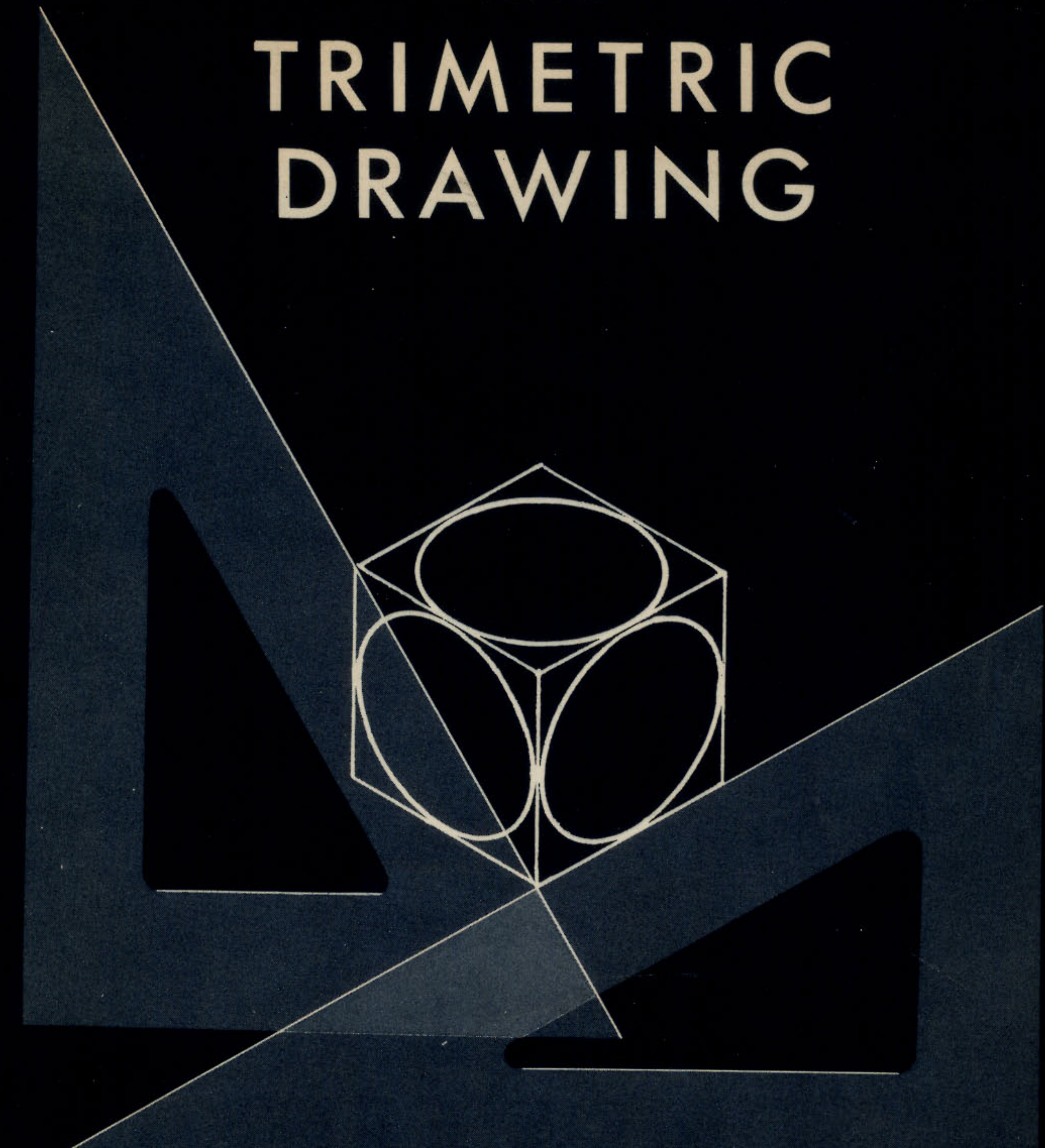
ISOMETRIC AND TRIMETRIC DRAWING



C. B. LOWE

ISOMETRIC
AND
TRIMETRIC

ISOMETRIC AND TRIMETRIC DRAWING

C. B. LOWE

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Foreword

Whilst it has become increasingly recognized that Isometric views are almost essential for explanatory hand-books of various mechanisms, sometimes by way of ghost drawings, and in other cases by exploded views showing the component parts, it does not seem to have been generally recognized that the advantages and clarity of this form of portrayal can be applied in an equal degree to actual working drawings.

