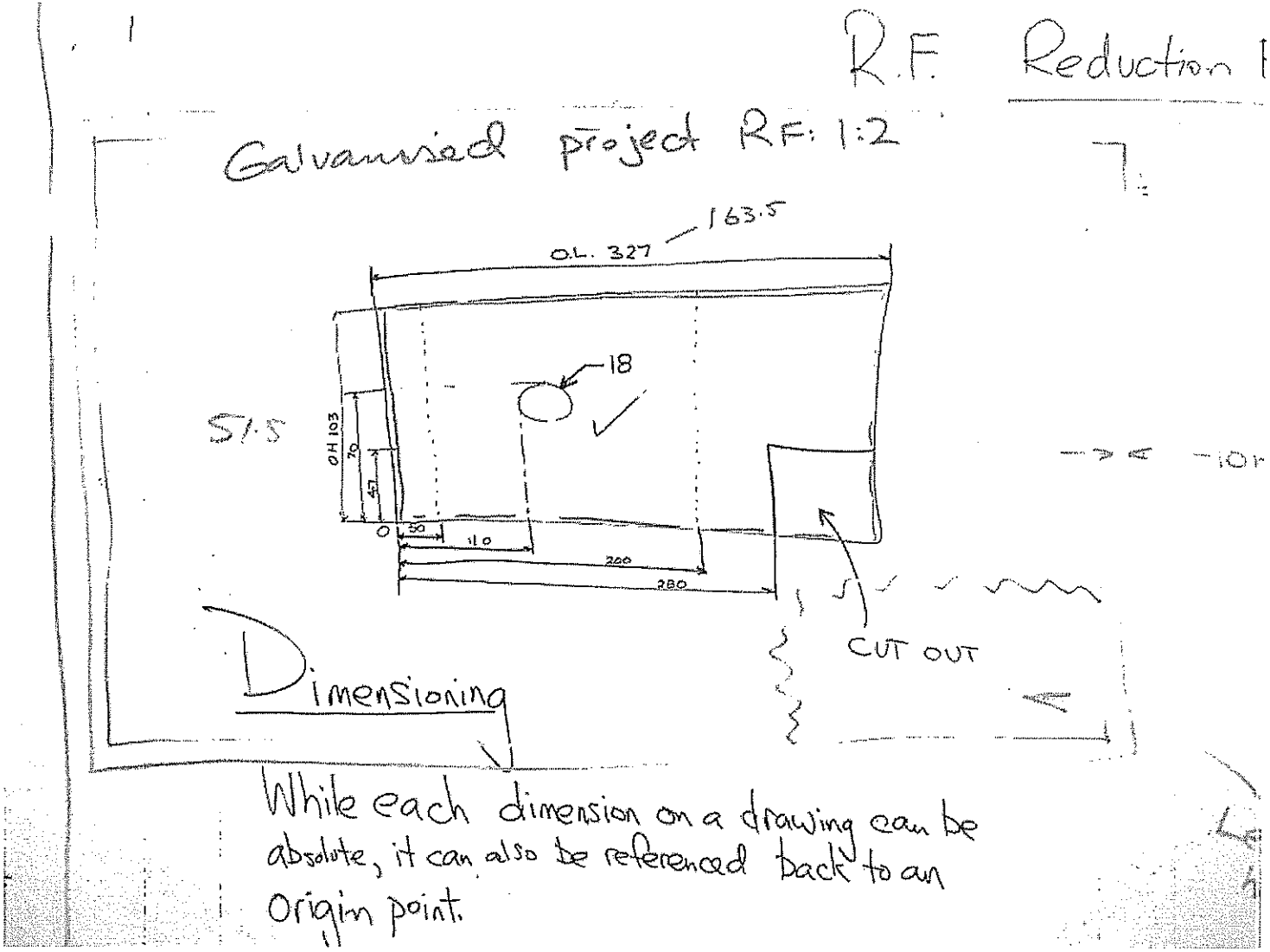
Drawing activity 1



Unit 1a

Drawing sheets, layouts and lines

1.1 Standard drawing sheet sizes

Standards in drawings require that drawing sheets be uniform in size. This not only facilitates storage but is important in the photocopying of drawings. The sizes of drawing sheets are based on a mathematical formula which enables the size of a drawing sheet to be calculated if a list of sizes is not available.

The shape of the sheets of paper used, or as it is often termed, their aspect ratio, is determined graphically in Figure 1.1.

In this construction the ratio between the two sides of the rectangle is equal to the ratio between the side and the diagonal of a square. Numerically this is in the ratio of $1:\sqrt{2}$.

The area of the basic sheet in the recommended series of sizes is one square metre ($1\ m^2$). Mathematically, if the length of one side is designated x and the other y, then:

$$xy = 1\ m^2 \qquad (1)$$

In addition, the two sides, x and y, are in the ratio $1:\sqrt{2}$ so that:

$$y = \sqrt{2}x \qquad (2)$$

Combining equations (1) and (2):

$$x.\sqrt{2}x = 1\ m^2$$
$$\sqrt{2}x^2 = 1\ m^2$$
$$x^2 = \frac{1\ m^2}{\sqrt{2}}$$
$$x^2 = \frac{1\ m^2}{1.414} \text{ (approximately)}$$
$$x^2 = 0.707\ m^2$$

taking the square root of both sides:

$$x = 0.841\ m$$
$$= 841\ mm$$

substituting x in equation (2):

$$y = \sqrt{2} \times 841$$
$$y = 1.414 \times 841$$
$$y = 1189\ mm$$

This establishes the size of the largest and basic sheet which is 841 mm × 1189 mm and is designated A0.

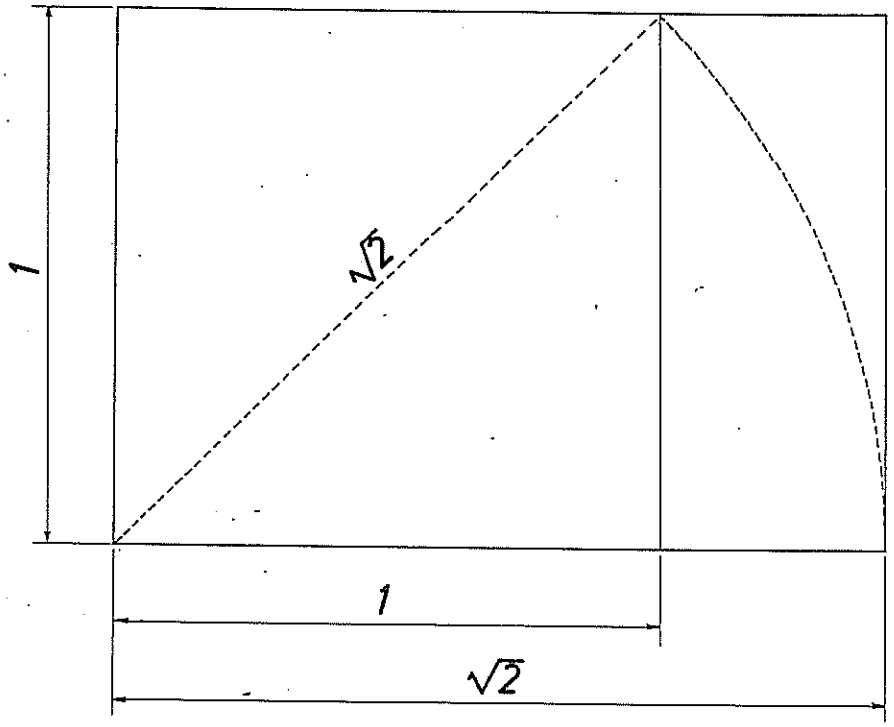


Fig. 1.1 *The geometric construction of a rectangle having sides in proportion of* $1:\sqrt{2}$

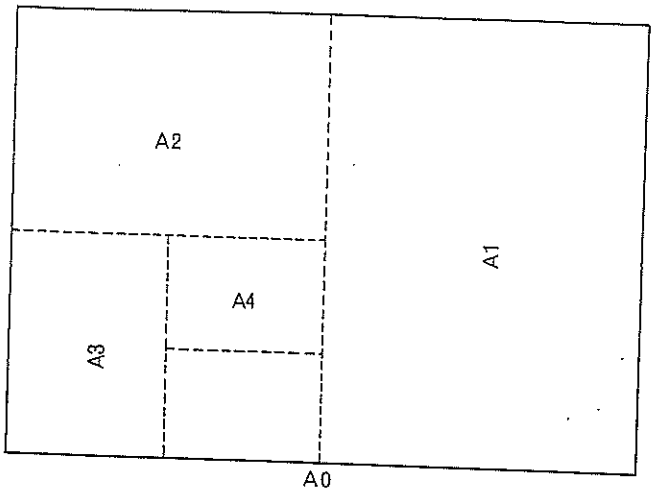


Fig. 1.2 *'A' series sheet proportions*

The series of drawing sheet sizes is built on the basis that each size sheet is half the area of the next bigger one in the series. This is achieved by dividing a sheet into two equal parts, the division being parallel to the shorter side. If an A0 sheet is thus divided, it becomes two sheets of dimensions 594 mm × 841 mm, which are designated A1. Similarly, one A1 sheet becomes two A2 sheets, one A2 sheet becomes two A3 sheets and so on (Fig. 1.2).

