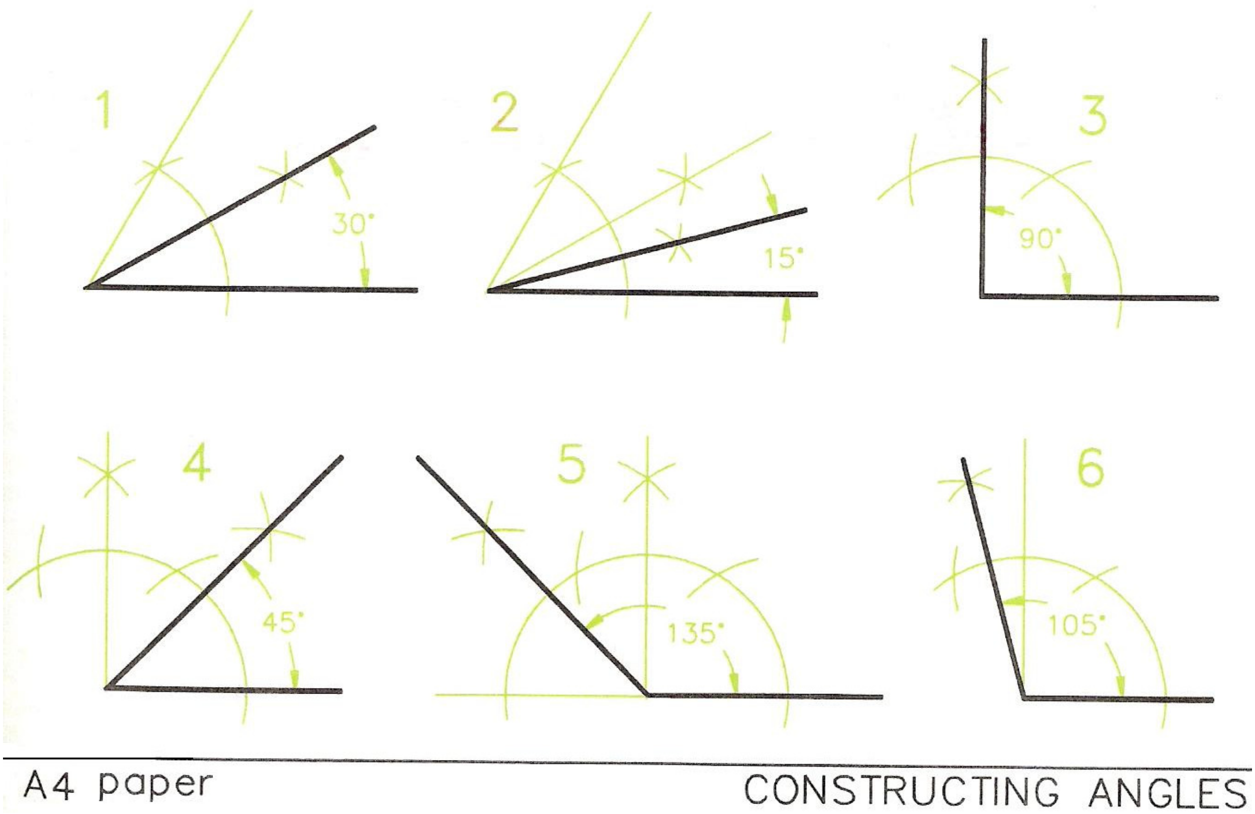


Figure 1 - Constructing Angles

Constructing an Angle with the Aid of a Protractor

Figure 2 shows the method of constructing an angle of 74 degrees with the aid of a protractor.