One of the reasons may be that heretofore there has not been available a simple work to form a basis for instruction in its practical application. I consider that *Isometric and Trimetric Drawing* does meet this requirement.

In my experience on automobile and aircraft armament design and construction, too few of the draughtsmen I have known have been able to make pictorial engineering drawings, due either to their non-appreciation of its benefits, or their lack of the constant practice by which it becomes a quick and easy medium of expression.

Those who use it freely have, in my opinion, a much more facile designing ability than those unversed in its art.

This book is written in simple language and includes small but important points which, though valuable, I have not previously seen brought forward.

Mr C. B. Lowe has long been an advocate of pictorial engineering drawing and I am very glad to see that in this hand-book he has put his wide knowledge of the subject within reach of our coming draughtsmen and designers.

A. Fraser-Nash
2-10-62

Introduction

Orthographic, or flat, drawing employing three or more views will always be the main method used when recording or setting out dimensioned shapes. These are drawn using either first or third angle projection. There are many occasions, however, when the addition of a three-dimensional view would be most helpful in order to clarify some particularly obscure feature.

Sometimes even engineers with long experience are puzzled when studying ordinary flat drawings of complicated parts, which although correctly drawn, may have some detail which is not immediately understood. It is in such cases that the inclusion of additional pictorial views has great value, permitting instant recognition of complicated shapes and detail which might otherwise be obscure.

Pictorial drawing may be carried out in three main ways:

Isometric, The simplest form.
Trimetric, More difficult but sometimes necessary.
Perspective, Essential for artistic representation.

Of these, isometric is the most favoured because of its relative simplicity. This is brought about by the fact that its three planes are equally tilted to the eye of the beholder and so have equality of measure along the edge lines. It must be admitted, however, that this equal tilting can bring disadvantages in some rare cases; for instance certain simple forms can appear to turn themselves inside-out, but this is an optical illusion which ceases as the drawing grows with added detail.

The only other slight disadvantage which might occur is the coincidence of some lines being in the direct sight path of others. When this is likely to occur, the draughtsman would be wise to use a trimetric attitude with the most direct plane (the fullest plane) showing the feature or features which require particular emphasis.

Both isometric and trimetric drawing are geometrically pure forms of drawing, being projections from orthographic views. There is no need for guesswork. Perspective vanishing does not occur in isometric or trimetric drawing; both, however, may be regarded as perspective at an infinite distance. To some extent the lack of vanishing is evident; it depends very much on the aspect ratio of the subject depicted. In compact subjects it is barely noticeable, particularly if they contain a lot of detail.

In any case we must keep in mind the fact that we are not trying to produce an artistic creation but a clear and easily understood mechanical document which is obvious in its meaning to all who study it.

All draughtsmen should be able to draw in isometric and in trimetric. They are not difficult once the main rules are mastered.

Perspective drawing, a most absorbing subject, is not taught in this book. It requires constant practice and is generally left to specialists.

Isometric Projection

HAVING EQUALITY OF MEASURE—ISOS *equal.* METRON *measure*

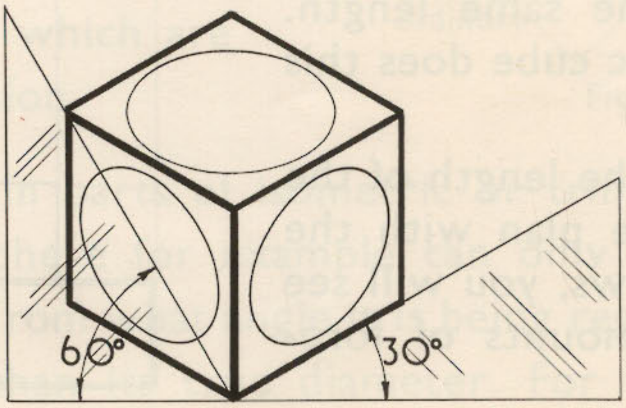
Isometric Projection is a method of drawing solid objects using the same scale of linear measurement on each of the three planes.

This is done by picturing the object cornerwise and at such a downward angle that each plane is equally inclined to the view, as in the figure below.

Because each plane is equally inclined, all edges are proportionately reduced in apparent length, being foreshortened to a known ratio. It is necessary therefore to use a smaller scale when producing isometric drawings.

The reason for this reduced scale, and how it is determined, must be clearly understood by the draughtsman if he is to be confident of every line of his drawing.