All sheets in the series are geometrically similar and have their sides in the constant proportion of $1:\sqrt{2}$. This enables any sheet to be photographically reduced and to fit exactly in the size of a smaller sheet.

The sizes of standard drawing sheets are set out in Table 1.1. From this it can be seen that the shorter side of a sheet is equal to the larger side of the sheet next below it in the series.

Fig. 1.3 *Characteristics of the sizes of drawing sheets in the 'A' series. The linear reduction is* $1:\sqrt{2}$

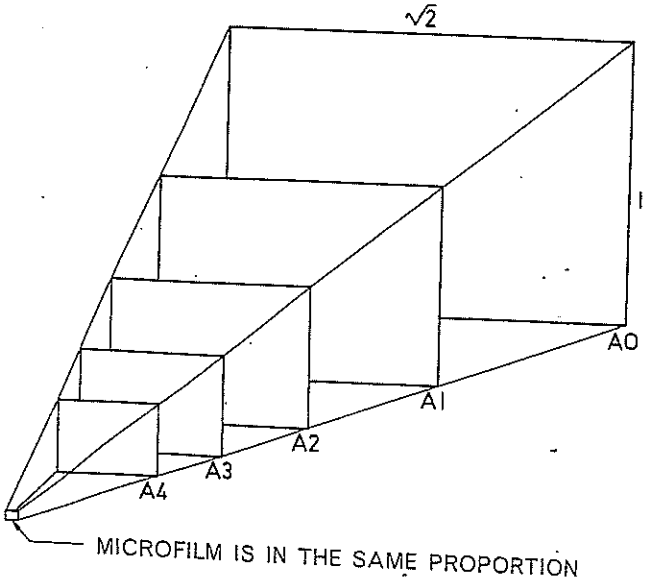


Table 1.1 Dimensions of drawing sheets

Standard designation	*Cut sheet dimensions (mm)*
A0	841 × 1189
A1	594 × 841
A2	420 × 594
A3	297 × 420
A4	210 × 297
A5	149 × 210
A6	105 × 149

Another very real advantage of the standardised sheet system is that drawings may be photographed on 35 mm microfilm which has a frame size in the same proportion. Quite often drawings are made in a size larger than that required, photographed on microfilm and then enlarged once more to the required size. The advantages of microfilm are that it has added security, takes up far less space than actual master prints and, with the use of correct equipment, may be quickly reproduced in a size convenient for use. Figure 1.4 illustrates a microfilm storage cabinet in which thousands of drawings are stored and Figure 1.5 features an actual microfilm card.

1.2 Layout of drawing sheets

As the dimensions of the standard drawing sheets in Table 1.1 are the cut sheet sizes, it is necessary to determine the actual border sizes of the sheets. A border not only aesthetically sets off a sheet, but limits

Fig. 1.4 *A drafter selects a microfilm of a drawing from a microfilm storage cabinet which contains thousands of drawings. Note the viewer on the right side, in which the microfilm drawing may be inspected.* BHP CO. LTD

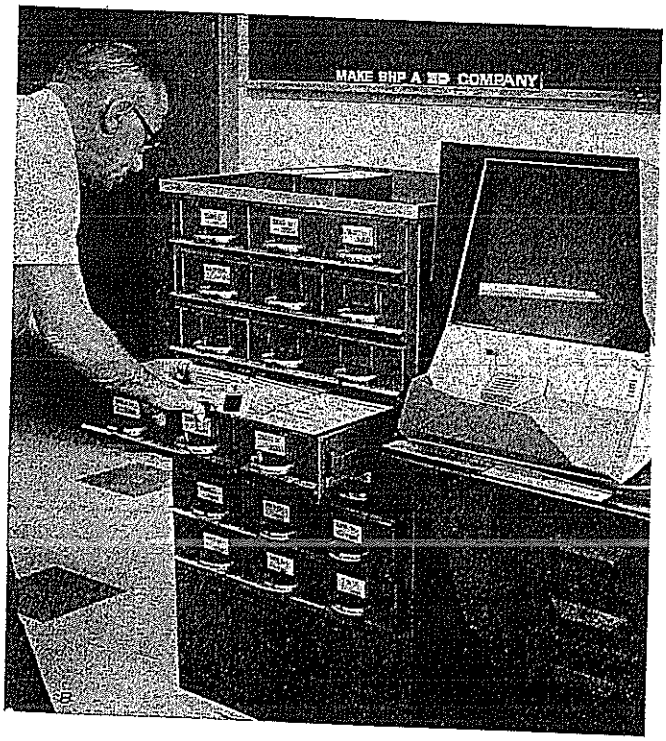


Table 1.2 Dimensions of drawing frame

Drawing sheet size designation	*Dimensions of drawing frame (mm)*	*Border width (mm)*	
		At top and bottom	*On sides*
A0	801 × 1133	20	28
A1	566 × 801	14	20
A2	400 × 566	10	14
A3	283 × 400	7	10
A4	200 × 283	5	7

the area within which the drawing is placed. The recommended sizes of borders on drawings are set out in Table 1.2. These border sizes do not allow a margin for filing, but where this is desired, it is usual to slightly reduce the frame size width and offset the frame to the right side, giving a wider margin on the left side. The placement of the drawing frame borders, consistent with the dimensions given in Table 1.2, is illustrated in Figure 1.6.

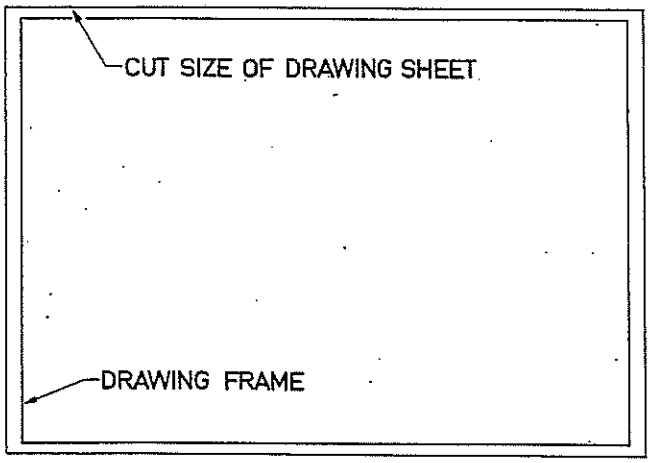


Fig. 1.6 *Position of the drawing frame on the standard drawing sheet*

As mentioned before, drawings are frequently reduced photographically to microfilm size, then enlarged to make further working copies. To facilitate this, camera alignment marks are placed in the centre edge of each sheet between the drawing frame and each edge. In addition to this, grid referencing is sometimes placed just inside the drawing frame, as illustrated in Figure 1.7. This is provided as reference for locating quickly any section of a drawing or diagram and is usually printed on drawing sheets. It is not suggested that students at this stage use these references, but they should at least know that they exist in some drawings.

Title blocks of a drawing are almost as important as the drawing itself. A title block contains all the information necessary to identify the drawing. It also notes its scale, the date of preparation and who prepared it.