1. Draw the base line of the angle.

2. Place the protractor in position on the line with the protractor cross lines on the end of the line.

3. Make a light pencil mark against the figures of the angle to be drawn.

4. Draw a line from the end of the base line through the pencil mark.

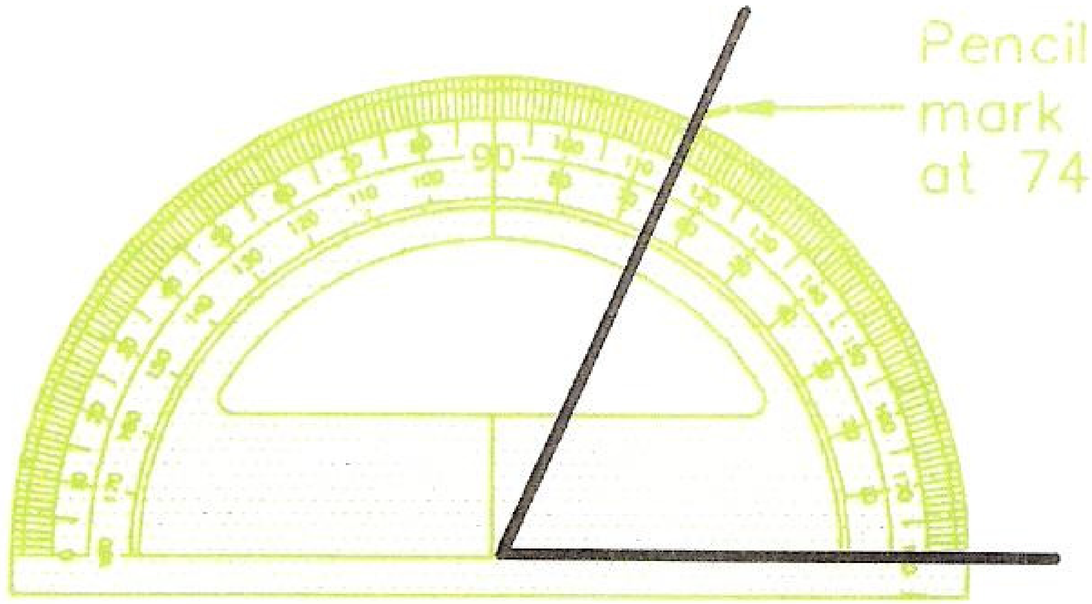


Figure 2 - Constructing an Angle with the Aid of a Protractor

The 3:4:5 Right-Angle Triangle

The upper of the two drawings of Figure 3 shows a triangle with sides in the proportion 3: 4: 5. Such a triangle is always a right-angle triangle. This is because:

The square on the hypotenuse is equal to the sum of the squares on the other two sides.

Taking the 3: 4: 5 triangle:

a) The square on the hypotenuse = 5 x 5 = 25.

b) The square on the shortest side = 3 x 3 = 9.

c) The square on the other side = 4 x 4 = 16; and 9 + 16 = 25.

Thus: if the sides of a triangle are 30 mm, 40 mm and 50 mm long, the triangle is a right-angled one.

If the sides are 27 mm, 36 mm and 45 mm in length the triangle is a right-angled one.

Other 3: 4: 5 triangles are found for example in a triangle ABC, in which AB = 28 mm, BC = 21 mm and AC = 35 mm. And also in triangle XYZ in which: XY = 57 mm, YZ = 76 mm and XZ = 95 mm.

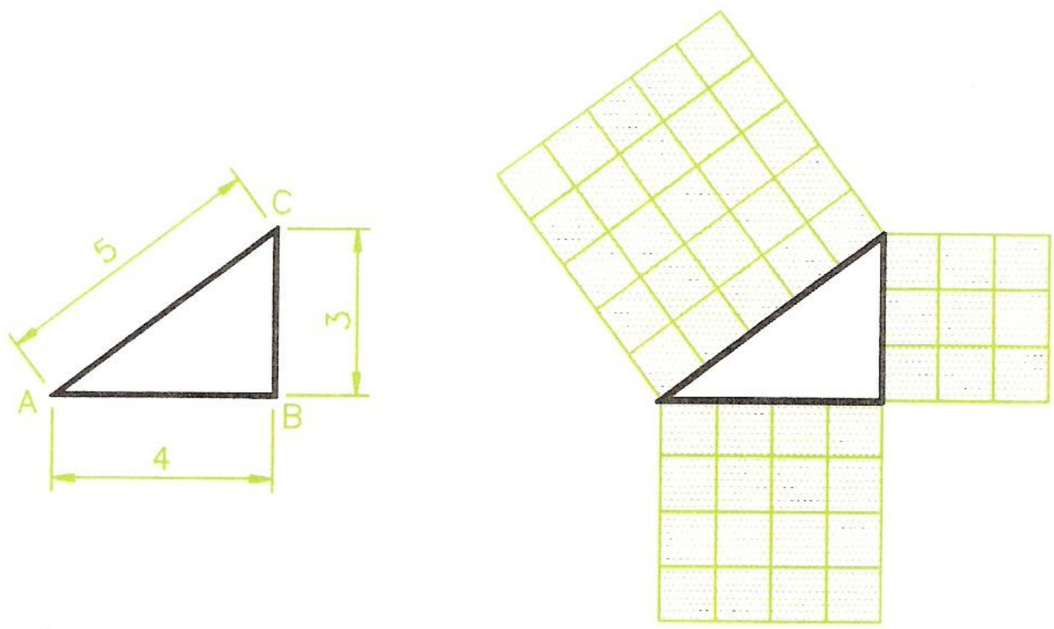


Figure 3 - In a Right-Angle Triangle, the Square on the Hypotenuse is Equal to the Sum of the Squares on the Other Two Sides

The Application of Welding Symbols to Working Drawings

The following notes are meant as a guide to the method of applying the more commonly used welding symbols relating to the simpler types of welded joints on engineering drawings. Where complex joints involve multiple welds it is often easier to detail such constructions on separate drawing sheets.

Each type of weld is characterised by a symbol given in Table 1. Note that the symbol is representative of the shape of the weld, or the edge preparation, but does not indicate any particular welding process and does not specify either the number of runs to be deposited or whether or not a root gap or backing material is to be used. These details would be provided on a welding procedure schedule for the particular job.