To this end, a simple exercise is given in the diagrams overleaf. Using everyday articles as models such as a matchbox and a cube of sugar, arrange them so that when viewed from above they appear as set out in the top figure overleaf.



Standing square to the desk or board on which they are placed, look downward and you see the plan view, Figure 1.

Moving backwards in a straight line, but still keeping square to the desk, you will see an ever-changing aspect, and the front corner angles of the box and cube will appear gradually to change from 90° to some increased angle according to the angle of view, as in Figures 2 and 3.

If your angle of view alters so much that your sight line is 90° from its original position then naturally the angles will have opened out so that they now form a straight horizontal line, the whole forming a corner elevation, Figure 4.

The isometric view lies between the two extremes and it will be noted how the dotted lines representing the invisible edges of the cube meet at the same point as the top front corner of the cube. Thus the nine lines forming the visible edges are all of the same length. Only in an isometric cube does this occur.

By comparing the length of the box taken from the plan with the lengths in other views, you will see the variation in amounts of foreshortening.

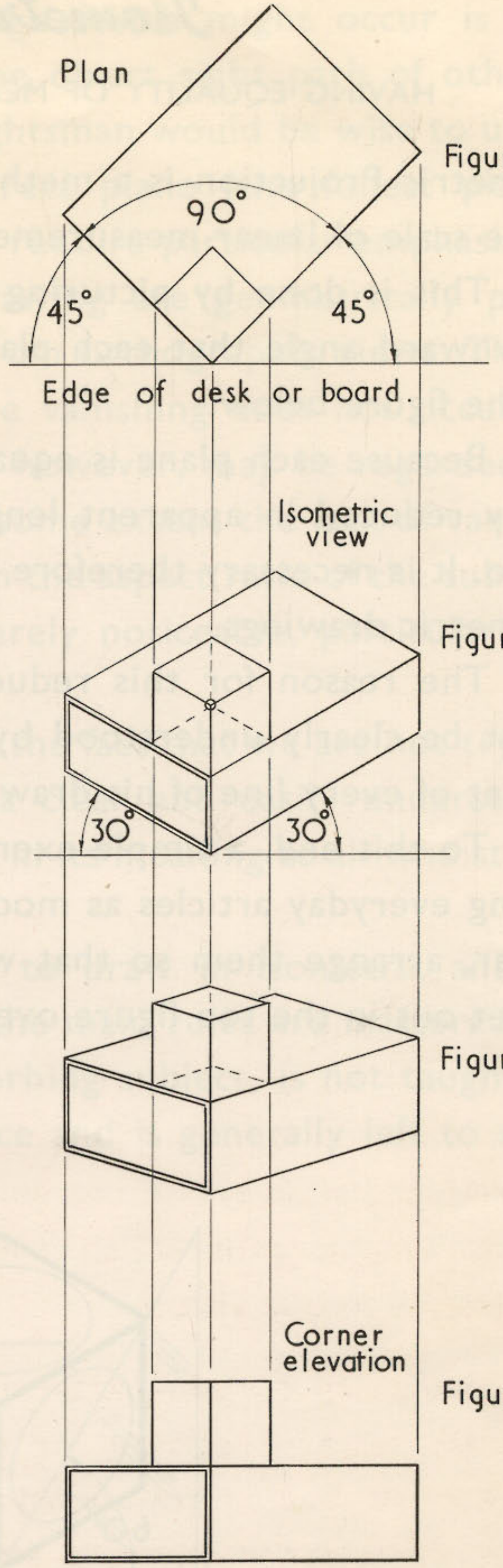


Figure 1

Figure 2

Figure 3

Figure 4

The Isometric Scale

Having seen the necessity of a reduced scale, we now learn how it is determined. It is a precise measurement for a given degree of foreshortening and its ratio to flat measure should be fully understood.

If we draw an inch cube isometrically but neglect to use the isometric scale it will look like Figure 5, i.e. too large.

