

Trade of Sheet Metalwork

Module 2:	Geometry and Pattern Development
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Unit 3:	Parallel Line
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	Phase 2
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Document Release History

Date	Version	Comments
25/07/06	First draft	
04/04/14	2.0	SOLAS transfer

Module 2 – Geometry and Pattern Development

Unit 3 – Parallel Line

Duration – 8 Hours

Learning Outcome:

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

- Discuss the terminology used in the construction of elbows, bends, offsets and tees
- Construct and position joint lines, and develop the patterns adding all joint allowances
- Develop right cylinders, bends and off-set connection pieces

Key Learning Points:

Rk	Determining positions of joint lines.
D	Development of patterns.
Rk	Addition of joint allowances.
Rk	Identifying notch removal areas.
Rk	Use of division of lines.
M	Circumference calculations.
D	Developing true shape of cut-outs.

Training Resources:

- Drawing instruments, materials and equipment
- Textbook: The Geometry of Sheet Metalwork
- Instructor handouts, drawings
- Sheet Metal software packet

Exercise:

Sample exercise - Figure 1.

Key Learning Points Code:

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

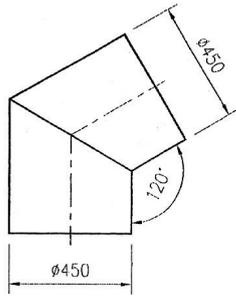


FIG. 1

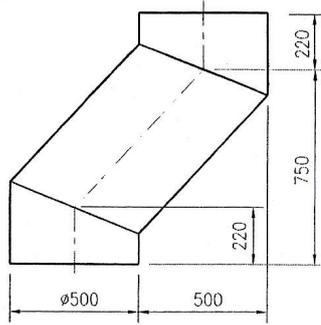


FIG. 2

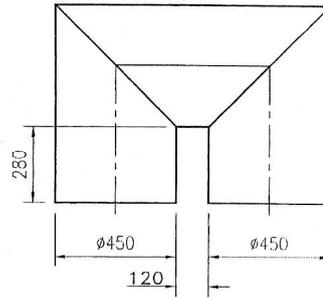


FIG. 3

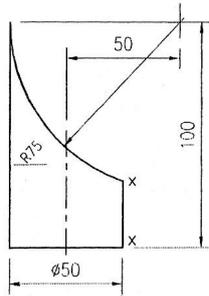


FIG. 4

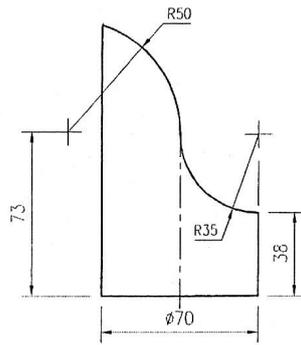


FIG. 5

Exercise/Procedure Instruction

Sample exercises 2.2.3 A, Figures 1-15

THE PARALLEL LINE METHOD

1. Fig.1 shows the elevation of an elbow composed of two parts. Develop the full template for one section with the seam on the short side. Scale 1:10
2. An offset formed in sections is shown in Fig.2. Develop the full template for the centre section
3. The elevation of a return elbow made in three pieces is shown in Fig.3. Develop the full template for the centre section with the seam at SS. Scale:1 : 10
4. A right cylinder cut by a circular arc is shown in Fig. 4. Draw this view and project the full template from it, placing the seam at XX. Scale: full size or 1 : 1.
5. The body for a scoop is drawn in elevation in Fig.5. Develop the full template, placing the seam on the shortest side. Scale: 1 : 10.

FIG. 6

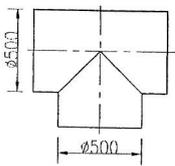


FIG. 7

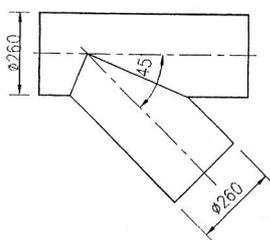


FIG. 8

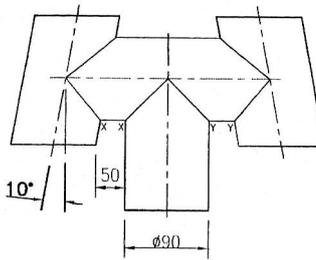


FIG. 9

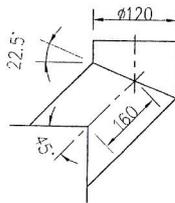
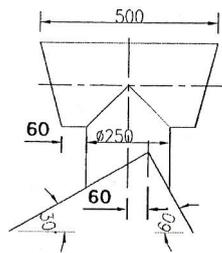


FIG. 10



Sample exercises 2.2.3 B.