It may be necessary to specify the shape of the weld surface on the drawing as flat, convex or concave and a supplementary symbol is then added to the elementary symbol.

A joint may also be made with one type of weld on a particular surface and another type of weld on the back and in this case elementary symbols representing each type of weld used are added together.

A welding symbol is applied to a drawing by using a reference line and an arrow line. The reference line should be drawn parallel to the bottom edge of the drawing sheet and the arrow line forms an angle with the reference line. The side of the joint nearer the arrow head is known as the 'arrow side' and the remote side as the 'other side'.

Sketch (a) shows the symbol for a single-V butt weld below the reference line because the external surface of the weld is on the arrow side of the joint.

Sketch (b) shows the same symbol above the reference line because the external surface of the weld is on the other side of the joint.

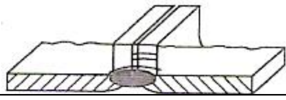
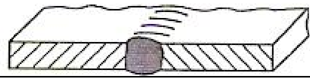
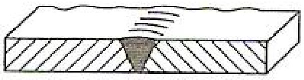
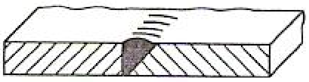
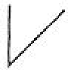
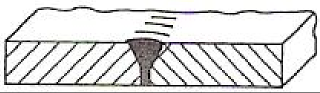
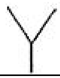
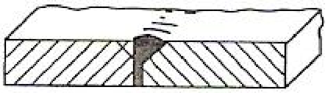
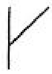
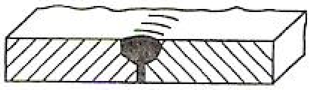
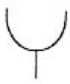
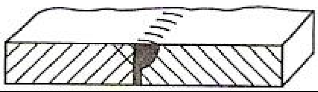
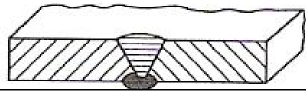
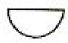
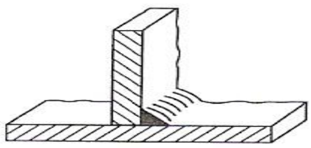
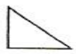
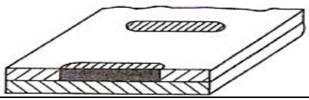
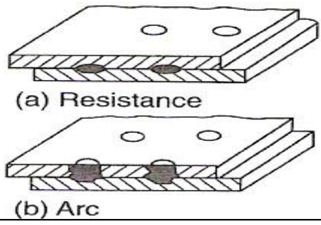
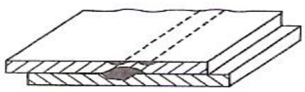
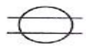
Form of Weld	Illustration	BS Symbol
Butt weld between flanged plates (the flanges being melted down completely)		
Square butt weld		
Single-V butt weld		
Single-bevel butt weld		
Single-V butt weld with broad root face		
Single-bevel butt weld with broad root face		
Single-U butt weld		
Single-J butt weld		
Backing or sealing run		
Fillet weld		
Plug weld (circular or elongated hole, completely filled)		
Spot weld (resistance or arc welding) or projection weld		
Seam weld		

Table 1 - Elementary Weld Symbols

Dimensioning Principles

A drawing should provide a complete specification of the component to ensure that the design intent can be met at all stages of manufacture. Dimensions specifying features of size, position, location, geometric control and surface texture must be defined and appear on the drawing once only. It should not be necessary for the craftsman either to scale the drawing or to deduce dimensions by the subtraction or addition of other dimensions. Double dimensioning is also not acceptable.

Theoretically any component can be analysed and divided into a number of standard common geometrical shapes such as cubes, prisms, cylinders, parts of cones, etc. The circular hole in Figure 4 can be considered as a cylinder through the plate. Dimensioning a component is the means of specifying the design intent in the manufacture and verification of the finished part.

A solid block with a circular hole in it is shown in Figure 4 and to establish the exact shape of the item we require to know the dimensions which govern its length, height and thickness, also the diameter and depth of the hole and its position in relation to the surface of the block. The axis of the hole is shown at the intersection of two centre lines positioned from the left hand side and the bottom of the block and these two surfaces have been taken as datums. The length and height have also been measured from these surfaces separately and this is a very important point as errors may become cumulative and this is discussed later in the chapter.

Dimensioning therefore, should be undertaken with a view to defining the shape or form and overall size of the component carefully, also the sizes and positions of the various features, such as holes, counterbores, tappings, etc., from the necessary datum planes or axes.

The completed engineering drawing should also include sufficient information for the manufacture of the part and this involves the addition of notes regarding the materials used, tolerances of size, limits and fits, surface finishes, the number of parts required and any further comments which result from a consideration of the use to which the completed component will be put. For example, the part could be used in sub-assembly and notes would then make reference to associated drawings or general assemblies.

British Standard 8888 covers all the ISO rules applicable to dimensioning and, if these are adhered to, it is reasonably easy to produce a drawing to a good professional standard.