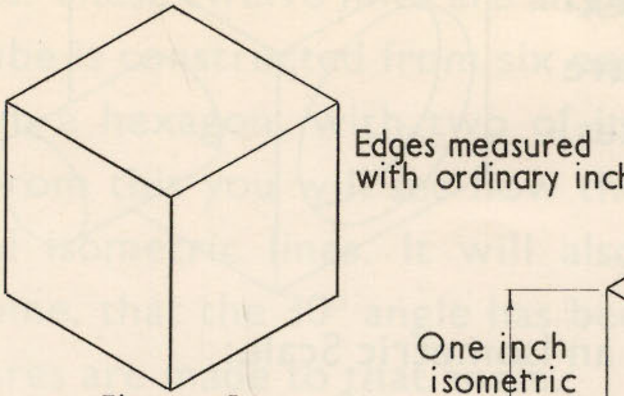


Figure 5

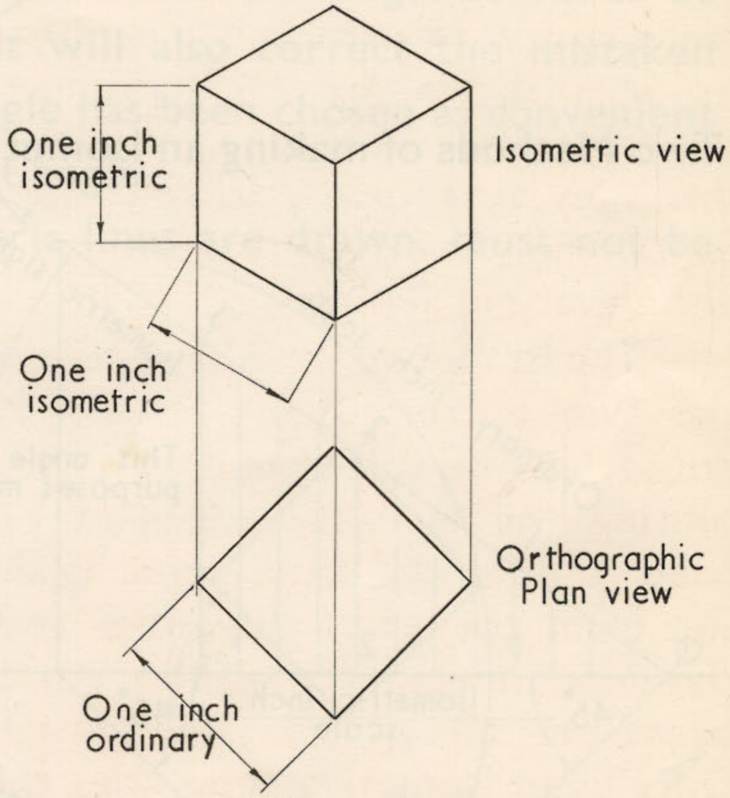


Figure 6

Compare the incorrectly scaled cube above with the cube drawn to correct scale, right. (Figure 6.)

It will be seen, therefore, that the reason for using a specially reduced scale is because we are drawing lengths which are at an angle to our vision.

There are certain parts of isometric or trimetric which retain ordinary scale. A sphere for example can only appear at its true diameter no matter from what angle it is being regarded. It can never be anything other than its true diameter. For the same reason a circular shaft or cylinder always shows its full diameter, as do circular holes, their full diameter being expressed as the major axis of an ellipse.

In Figure 7 a $1\frac{1}{2}$-in. cube is shown with a circular feature on each of its planes.

Note that all representations of diameter, expressed by ellipses, have full scale on their major axes.

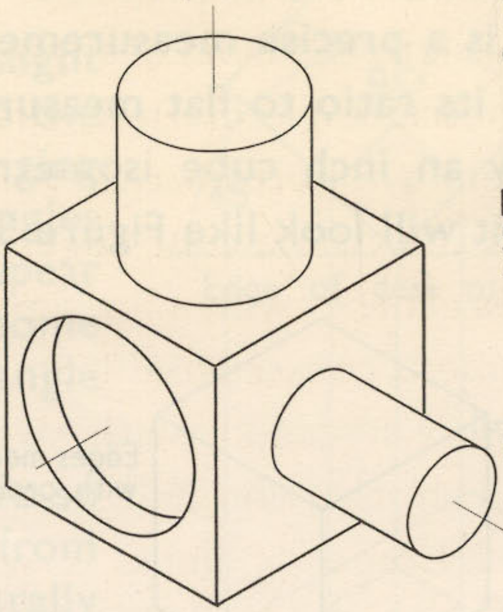


Figure 7

Two Methods of making an Isometric Scale:

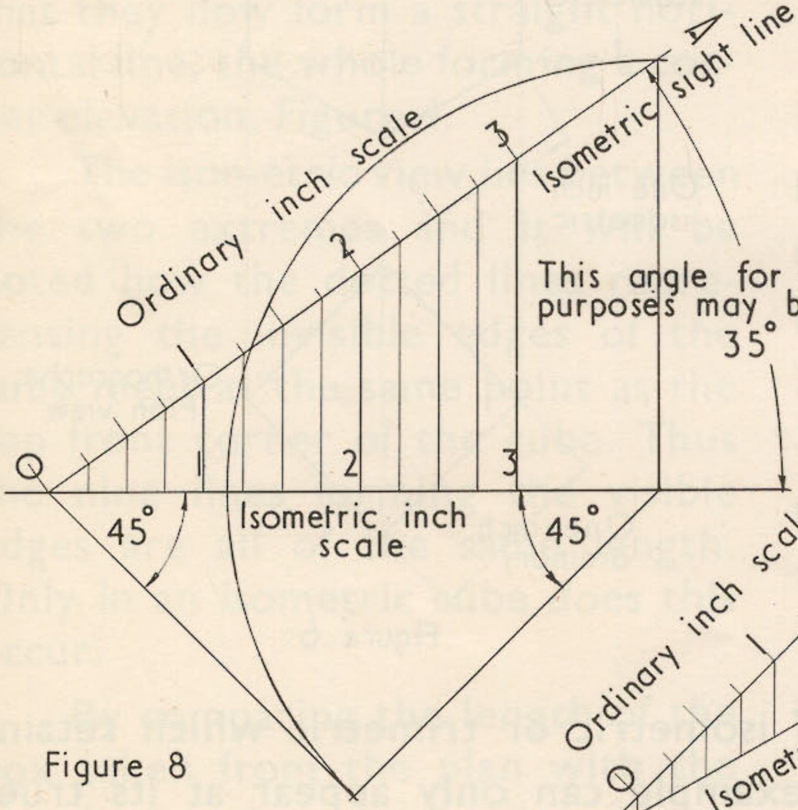


Figure 8

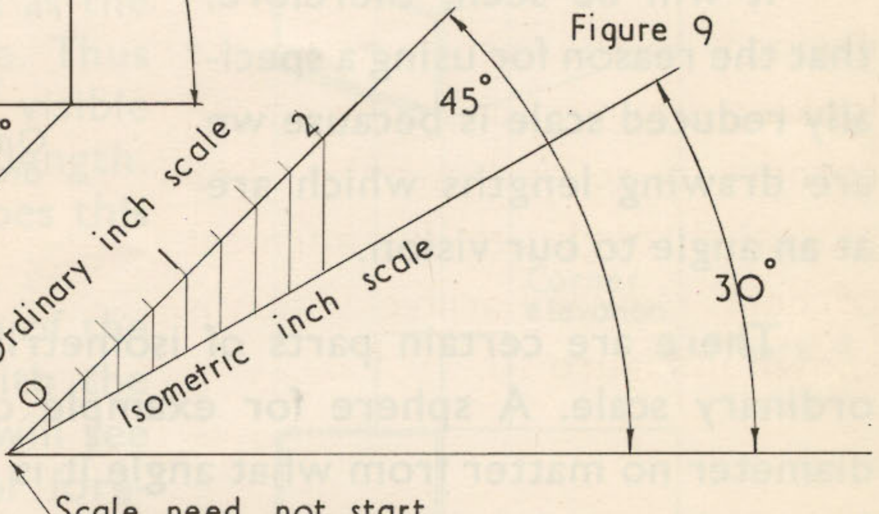


Figure 9

There may be a little confusion in connection with the isometric sight angle, which may be taken as 35°, and the 30° angle at which normal isometric lines are drawn.

Referring back to the cube of sugar in Figure 2 you will remember that at the isometric angle of view, the top front corner of the cube (solid lines) meets the bottom rear corner (dotted lines). Thus, nine solid lines depict the visible cube edges and three dotted lines indicate the hidden edges. These twelve lines are all of the same length, in fact the isometric cube is constructed from six equilateral triangles fitting together to form a hexagon, with two of its sides vertical, for the outside shape. From this you will see how the 30° angle comes to be used for normal isometric lines. It will also correct the mistaken belief held by some, that the 30° angle has been chosen as convenient because set squares are made to that angle.

The 30° angle at which isometric lines are drawn, must not be confused with the sight angle (the angle at which you are looking downwards). The sight angle, which from now on will be shown by the symbol ➤ is decided by the fact that we are looking down on the cube placed cornerwise so that our sight line passes through its furthermost corners. How we arrive at this is shown in Figure 10.