Title blocks are usually placed on the bottom right side of a drawing sheet, just big enough to contain the required information adequately (Fig. 1.7). It is usual for the title block to contain the following information:

1. Name of firm or organisation and possibly address
2. Title or name of drawing
3. Drawing number*
4. Sheet size
5. Scale
6. Name of drafter
7. Name of checker
8. Date of completion

The recommended style of title block suitable for use by students on A3 sheets is illustrated in Figure 1.8. It may be seen from this that all the information shown in the above list is included. Note that the position of the sheet size notation is in the bottom right corner, as recommended in AS1100.4, as this is the first part of the drawing to be seen when removing it from a file. Next to this is the drawing number which is often more important than the actual title. The title appears just above these last two features and above the scale which is also very important. (Scales and uses of scales will be discussed in Unit 3.)

The name of the organisation is certainly known within that organisation and is only of minor interest to those outside it, so it is only of secondary importance. In addition to this, on the left side of the title block, three other references appear: the date, the drafter and the checker. Some styles of title blocks from different organisations are illustrated in Figure 1.9. Note that although these differ somewhat in actual layout, they still conform to the accepted pattern.

In some drawings it is necessary to list the materials or items required to make the article. This materials list may be placed in either of two positions on the drawing. One position (Fig. 1.10) is just above the title block; the other position (Fig 1.7) is in the top right corner of the drawing.

When placed above the title block, the material list is made to be read from the bottom up (Fig. 1.10). This allows items to be added in case amendments are made to the drawing at a later stage. The requirements of different organisations vary, but a material list usually contains the item name, number required, material from which it is to be made, part number or reference, brand name (if any), size, and any special remarks on finish.

*The number to be inserted by the students in exercises is the actual number that appears at the beginning of each exercise instruction. ED1, ED2 or ED3 is placed before that number, referring to Electrical Drawing Stage 1, etc.