1. Dimension and projection lines are narrow continuous lines 0.35 mm thick, if possible, clearly placed outside the outline of the drawing. As previously mentioned, the drawing outline is depicted with wide lines of 0.7 mm thick. The drawing outline will then be clearly defined and in contrast with the dimensioning system.

2. The projection lines should not touch the drawing but a small gap should be left, about 2 to 3 mm, depending on the size of the drawing. The projection lines should then continue for the same distance past the dimension line.

3. Arrowheads should be approximately triangular, must be of uniform size and shape and in every case touch the dimension line to which they refer. Arrowheads drawn manually should be filled in. Arrowheads drawn by machine need not be filled in.

4. Bearing in mind the size of the actual dimensions and the fact that there may be two numbers together where limits of size are quoted, then adequate space must be left between rows of dimensions and a spacing of about 12 mm is recommended.

5. Centre lines must never be used as dimension lines but must be left clear and distinct. They can be extended, however, when used in the role of projection lines.

6. Dimensions are quoted in millimetres to the minimum number of significant figures. For example, 19 and not 19.0. In the case of a decimal dimension, always use a nought before the decimal marker, which might not be noticed on a drawing print that has poor line definition. We write 0,4 and not .4. It should be stated here that on metric drawings the decimal marker is a comma positioned on the base line between the figures, for example, 5,2 but never 5.2 with a decimal point midway.

7. To enable dimensions to be read clearly, figures are placed so that they can be read from the bottom of the drawing, or by turning the drawing in a clockwise direction, so that they can be read from the right hand side.

8. Leader lines are used to indicate where specific indications apply. The leader line to the hole is directed towards the centre point but terminates at the circumference in an arrow. A leader line for a part number terminates in a dot within the outline of the component. The gauge plate here is assumed to be part number six of a set of inspection gauges.