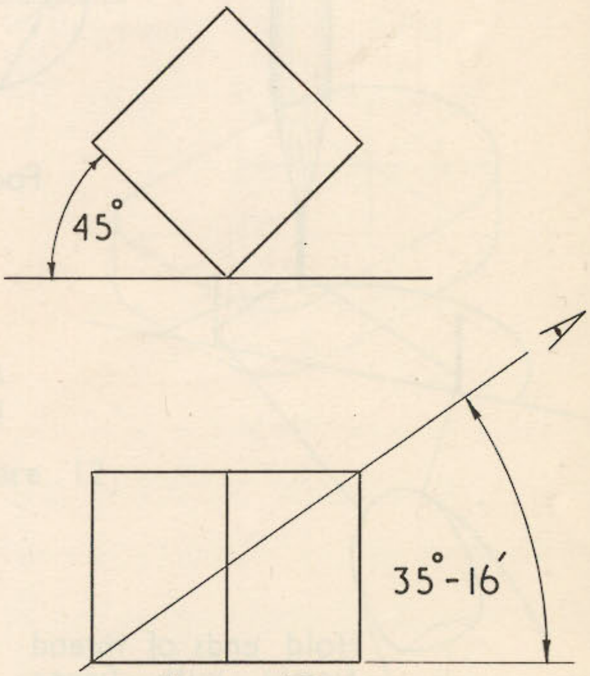
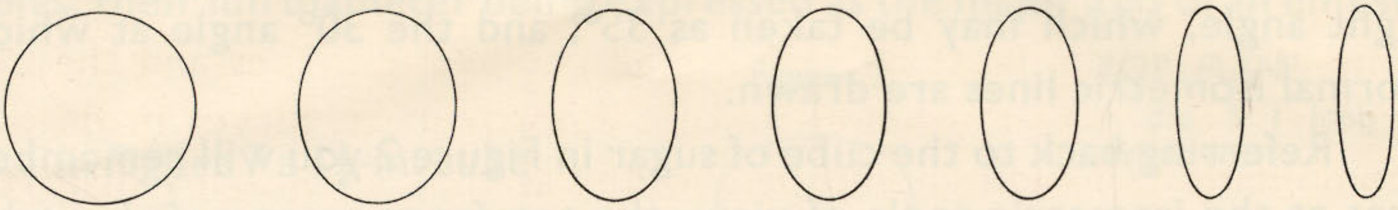


Figure 10

When a circle is tilted to the eye it becomes an ellipse.



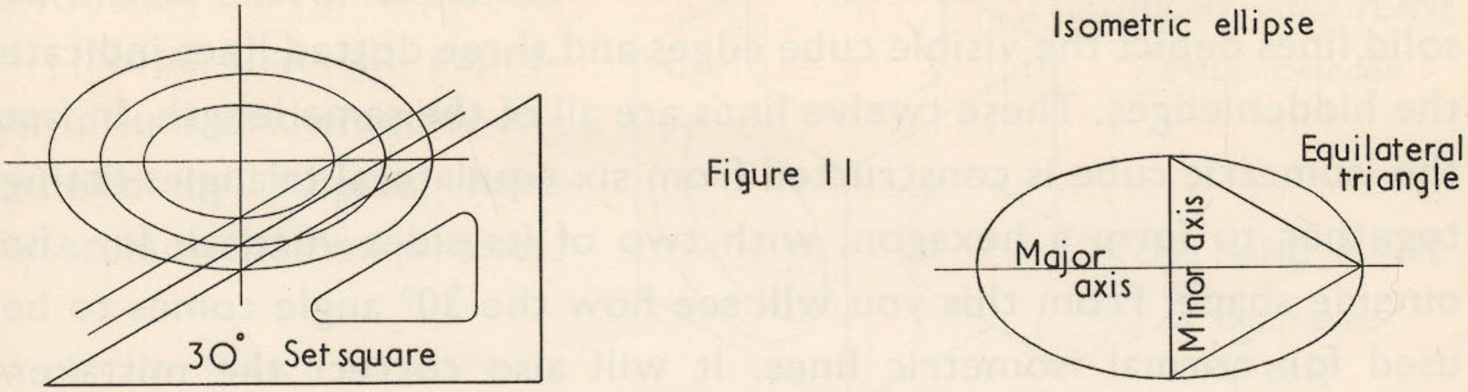


Figure 11

Ellipses around a given axial centre line all have the same major/minor proportion. This applies to isometric ellipses or others.