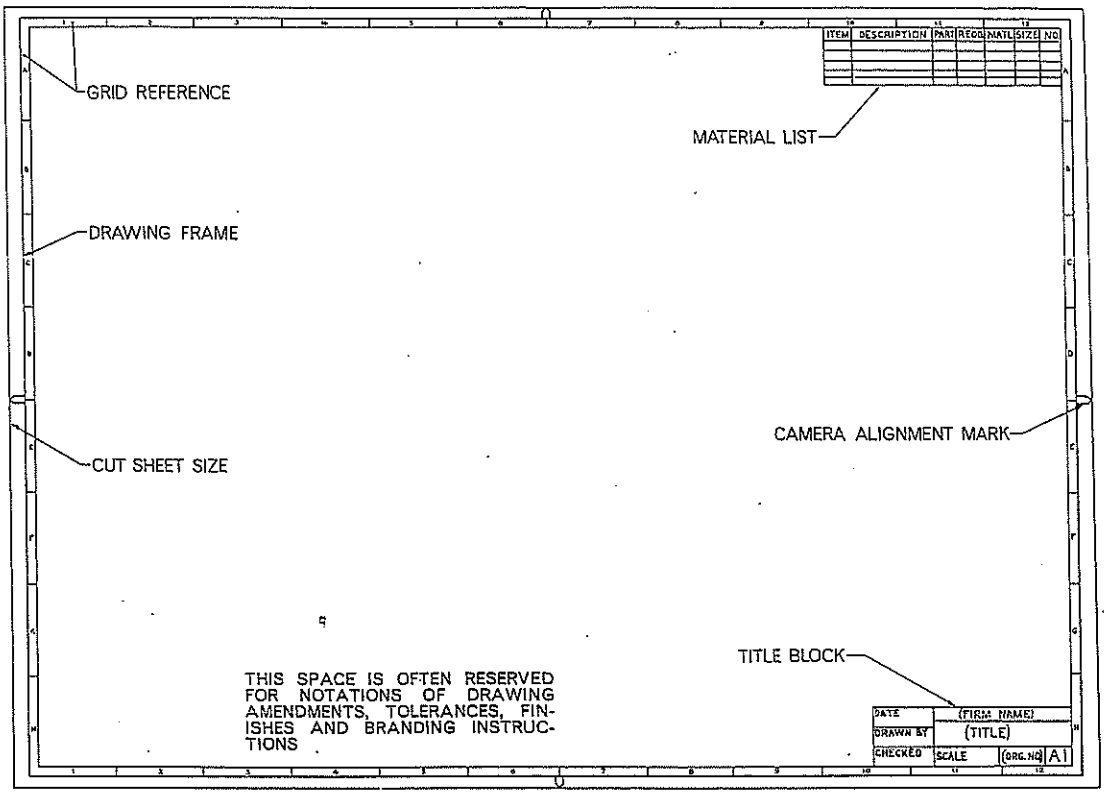


Fig. 1.7 *Typical layout of a drawing sheet*

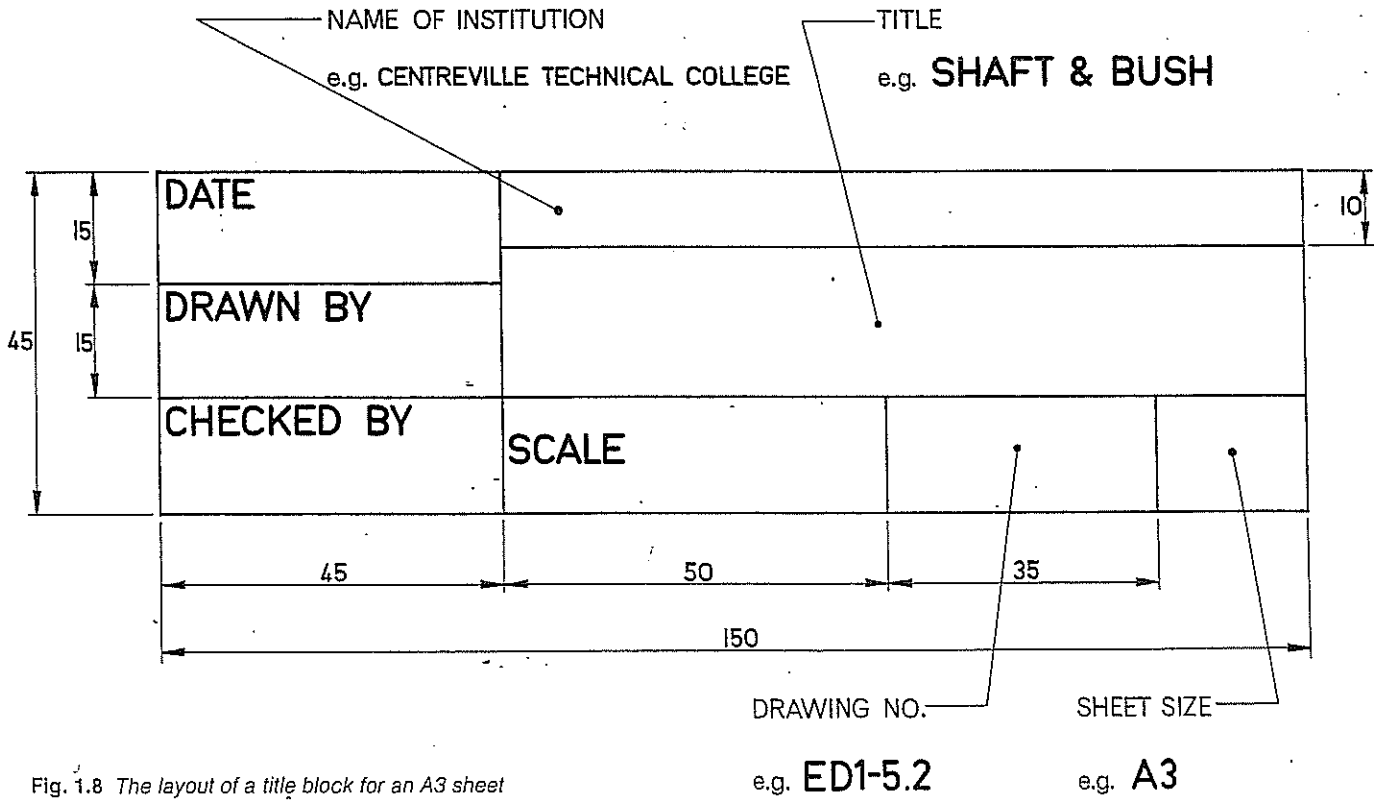


Fig. 1.8 *The layout of a title block for an A3 sheet*

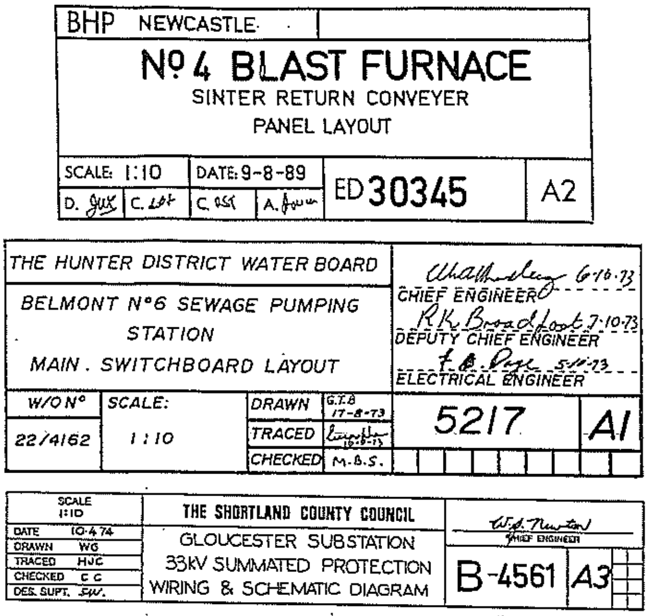

BHP NEWCASTLE
Nº 4 BLAST FURNACE
SINTER RETURN CONVEYER
PANEL LAYOUT
SCALE: 1:10
DATE: 9-8-89
ED 30345
A2
THE HUNTER DISTRICT WATER BOARD
BELMONT Nº6 SEWAGE PUMPING STATION
MAIN. SWITCHBOARD LAYOUT
CHIEF ENGINEER
DEPUTY CHIEF ENGINEER
ELECTRICAL ENGINEER
W/O Nº
22/4162
SCALE:
1:10
DRAWN
TRACED
CHECKED
M.B.S.
5217
A1
SCALE 1:10
DATE 10-4-74
DRAWN WG
TRACED HJC
CHECKED C C
THE SHORTLAND COUNTY COUNCIL
GLOUCESTER SUBSTATION
33kV SUMMATED PROTECTION
WIRING & SCHEMATIC DIAGRAM
CHIEF ENGINEER
B-4561
A3

Fig. 1.9 *Example of title blocks used by different organisations*
BHP CO. LTD, HUNTER DISTRICT WATER BOARD, SHORTLAND COUNTY COUNCIL

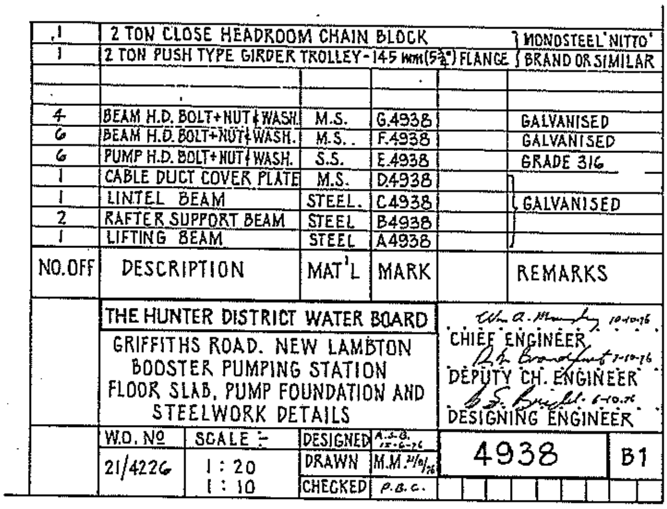

1 2 TON CLOSE HEADROOM CHAIN BLOCK
1 2 TON PUSH TYPE GIRDER TROLLEY-145 mm(5¾") FLANGE
MONOSTEEL 'NITTO' BRAND OR SIMILAR
4 BEAM H.D. BOLT+NUT+WASH. M.S. G.4938 GALVANISED
6 BEAM H.D. BOLT+NUT+WASH. M.S. F.4938 GALVANISED
6 PUMP H.D. BOLT+NUT+WASH. S.S. E.4938 GRADE 316
1 CABLE DUCT COVER PLATE M.S. D4938
1 LINTEL BEAM STEEL C4938 GALVANISED
2 RAFTER SUPPORT BEAM STEEL B4938
1 LIFTING BEAM STEEL A4938
NO.OFF DESCRIPTION MAT'L MARK REMARKS
THE HUNTER DISTRICT WATER BOARD
GRIFFITHS ROAD. NEW LAMBTON
BOOSTER PUMPING STATION
FLOOR SLAB, PUMP FOUNDATION AND
STEELWORK DETAILS
CHIEF ENGINEER
DEPUTY CH. ENGINEER
DESIGNING ENGINEER
W.O. Nº
21/4226
SCALE :-
1 : 20
1 : 10
DESIGNED
DRAWN
CHECKED
4938
B1

Fig. 1.10 *A materials list positioned above the title block*
HUNTER DISTRICT WATER BOARD

1.3 Drawing techniques

The materials and methods by which drawings are produced vary according to the purpose for which the drawings are made. An experienced drafter in a drawing office will use a precision drafting machine, carry out all drawing in ink and draw on opaque or translucent tracing paper. Figure 1.11 illustrates this type of drawing production. From these drawings, prints are directly made by a number of photographic processes.

A design engineer may make a rough drawing in pencil on drawing paper and although it may be complete in all detail it would not be acceptable as a finished product or be capable of being satisfactorily reproduced. A specially trained tracer may take the drawing and with translucent tracing paper, trace from it a carefully executed and neatly annotated ink drawing. The advantage of drawing on paper with pencil is that corrections and alterations may be easily made with an eraser.

Drawing in ink requires more skill, patience and care to produce a professional result and although small erasures may be carried out, each line is usually a finished job and cannot be altered. Before commencing ink drawing, students should become proficient with pencil, since once the correct techniques of drawing practice have been mastered for pencil work, it is easy to transfer these techniques to ink. Drawing in ink is covered in Part Three of this book.

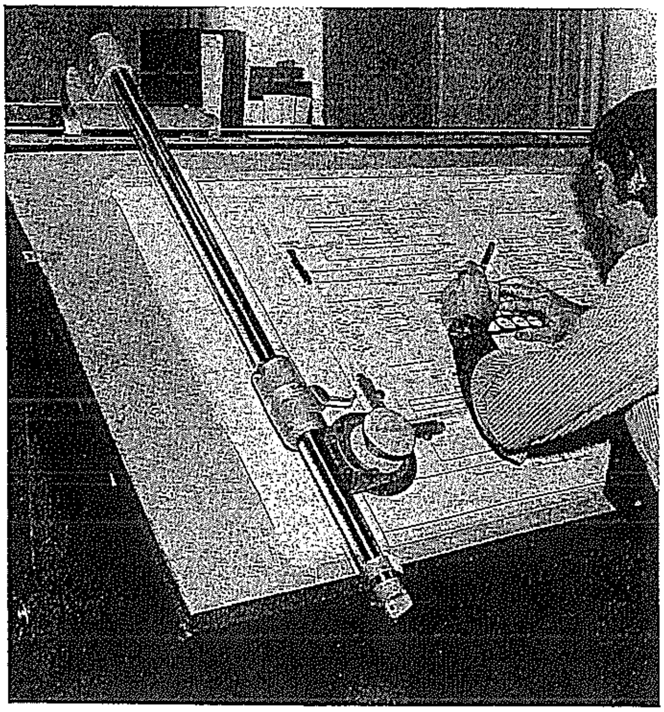
Drawings may also be carried out by computers. In many instances computer programs are able to drive a device called an *XY plotter* which, when fitted with a drawing pen, can completely carry out the drawing operation including all lettering. These machines are very expensive and are only found in the larger organisations. Smaller concerns still use hand drawing and even in larger organisations there is still quite a large proportion of drawing carried out by hand.