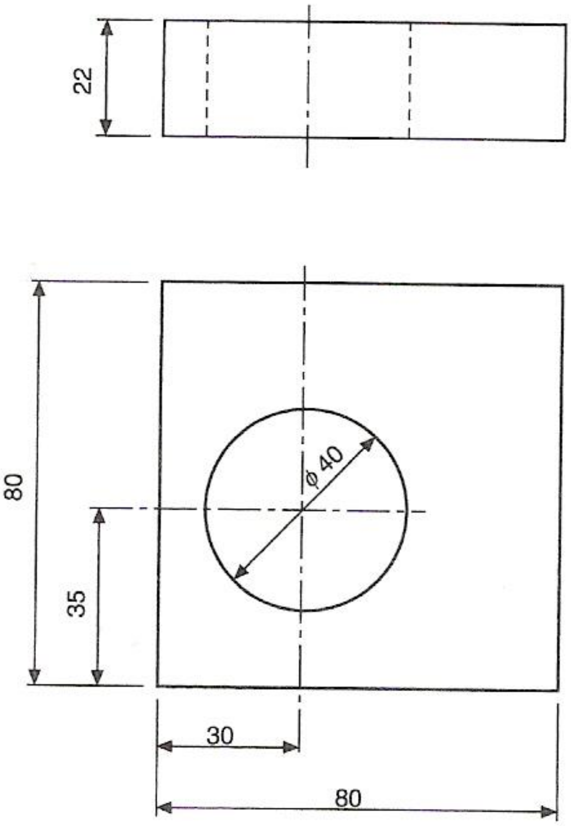


Figure 4 - Solid Block with Circular Hole

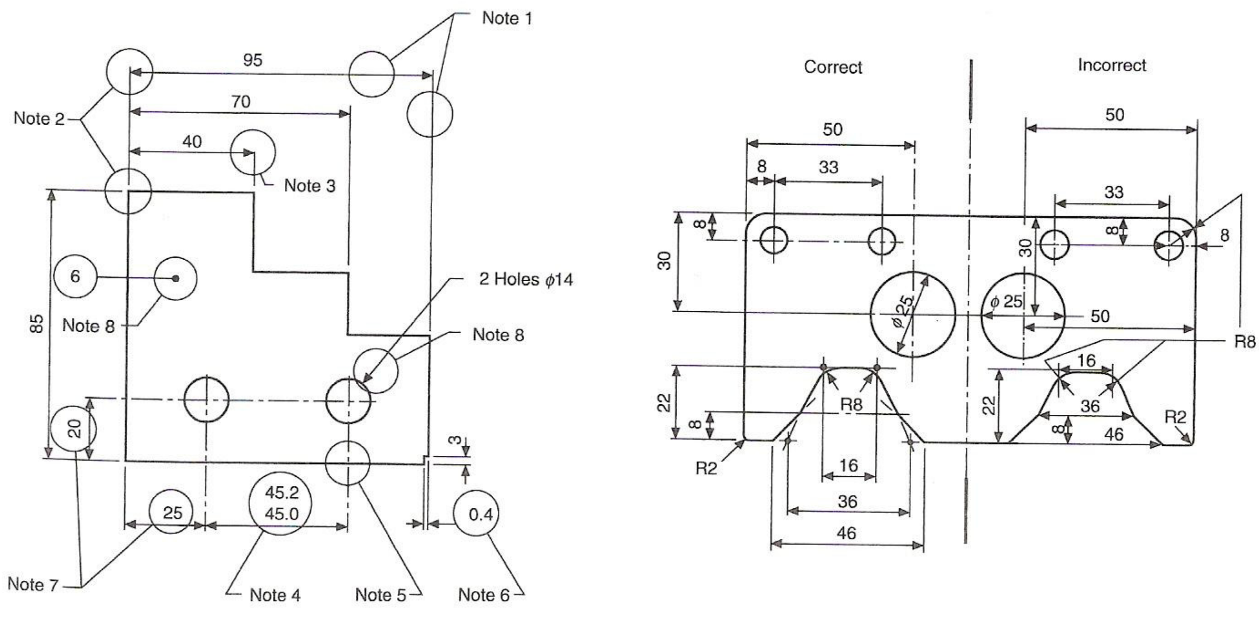


Figure 5 - Partly Completed Drawing of Gauge and Principles

Figure 5 shows a partly completed drawing of a gauge to illustrate the above aspects of dimensioning.

When components are drawn in orthographic projection, a choice often exists where to place the dimensions and the following general rules will give assistance.

1. Start by dimensioning the view which gives the clearest understanding of the profile or shape of the component.

2. If space permits, and obviously this varies with the size and degree of complexity of the subject, place the dimensions outside the profile of the component as first choice.

3. Where several dimensions are placed on the same side of the drawing, position the shortest dimension nearest to the component and this will avoid dimension lines crossing.

4. Try to ensure that similar spacings are made between dimension lines as this gives a neat appearance on the completed drawing.

5. Overall dimensions which are given for surfaces that can be seen in two projected views are generally best positioned between these two views.

Remember, that drawings are the media to communicate the design intent used to the manufacturing and verification units. Therefore always check over your drawing, view it and question yourself. Is the information complete? Ask yourself whether or not the machinist or fitter can use or work to the dimension you have quoted to make the item. Also, can the inspector verify the figure, in other words, is it a measurable distance?

Figure 5 also shows a component which has been partly dimensioned to illustrate some of the principles involved.

Careless and untidy dimensioning can spoil an otherwise sound drawing and it should be stated that many marks are lost in examinations due to poor quality work.

Dimensioning of Features Not Drawn to Scale

This method of indication is by underlining a particular dimension with a wide line as indicated in Figure 6. This practice is very useful where the dimensional change does not impair the understanding of the drawing.

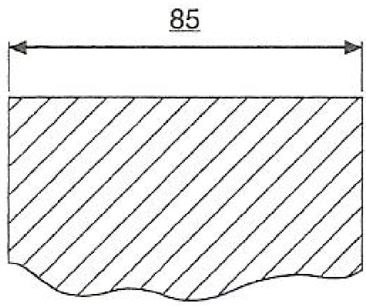


Figure 6 - Underlining a Dimension with a Wide Line

Chain Dimensioning and Auxiliary Dimensioning

Chains of dimensions should only be used where the possible accumulation of tolerances does not endanger the function of the part.

A plan view of a twist drill stand is given in Figure 7 to illustrate chain dimensioning. Now each of the dimensions in the chain would be subject to a manufacturing tolerance since it is not possible to mark out and drill each of the centre distances exactly. As a test of drawing accuracy, start at the left hand side and mark out the dimensions shown in turn. Measure the overall figure on your drawing and check with the auxiliary dimension given. Note the considerable variation in length, which results from small errors in each of the six separate dimensions in the chain, which clearly accumulate. Imagine the effect of marking out say twenty holes for rivets in each of two plates, how many holes would eventually line up? The overall length is shown in parentheses (157) and is known as an auxiliary dimension. This dimension is not one which is worked to in practice but is given purely for reference purposes. You will now appreciate that it will depend on the accuracy with which each of the pitches in the chain is marked out.