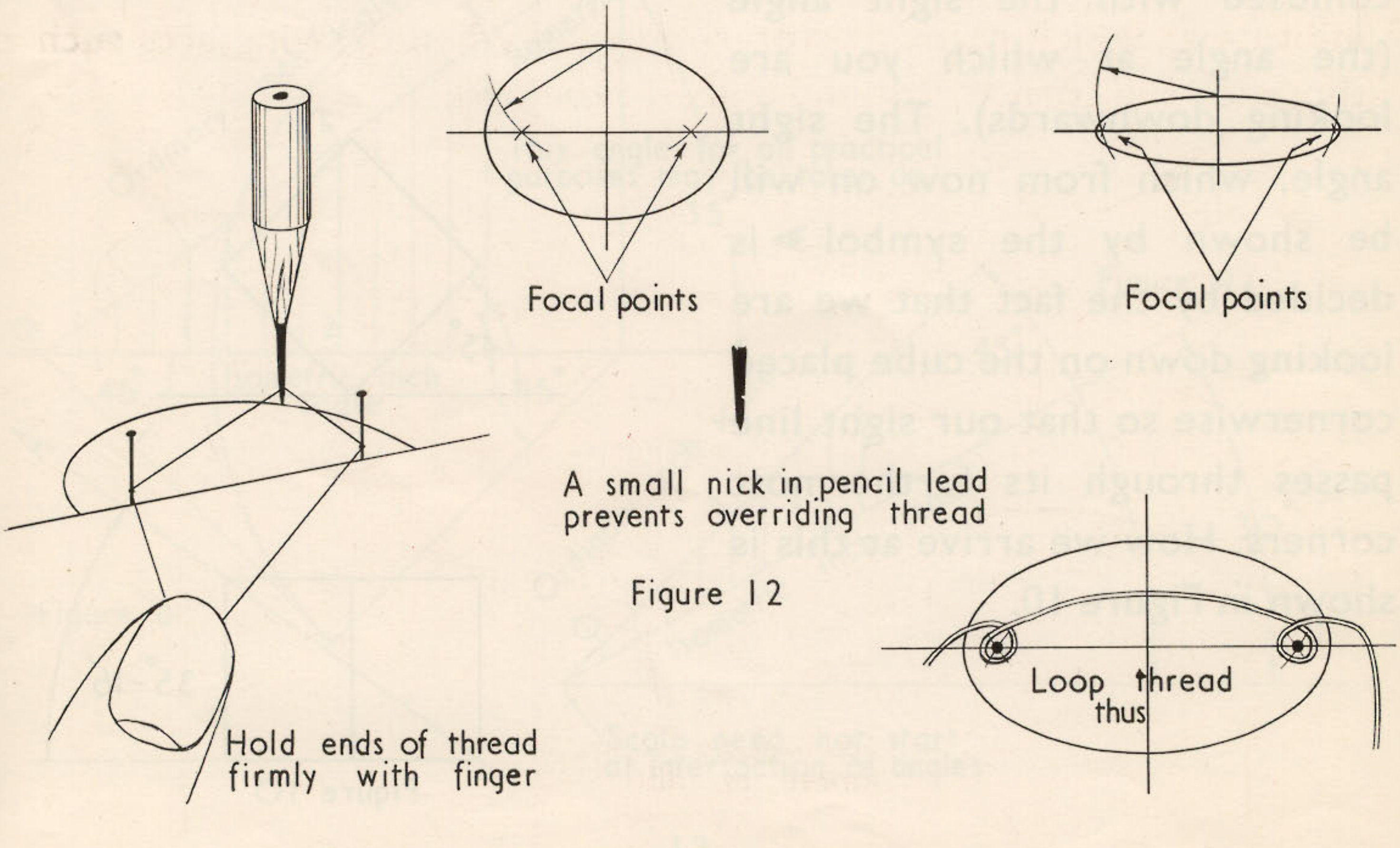


Figure 12

The Ellipse

The ellipse is the most beautiful of all geometric shapes and the care taken in drawing it is amply repaid. Approximate curves made by a combination of radii should be avoided as they are usually distorted and most displeasing. A freehand ellipse is better than one made by radii. Correct major to minor proportions are necessary and in the case of isometric ellipses are easily decided, as shown in Figure 11.