Figures 1-15

THE PARALLEL LINE METHOD

6. A T junction between two cylinders of equal diameter is shown in Fig.6. Develop the full template for the branch and the shape of the hole in the main pipe.
7. The elevation of the junction between cylinders of equal diameter is shown in Fig.7. Develop the full template for the branch with the seam on the shortest side and project the true shape of the hole in the main pipe. Scale: 1:5.
8. The elevation of the smoke cowl is shown in Fig.8. Develop the full template for the horizontal section with the seam at XX and YY. Develop also the contour of the holes in the members inclined at 10o to the vertical. Scale 1: 2.
9. The assembly of an inlet pipe to the square corner of a tank is shown in elevation in Fig. 9. Develop the full template for the inclined pipe, and the true shape of the hole in the tank when flat. Scale 1: 2.
10. The elevation of ventilating cowl sited on the peak of a roof is shown in Fig. 10. Develop the full template for the vertical member and the shape of the hole in the roof when flat. Scale 1: 5

Figure 1 - Parallel Line Method

Joint Lines

We always aim to put the joint line on the shortest side. The reason it is put there is to save time and effort.

Sometimes we put the joint elsewhere for appearances of a job or to maximise use of metal.

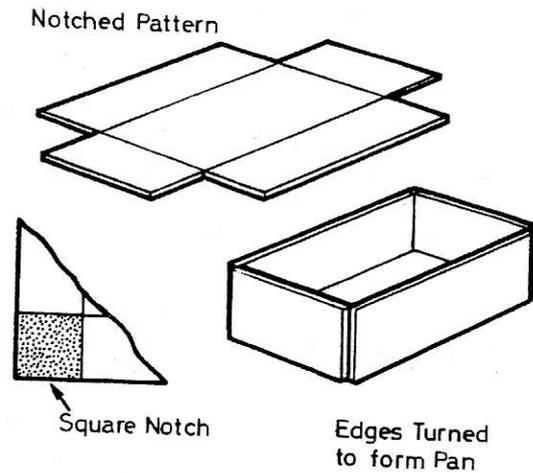
There are many joints in sheetmetal. Some joints are called self-secured joints. This is where we use the job's own metal. Examples are Groove joint, Skip joint and Pein joint. They all have different amounts of metal involved in their assembly. It is important to allow for these joints when marking out a pattern.

Notching

Notching is used to remove portion of the metal to prevent overlapping and bulging on seams and edges.

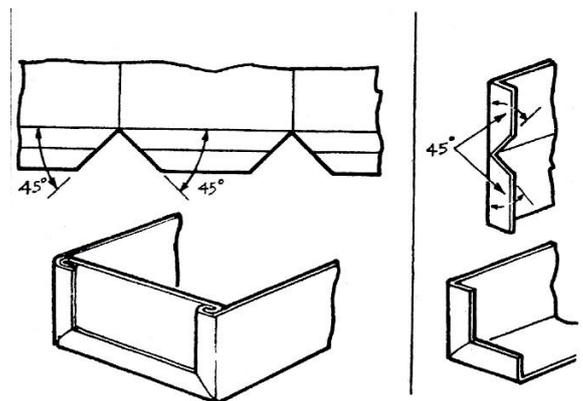
Square Notch

The square notch is used on pans and boxes to enable the corners to fit together. The size of the notch is determined by the bend lines on the pattern.



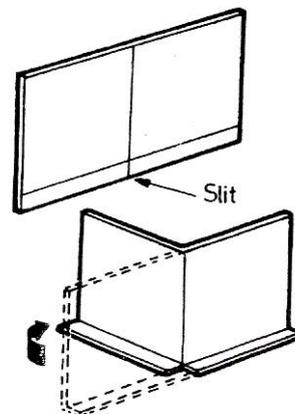
45° Notch

The 45° notch made in the form of a V is used when making a knocked up joint or when making a 90° bend on any job with an inside flange. When the bend of an inside flange meets at an angle other than 90°, the notch must be marked to the necessary angle.