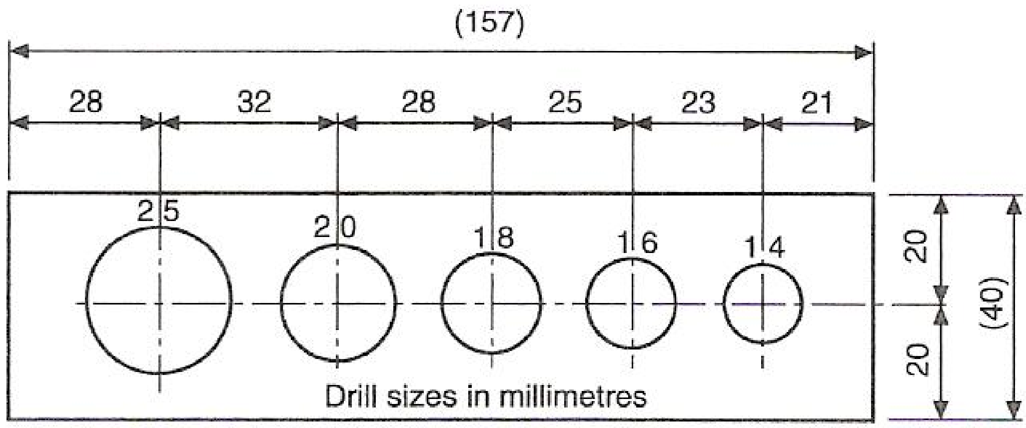


Figure 7 - Plan View of a Twist Drill Stand

Parallel Dimensioning

Improved positional accuracy is obtainable by dimensioning more than one feature from a common datum, and this method is shown in Figure 8. The selected datum is the left hand side of the stand. Note that the overall length is not an auxiliary dimension, but as a dimensional length in its own right.

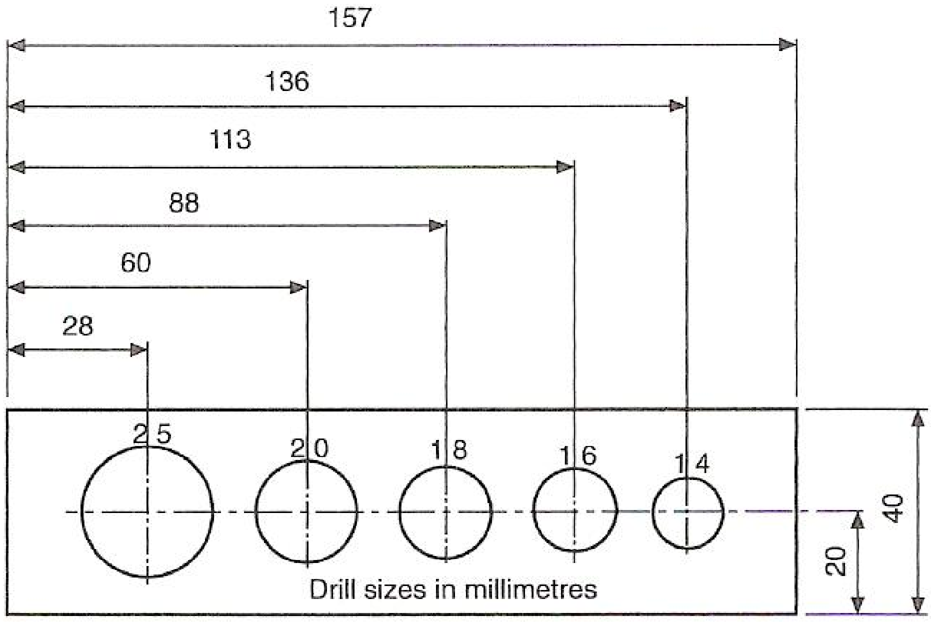


Figure 8 - Parallel Dimensioning

Running Dimensioning

Is a simplified method of parallel dimensioning having the advantage that the indication requires less space. The common origin is indicated as shown (Figure 9) with a narrow continuous circle and the dimensions placed near the respective arrowheads.

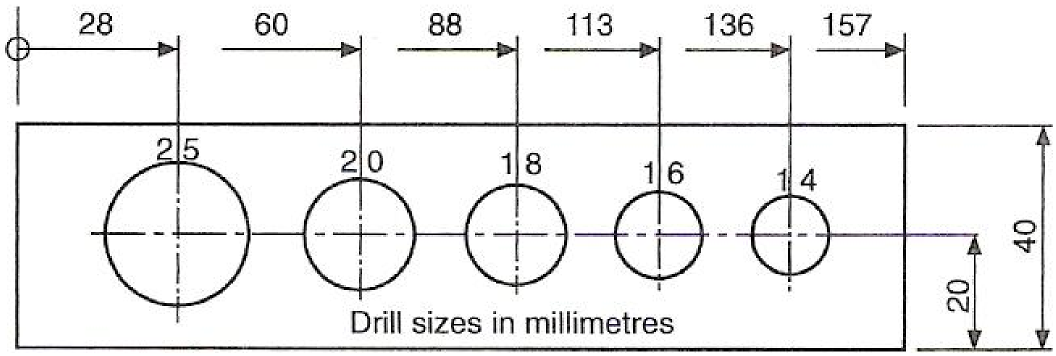


Figure 9 - Running Dimensioning

Staggered Dimensions

For greater clarity a number of parallel dimensions may be indicated as shown in Figure 10.