1.4 Drawing board accessories

As mentioned before, drafting machines of various types may be employed in drawing offices but as these are specialist and non-portable drawing aids, the simpler drawing methods will be discussed in this book.

The two fundamental requisites for drawing are a drawing board and a tee square. Drawing boards may be portable or fixed to a table. In either case they

Fig. 1.11 *An electrical drafter completing an electrical circuit drawing on translucent copying paper with the aid of a drafting machine and table* BHP CO. LTD



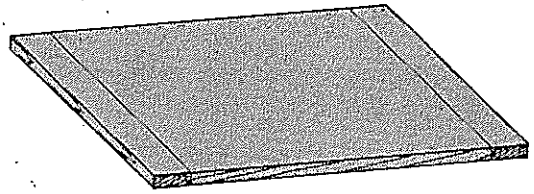


Fig. 1.12 *A simple but effective wooden drawing board. It is most important for the left side of the board to be perfectly straight.*

should be raised at the rear so that they meet the table at about a 10° angle. With the simple type of board, a 50 mm square block placed at the rear of the board is usually sufficient, but if it can be tapered towards the front and possibly attached to the board, it is more satisfactory. A drawing board must be strongly made and be perfectly straight on the left edge. Check this by placing a straight edge against the edge of the board. A simple drawing board is illustrated in Figure 1.12. A more elaborate and yet not expensive type of drawing board is shown in Figure 1.13. These types have a built-in tee square which may be used in a horizontal or vertical position.

The tee square, used with a simple drawing board, is made of two parts: the head and the blade. The head is placed against the left side of the board and the blade, with its bevelled drawing edge, lies across the

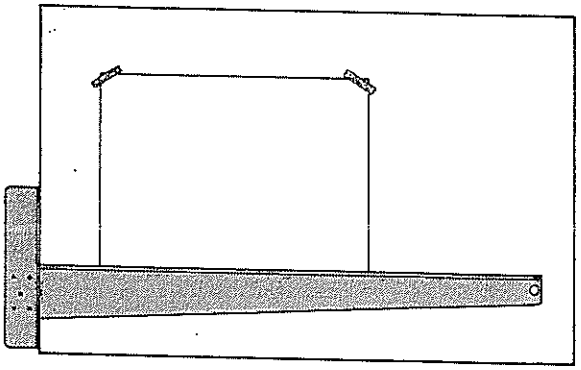


Fig. 1.14 *When using a simple drawing board the paper is positioned on the tee square and fixed to the drawing board with masking tape at the top corners*

board. As the head is moved along the left edge of the board, the blade will always be parallel with its previous positions. The tee square is also used to position the drawing paper horizontally on the drawing board (Fig. 1.14).

When using the plastic drawing boards (Fig. 1.13), the paper is clamped to the board by an inbuilt clamp and is therefore automatically correctly positioned. When attaching drawing paper to a simple type of board, only drafting or masking tape must be used. *Never* use any type of pin fastener on a board (Fig. 1.14).

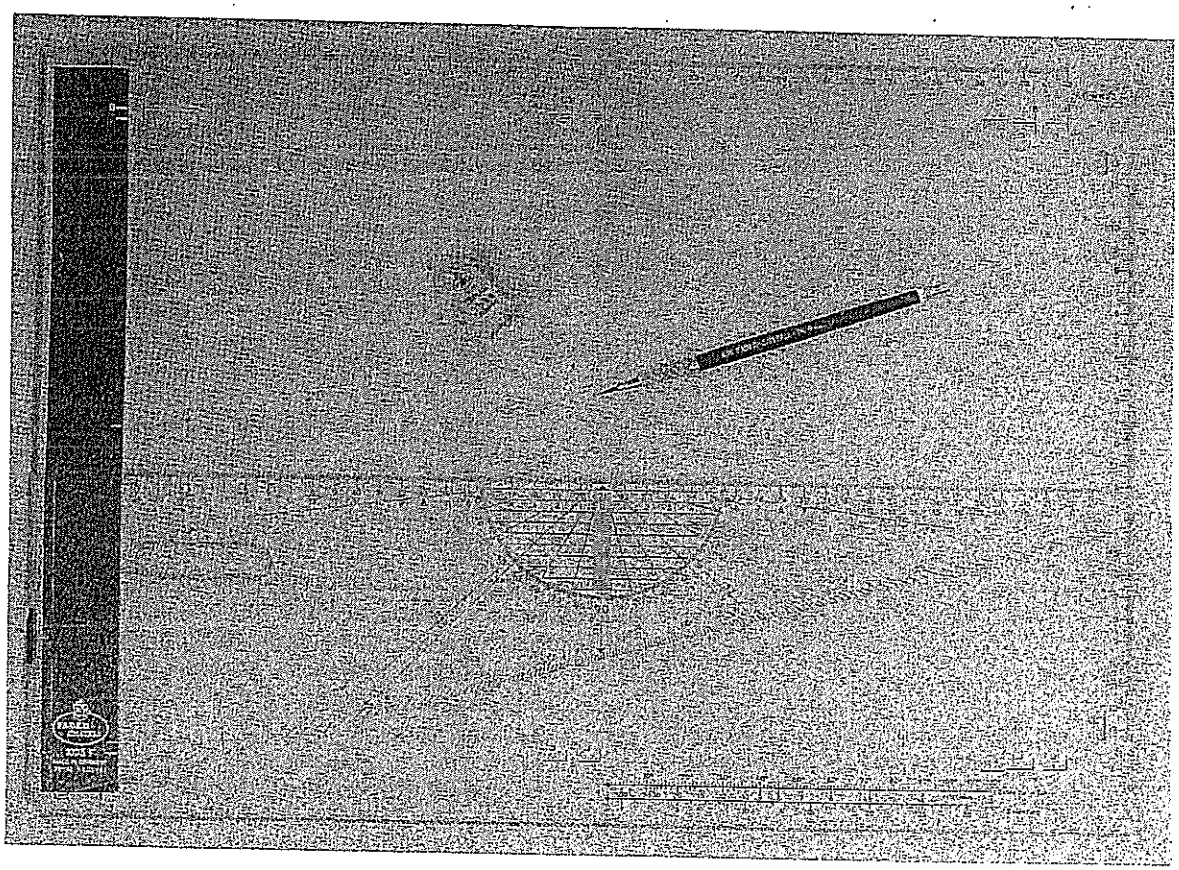


Fig. 1.13 *Plastic drawing boards which use transparent squares in guide rails. A range of accessories extends the versatility of this type of drawing board.*

With the paper fixed to the board, the tee square (or inbuilt square) is moved up and down the paper to draw horizontal lines at any point on the paper. Horizontal lines should be drawn this way in order to make them parallel and true. Avoid the temptation to use an ordinary rule to estimate whether the line is horizontal or not (Fig. 1.15).

Vertical lines should only be drawn with the aid of set squares placed on the working edge of the tee square (Fig. 1.16) or by using the inbuilt square in the vertical position on the plastic boards (Fig. 1.13).

Set squares should be made of clear, strong plastic material no thicker than 2 mm. The two types used are generally referred to as 45° and 60°–30° (Fig. 1.17). The 45° type should be at least 200 mm long measured along the hypotenuse (opposite the right angle), and the 60°–30° the same length measured along the longest side adjacent to the right angle. It is also very useful if each set square is graduated in millimetres along at least one edge. In Figure 1.18 it can be seen that in addition to the basic angles of 30°, 45° and 60°, angles of 15° and 75° may also be drawn with the aid of the two set squares.