Straight Notch or Slit

An application for the straight notch or slit is shown here.



Using Patterns

In sheet metal work, a pattern is a piece of material which is cut to the exact size and shape that the sheet metal must be cut in order to be formed into the product desired. Original patterns are usually made on paper. In most cases the pattern will have to be used several times so it is transferred to a piece of metal which becomes a permanent pattern which may be used repeatedly without wear or damage.

Patterns and Drawings

Sheet metal articles are made of flat pieces of metal cut according to outlines that are drawn or traced on the sheets of metal.

To obtain the correct shape and size, patterns are used. These patterns as explained above may be drawn on paper or directly on the material. It is better for beginners to draw them on paper, since any adjustments when developing can be made saving valuable material. Patterns that are used repeatedly are made of metal and are called master patterns or templates.

The term development refers to the distance across the flat pattern or flat piece of metal before it is formed into shape. See illustration of square and cylindrical job for clarification. The development is the same as the distance round the object.

On a round pipe it would be the circumference.

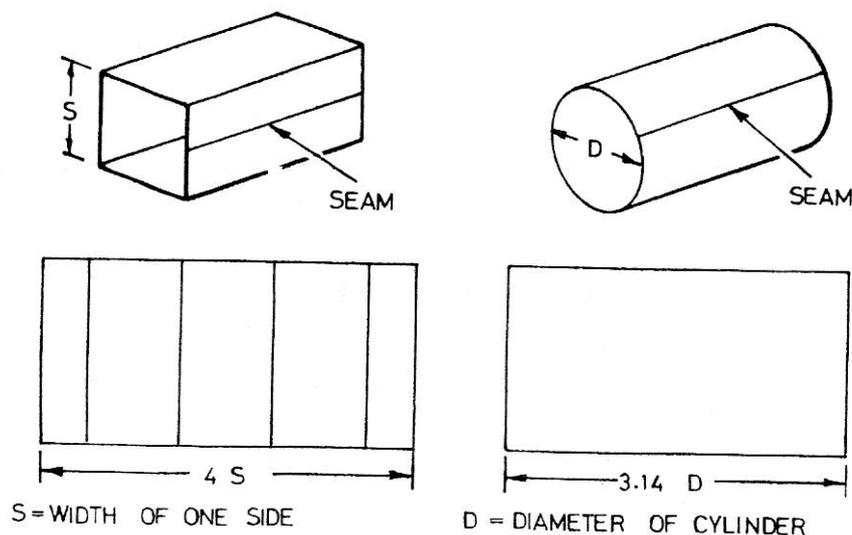


Figure 2 – Square and Cylindrical Job

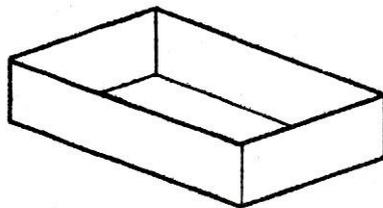
Layout or Development

Layout or development generally refers to the method of developing the lines which form the pattern. The common methods of layout or development are:-

1. Parallel Line Development
2. Radial Line Development
3. Triangulation

Pictorial Drawings

Pictorial drawings show the object as it actually appears after being formed into shape. Such a drawing is useful to show the shape of the finished object and it is sometimes used in the shop to show simple dimensions. For many objects, the true shape of each side cannot be shown and it becomes difficult to put on clearly understood dimensions. For more complex items a working or mechanical drawing is used.



Pictorial drawings show the shape of objects as they appear after forming.

Figure 3 - Pictorial Drawing

Mechanical Drawing

A working or mechanical drawing shows the exact size and shape of each side.

Note each view is what you see when looking directly at the various sides.

Since some of the views are alike i.e. top, bottom, front, back, right and left sides, it's only necessary to draw the number of views required to show the size and shape of the object.

In most cases this will be three; top, front and end views.