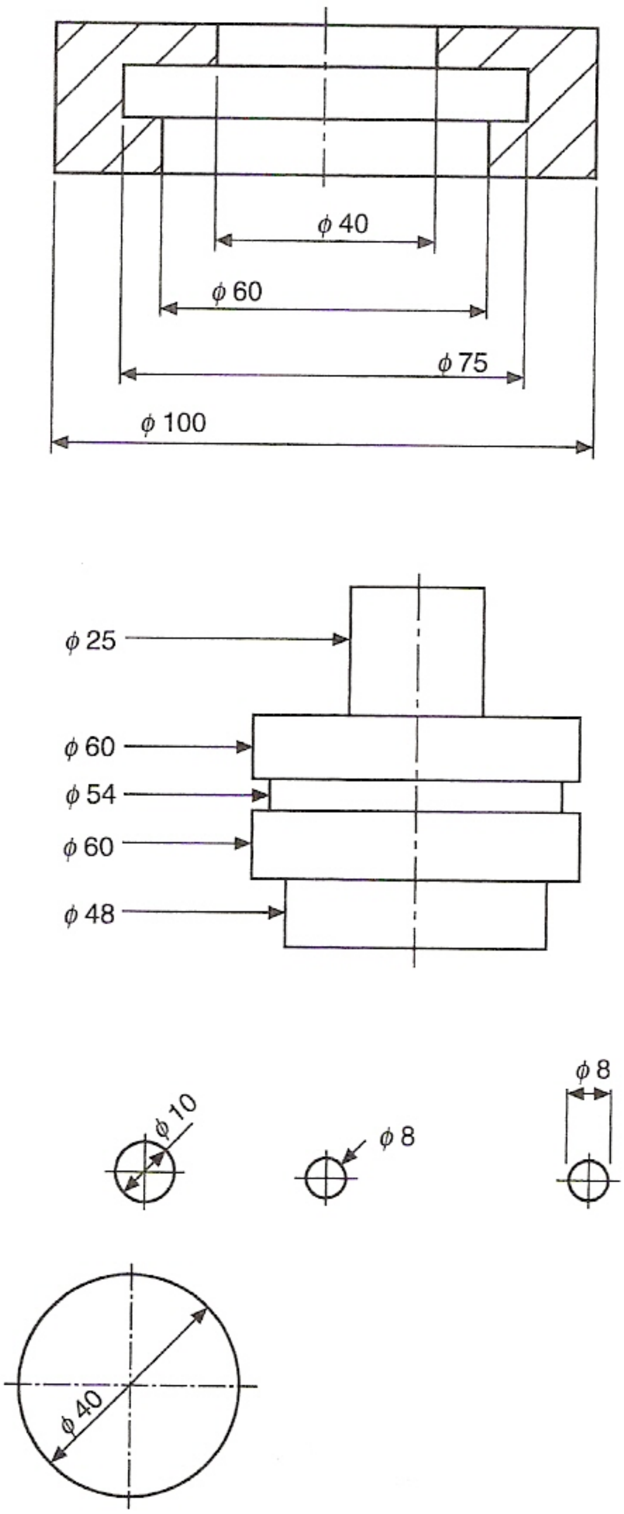


Figure 10 - Staggered Dimensions

Dimensioning Circles

The symbol Ø preceding the figure is used for specifying diameters and it should be written as large as the figures which establish the size, e.g. Ø65. Alternative methods of dimensioning diameters are given here. The size of hole and space available on the drawing generally dictates which method the draughtsman chooses.

Dimensioning Radii

Alternative methods are shown where the position of the centre of the arc need not be located. Note that the dimension line is drawn through the arc centre or lies in a line with it in the case of short distances and the arrowhead touches the arc.