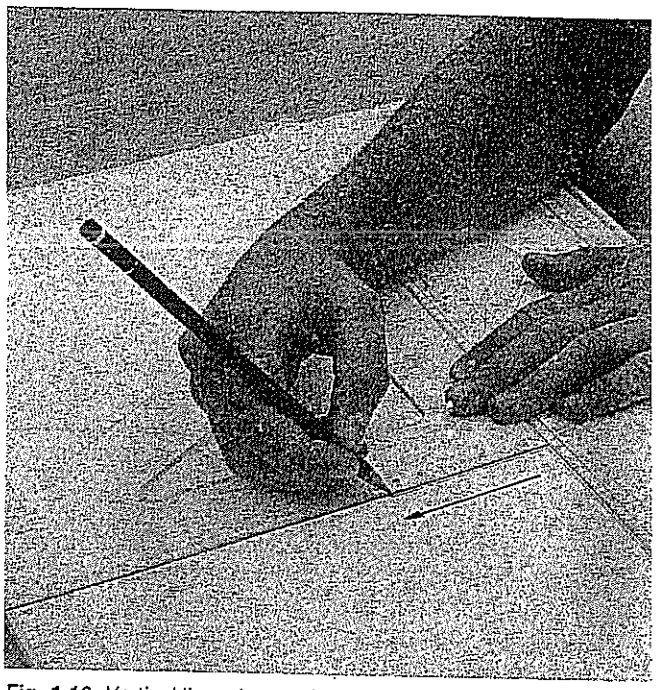
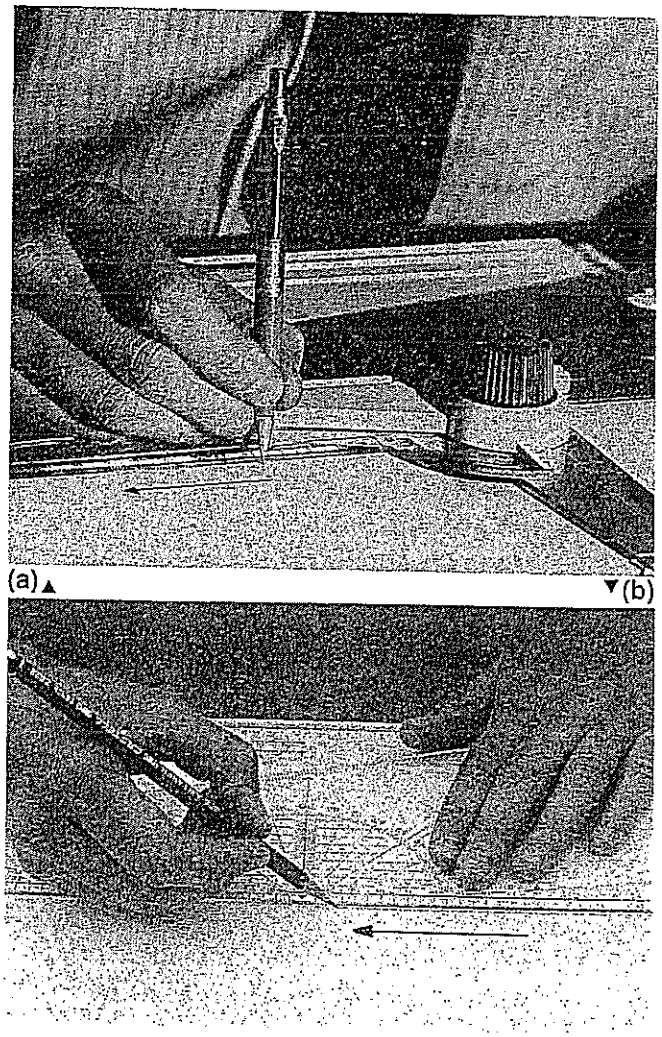


Fig. 1.16 *Vertical lines drawn with tee square and set square. The line should be drawn away from the tee square towards the top of the board*

Fig. 1.15 *Horizontal lines should only be drawn with the aid of the tee square or inbuilt square and be drawn from left to right (right to left for left-handed persons).* TOP PHOTO JASCO PTY LTD



To produce angles not provided by the set squares, a protractor is an essential part of drawing board accessories. Protractors are either semicircular or circular. The circular type has the advantage that it can be used to mark off several points around 360° from the datum point, but it may be difficult sometimes to fit it into a particular area. The suggested minimum diameter for each type is 150 mm. A combination set square and protractor, as shown in Figure 1.19, is very useful. The plastic-type drawing boards have accessories which, to a large extent, replace protractors in actual drawing work, although they do not eliminate their usefulness. The use of one of these accessories is shown in Figure 1.20.

Drawing paper is made in a variety of qualities and may be purchased in ready-cut A series sheets. Although white paper is the name given to all drawing paper, a slightly off-white colour is less tiring on the eyes while drawing and does not appear to become as dirty with use. For pencil drawing, paper should have a surface texture or grain to abrade the pencil 'lead'* and leave a good deposit on the paper. It should have a hard surface not easily grooved by the pencil and be capable of withstanding erasures without spoiling the surface.

*The 'lead' of a pencil is made from a controlled mixture of clay and graphite. Lead was once used but was superseded by graphite about 1895.

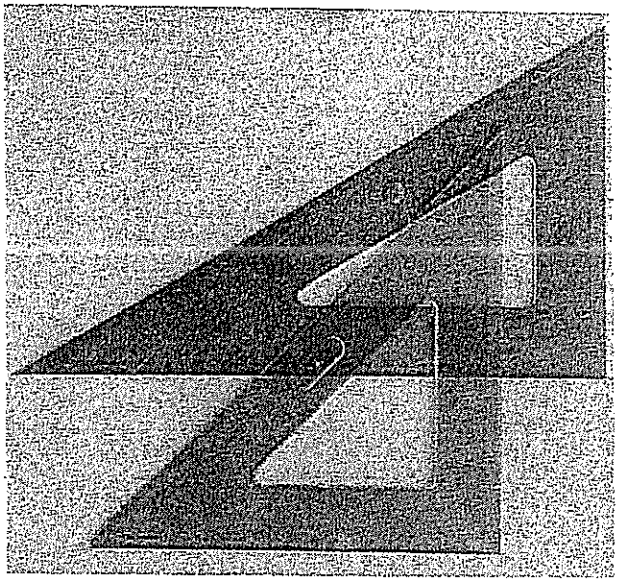


Fig. 1.17 *45° and 60°-30° set squares*

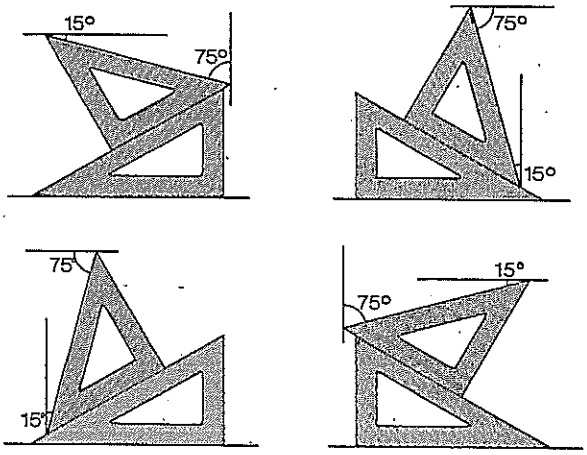


Fig. 1.18 *A 45° and 60°-30° set square may be positioned to form angles of 15° and 75° to the horizontal and vertical*

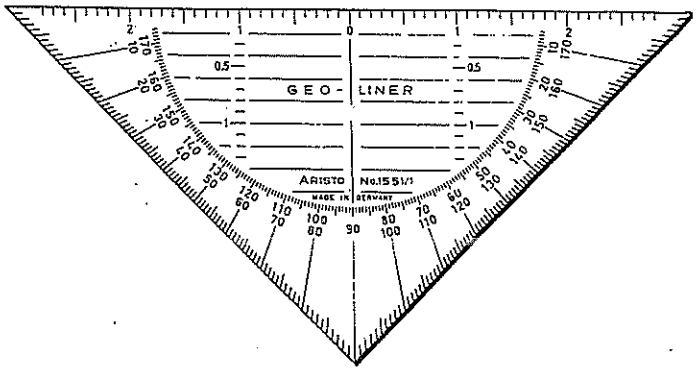


Fig. 1.19 *A combination 45° set square and protractor*
JASCO PTY LTD

Fig. 1.20 *Using an adjustable drawing head to produce angles not available from set squares*

1.5 Pencils for drawing

Pencils for drawing must be of good quality to provide uniform results. Pencils are produced in varying grades of hardness from extremely soft (8B) to soft (B); medium (HB); firm (F) and hard (H) to extremely hard (10H). For drawing purposes the recommended hardnesses are 2H and H. The 2H grade is used for all line work and the H grade for printing and freehand drawing. Use a 4H grade for light construction lines since it leaves a deposit just heavy enough to be seen but light enough, if left, not to detract from the drawing outlines. Some drafters prefer a softer grade of pencil such as F or HB for construction lines. If these lines are carefully and *lightly* drawn, they can be easily erased without removing the drawing outlines.