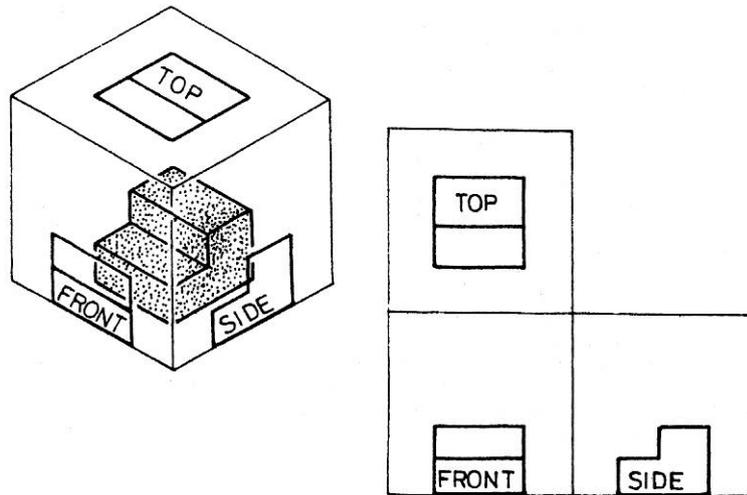


Figure 4 - Mechanical Drawing

The term elevation means any view which shows the height of an object. The term plan view means the top view. Front elevation means front view. End elevation means end view. With this type of information, the pattern seen is easily developed.

The X on the lines indicates the place where the metal is to be bent or folded. These lines are called fold lines.

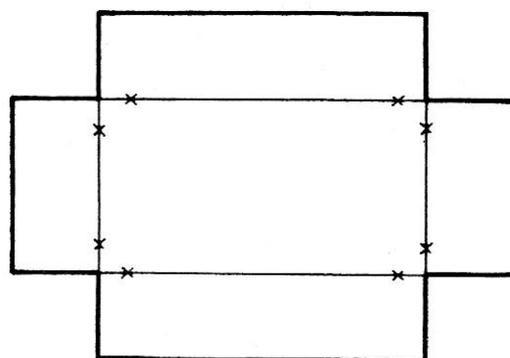


Figure 5 - Fold Lines

Pattern Information Notching

Notching is used to cut away portions of the metal to prevent overlapping and bulging on seams and edges. Proper notching is very important for a good job and the skill can only be acquired by experience.

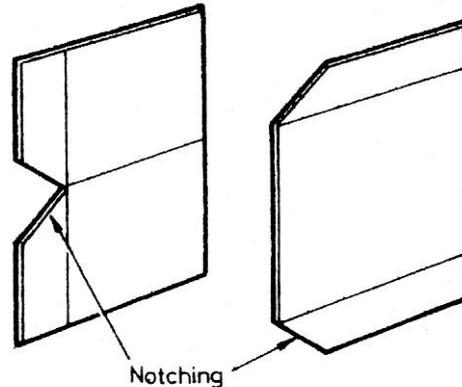


Figure 6 - Notching

Tracing Around a Metal Pattern

When tracing around a metal pattern, it should be held in place by vice grips or some device to prevent the pattern slipping.

Using a scribe or pencil to trace the pattern on the material required.

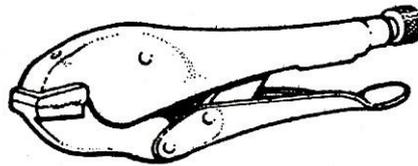


Figure 7 - Vice grips

Transferring a Paper Pattern to Metal

Trying to trace around a paper pattern is very difficult since the paper will wrinkle at the slightest pressure. The best method of transferring a pattern from paper to metal is not to cut out the paper pattern at all, but leave it intact on the paper. Then lay it over the metal with weights to keep it from moving, and prick mark through the paper at the ends of all lines and at intervals around curves. Then remove the paper and with a rule and scribe, draw lines connecting all prick marks in the proper manner.

Direct Layout on Metal

Many experienced workmen do many of their developments directly onto the metal. However for the apprentice it is better to make the more difficult developments on paper and only those for the simple fittings on the metal.

Preparing the Metal

One of the first steps in preparing to develop a pattern on metal is to square the left end of the metal. Sheet metal is not usually squared accurately before it leaves the factory. The steel square may be used for this purpose, or the sheet may be squared directly by the use of the power or treadle guillotine. The next step is to see that the sheet of metal lies perfectly flat on the bench and not on tools or other equipment.

The measurements for the pattern should be taken from the bottom of the sheet and from the squared-up line at the left end of the sheet. Patterns are always located in the lower left hand corner of the sheet. This practice minimises the waste of metal when cutting out patterns.

Allowances for Seams

Sheet metal parts are joined by means of seams of various kinds, which we shall deal with in more detail later. The addition of the seams makes it necessary to add material to the pattern.