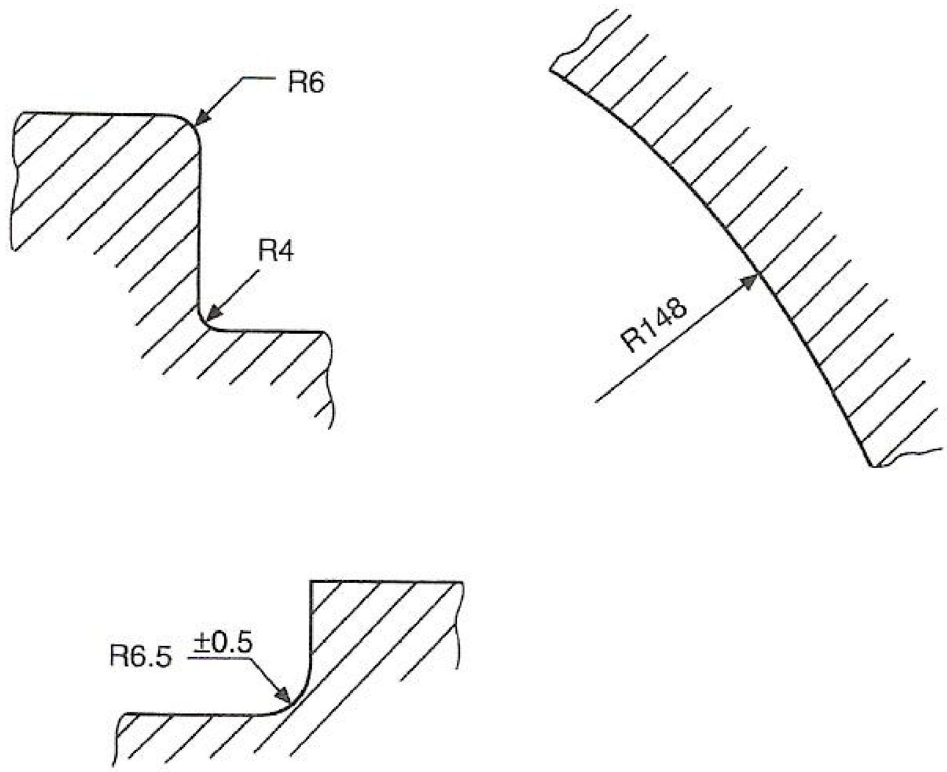


Figure 11 - Dimensioning Radii

Dimensioning Spherical Radii and Diameters

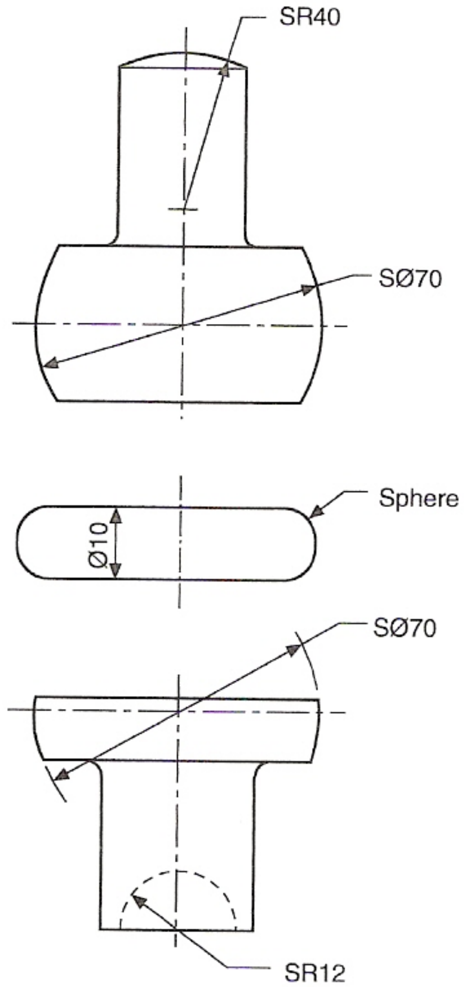


Figure 12 - Spherical Radii and Diameters

Dimensioning Curves

A curve formed by the blending of several radii must have the radii with their centres of curvature clearly marked.

Dimensioning Irregular Curves

Irregular curves may be dimensioned by the use of ordinates. Since the hull is symmetrical about the vertical centre line it is not necessary to draw both halves in full and if the curve is presented in this manner then two short thick parallel lines are drawn at each end of the profile at right angles to the centre line. The outline is also extended slightly beyond the centre line to indicate that the shape is to be continued. Ordinates are then positioned on the drawing and the outline passes through each of the chosen fixed points.

Self Assessment

Questions on Background Notes – Module 3.Unit 12

1. Briefly explain the constructing of a Right Angle using the 3: 4: 5 method.

Answer to Question 1. Module3.Unit 12

1.

The 3:4:5 Right –Angle Triangle:

The square on the hypotenuse is equal to the sum of the squares on the other two sides.

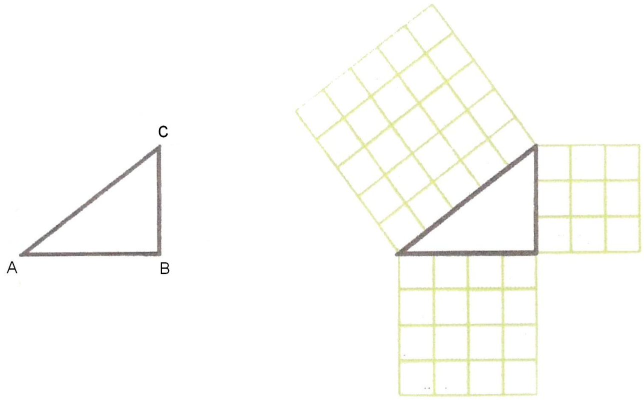
The 3:4:5 Triangle:

a. The square on the hypotenuse = 5 x 5 = 25
b. The square on the shortest side = 3 x 3 = 9
c. The square on the other side = 4 x 4 = 16; and 9 + 16 = 25

If the sides of a triangle are 30mm, 40mm and 50mm long, the triangle is a right-angled one.

If the sides are 27mm, 36mm and 45mm in length, the triangle is a right-angled one.

Figure 4:



Other 3:4:5 triangles are found for example in a triangle ABC or XYZ.

Triangle ABC: AB = 28mm, BC = 21mm and AC = 35mm.

Triangle XYZ: XY = 57mm, YZ = 76mm and XZ = 95mm.

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