Figure 1.21 illustrates the deposit left by varying grades of pencils in a standardised test. The weight, or darkness, of a line drawn with a pencil depends on three factors: the hardness of the pencil; the texture of the paper; the pressure applied by the user. In general, the weight of a line is dependent on the pressure applied to the pencil (Fig. 1.22).

There are three general types of pencil used in drawing work: the wooden pencil, the press-action clutch pencil and the fineline constant thickness

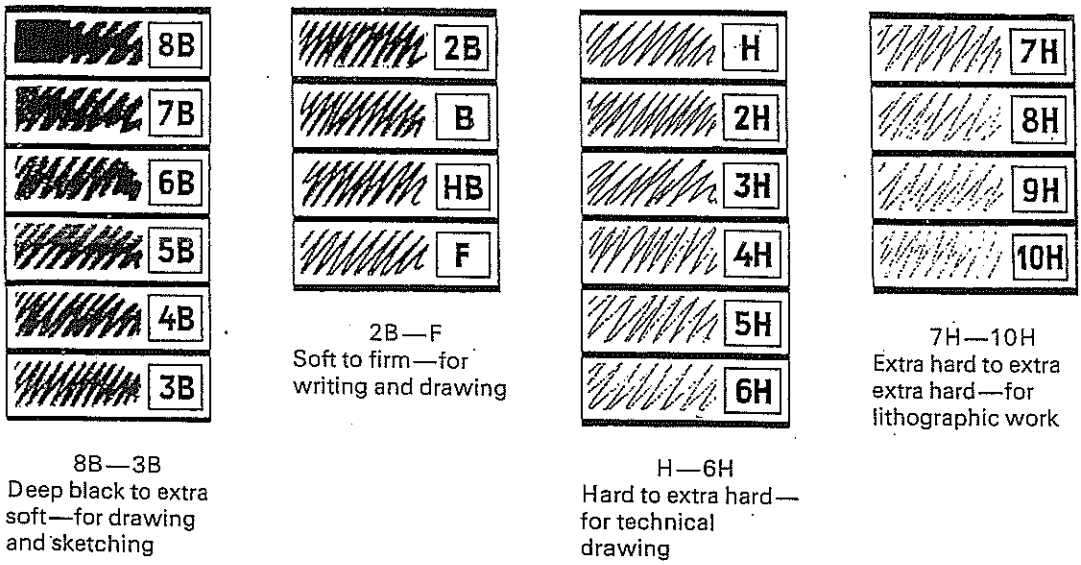


Fig. 1.21 *A wide variety of line weights produced by a complete range of pencil grades* A. W. FABER-CASTELL

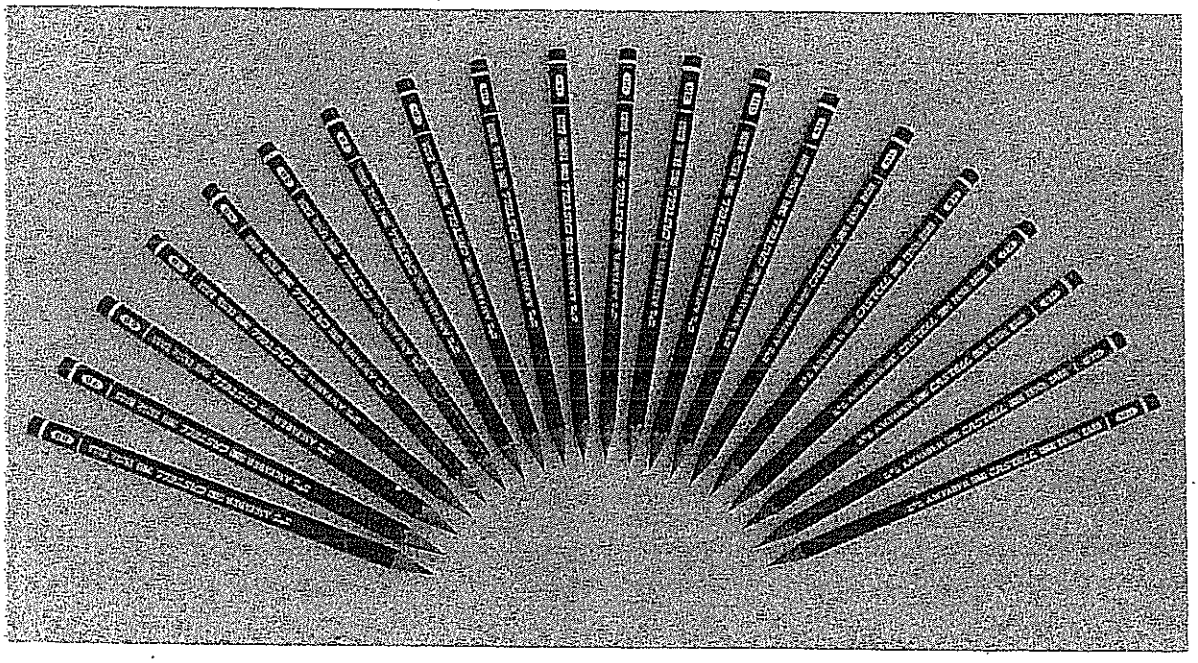


Fig. 1.22 *A full range of pencil grades*

automatic pencil (Fig. 1.23). The wooden pencil is best sharpened in a mechanical sharpener and the correct point produced with glass paper (Fig. 1.24). The point for drawing lines is often made as a chisel point so that the wear is spread over a larger section of the pencil lead which remains the correct width for a much longer time. Care must be taken when using a chisel-pointed pencil to ensure that the length of the chisel-edge lies exactly along the line being produced. For lettering and sketching use a conical point. Make sure that the pencil is resharpened as wear takes place, so that the line weight remains uniform.

The clutch-type pencil lead is resharpened with the cap (in most cases) or with a small 2 mm lead sharpener (Fig. 1.25). It is also ground to the correct point with glass paper.

The fineline automatic pencil comes in two main thicknesses: 0.5 and 0.7 mm. The distinct advantage of this type of pencil is that lines will have a constant thickness. As the lead wears down to the fine supporting tube, a touch of the button on the end of the pencil produces once more a usable length. These are the best, but most expensive, type of drawing