Making Irregular Curves

When laying out a pattern on metal, a series of points along an irregular curve are located and then a smooth curve must be drawn through these points. The most common method of doing this is by means of a flexible rule. Made of steel it can be bent and will return to its original shape. A strip of metal the same width as the rule can also be used.

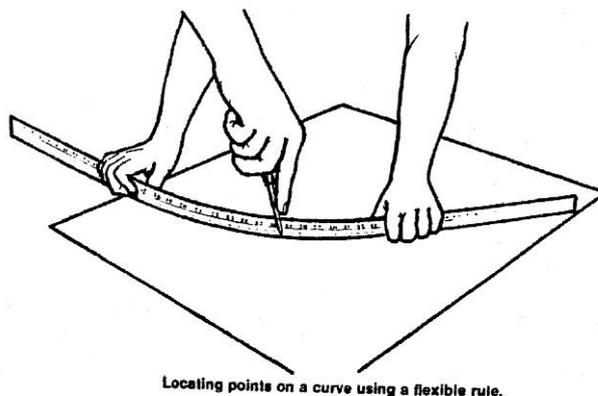


Figure 8 - Making Irregular Curves

How to Read the Circumference Rule

There are two general methods of finding the circumference of a cylinder:

1. By the use of the circumference rule.
2. By the use of formula.

Finding the circumference of a cylinder by the use of the rule is both accurate and simple.

If you examine the rule, you will observe that the upper part of it is used in a manner similar to the ordinary rule. The lower part is used to find the circumference of pipes. The reverse side of the rule is used for finding various angles (degrees).

To read the circumference rule, determine the pipe diameter, i.e. 3" and note the figure in this case 3" on the upper part of the rule as shown in Figure 9.

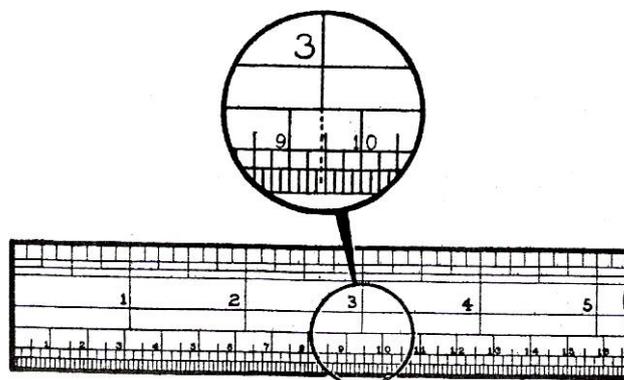


Figure 9 - Reading the Circumference Rule

Now notice that the divisions on the lower part of the rule represent eighths of an inch. Also notice that the figure 3 lines up directly between the third and fourth division reading from 9-10 on the lower part of the rule. The circumference is read as $9 \frac{7}{16}$ ". The circumference rule is usually graduated down to $\frac{1}{8}$ " and the nearest $\frac{1}{16}$ " is estimated by the operator or apprentice. Finding the circumference by use of formula.

Occasionally the sheet metal worker needs to find the distance around a pipe without the use of a circumference rule. The method for doing this is to multiply the diameter of the pipe by 3.14 or $3 \frac{1}{7}$ th. The former is generally preferred. For example, suppose that a pipe 3" in diameter is to be made. The first step would be to find the circumference in inches. This can be done in the following steps:

1. Multiply 3.14 by the diameter, 3"

$$\begin{array}{r} 3.14 \\ \times 3 \\ \hline 9.42 \end{array}$$

2. Change the decimal remainder .42 to a fraction that can be read on the common rule. To do this, multiply the decimal by the denominator of the fraction to be used. The fractions commonly used in sheet metal work are $\frac{1}{8}$ ", $\frac{1}{16}$ " or $\frac{1}{32}$ of an inch, depending upon the degree of accuracy required. For this problem consider that the accuracy should be within the nearest $\frac{1}{16}$ of an inch.

Thus:

$$\begin{array}{r} .42 \\ \times 16 \\ \hline 252 \\ 42 \\ \hline 6.72 \text{ or } 7/16" \end{array}$$

3. The decimal .42 is now read as $\frac{7}{16}$ " so the circumference of a 3 inch pipe would read $9 \frac{7}{16}$ " on the common rule. Hence, we see that multiplying the decimal by the denominator of any of the fractional inch graduations on the rule will give the numerator of the desired fraction as shown by the example.

Self Assessment

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