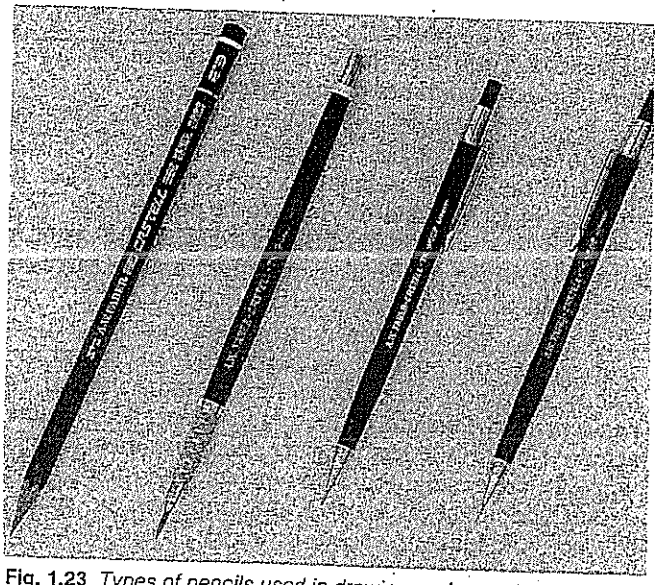
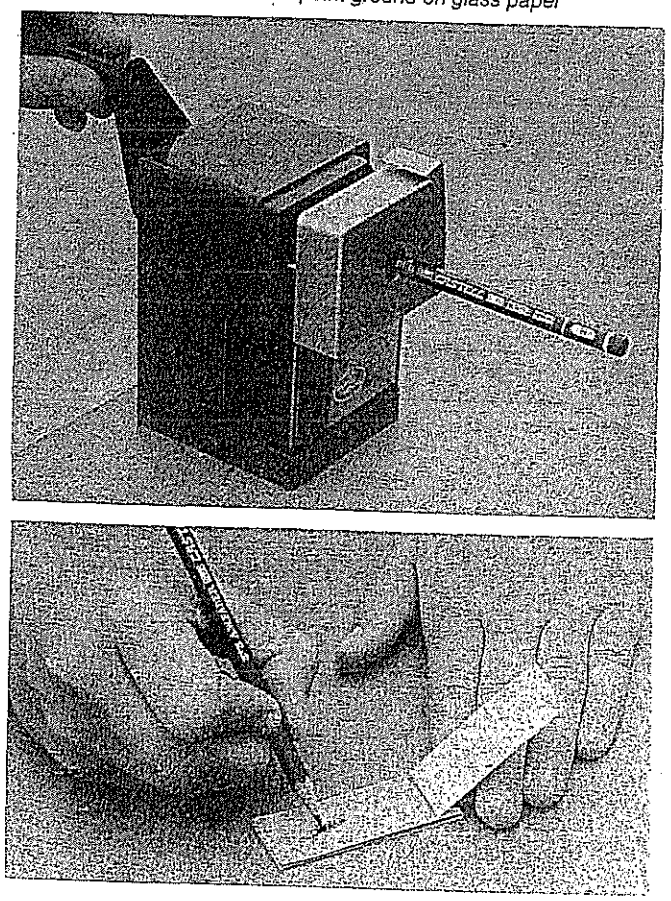


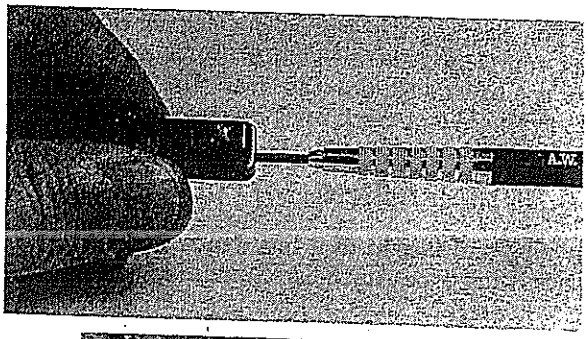
Fig. 1.23 *Types of pencils used in drawing work: wooden, clutch type and two thicknesses of constant thickness automatic pencils 0.5 mm and 0.7 mm* FABER

pencil. Figure 1.15(a) illustrates the use of such a pencil.

A further advantage of the automatic pencil is that there is no deposit of lead left against the edge of the tee square or set squares. When using wooden or clutch pencils, this deposit must be periodically wiped away

Fig. 1.24 *Wooden pencils should be sharpened in a mechanical sharpener and then have the point ground on glass paper*





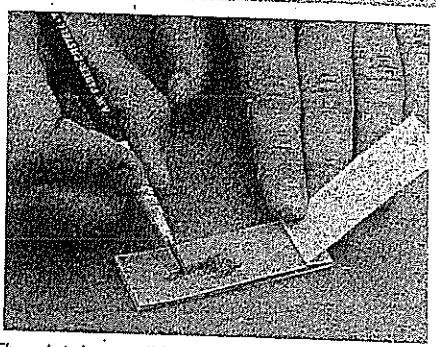
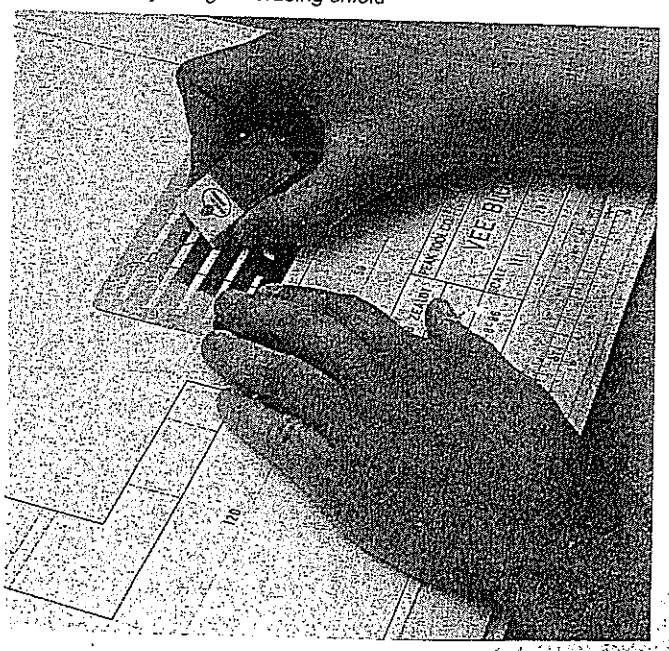


Fig. 1.25 *The clutch pencil is sharpened by allowing the lead to project beyond the clutch and be sharpened by a special lead sharpener. The point is then ground on glass paper.*

with a clean cloth to prevent leaving an unwanted deposit on the drawing paper. If using a softer HB pencil for construction work, make certain that the softer lead is not smudged and spread across the drawing. For this reason construction lines drawn with an HB pencil should be erased as soon as possible.

For erasing unwanted lines and construction lines use a good quality soft rubber eraser and an erasing shield (made of very thin stainless steel). The shield enables lines in a closely defined area to be erased without affecting lines that are to be left in (Fig. 1.26).

Fig. 1.26 *Unwanted lines may be erased without interfering with wanted lines by using an erasing shield*



For cleaning the general plain areas of a drawing after completion the art-gum eraser is preferred. Take care not to smudge drawing lines. Use the edge of the erasing shield as a mask when erasing near lines.

1.6 Types of lines

The type and weight of a line denotes certain features of a drawing. The Australian Standard, AS1100.5, lists the style and thickness of lines together with their uses in drawing. Table 1.3 sets out a selection of lines for pencil drawing on an A3 size sheet, together with their applications.

Type A lines are the most important in a drawing and should have a weight that will make them stand out from the drawing sheet. The borders of the sheet, the title block and the outlines of objects should be this weight. The weight of all these lines should be uniform to give a completeness and authority to the drawing. The actual appearance of the line will depend on the brand, quality and designated hardness of the pencil, the paper surface texture and the pressure applied by the drawer.

Type B lines are only half the relative weight of type A and may be drawn with reduced pressure on the pencil or by using a harder pencil and thinner point. As these lines only provide auxiliary information such as dimension lines, they must not draw attention away from the actual outlines of the objects.

Type C lines are lightweight lines and are used to denote breaks in objects depicted where only a certain detail of the object is required or where the object is uniform in section and too long to fit on the page. The freehand line is made deliberately wavy and is usually only used where the break depicted is small. The ruled zig-zag line is preferred where the break is long.

Type D lines are of medium weight and are used to represent actual outlines and detail hidden behind the face of an object. In practice they should be about 70 per cent of the weight of the type A lines. This can be achieved by a little less pressure than that used for the type A line, using the same pencil and point. The dashes should be at least 3 mm long and the spaces between the dashes about 1 mm. If the dashes are longer, the spaces should be extended; in other words, maintain the same dash : space ratio.

Type E lines are used mainly as centre lines drawn down the axis of symmetry of an object depicted in the drawing. The line is thin and half the weight of type A so as not to detract from the actual outlines. The spaces are at least 1 mm wide; the small dashes are from 2 to 3 mm long while the longer ones are from 6 to 30 mm.

Table 1.3 Line types and their applications

Type of line and weight	*Type designation and example*	*Application*	*Approximate thickness on A3 size sheet in mm*
Continuous—thick	A	visible outlines border lines	0.7
Continuous—thin	B	dimension lines projection lines leaders fold lines short centre lines hatching	0.35
Continuous—thin freehand or ruled with zig-zag	C	break lines	0.35
Dashed—medium	D	hidden outlines	0.5
Chain—thin	E	centre lines pitch lines alternative position of moving part	0.35
Chain—thick at ends and at change of direction, otherwise thin	F	indication of section planes	0.35