The most practical way of striking elliptical curves is by using cotton or nylon thread as shown in Figure 12 (opposite). The radius of the arc for obtaining the focal points is equal to half the major axis for an ellipse of any size or proportion.

Elliptical masks are a boon to the draughtsman enabling him to draw ellipses crisply and quickly, but if these aids are not available ready-made, they can be made from thin cardboard or stiff paper. When making them, it is helpful to add two cross lines at 30° to the major axis in addition to the major and minor axis lines for they indicate at which point to stop the pencil when drawing arcs such as those for the corner radii in Figure 12 (below).

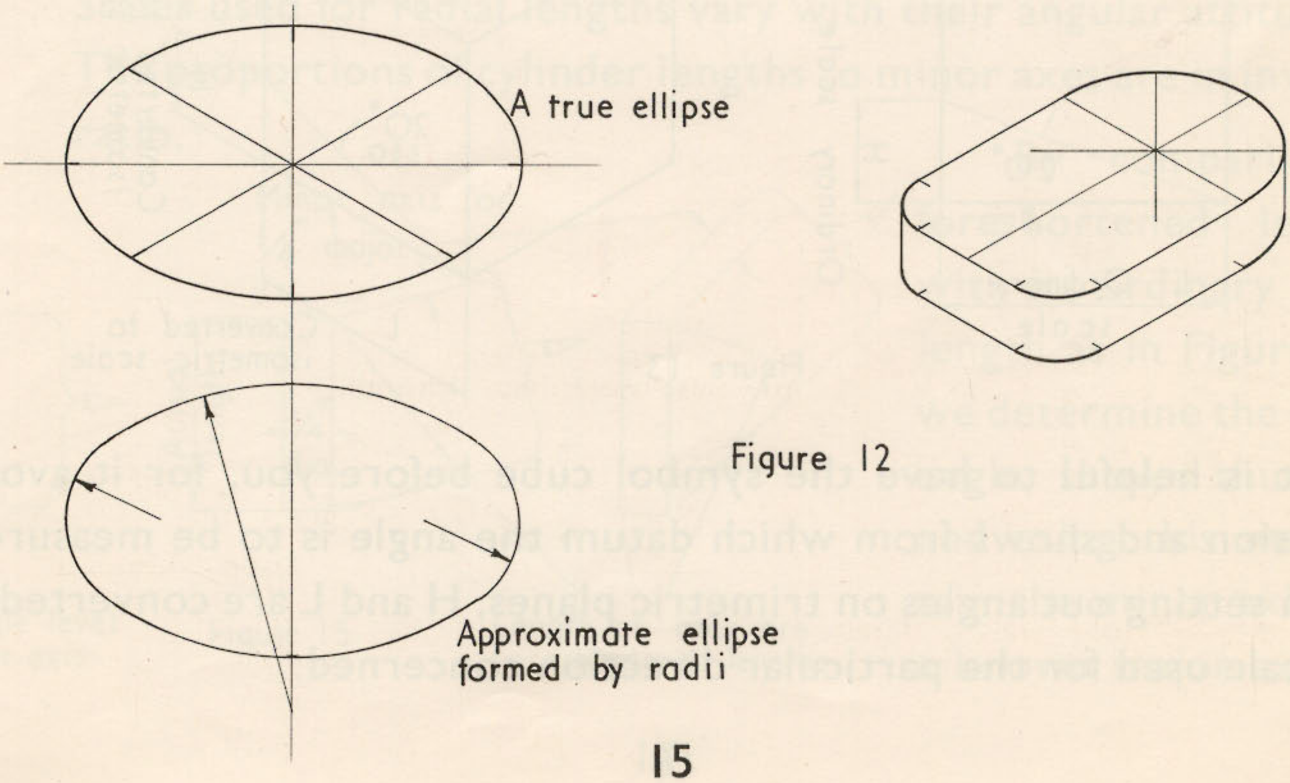


Figure 12

Angular Subjects

Before starting a three-dimensional drawing, be it isometric or trimetric, it is necessary to have before you an orthographic drawing of the subject to be illustrated.

When setting out angles on any of the three planes it is not possible to use an ordinary protractor because the angles need to be converted; angles, like lengths, become foreshortened. Each angular line on any plane must therefore be subject to the scale of lengths used on that particular plane.

To determine an angle, we know that a line rises so much in a distance of so much. In flat drawing these distances or lengths are at right angles to each other. They are not so in three-dimensional drawing, as can be seen below, Figure 13 (right).

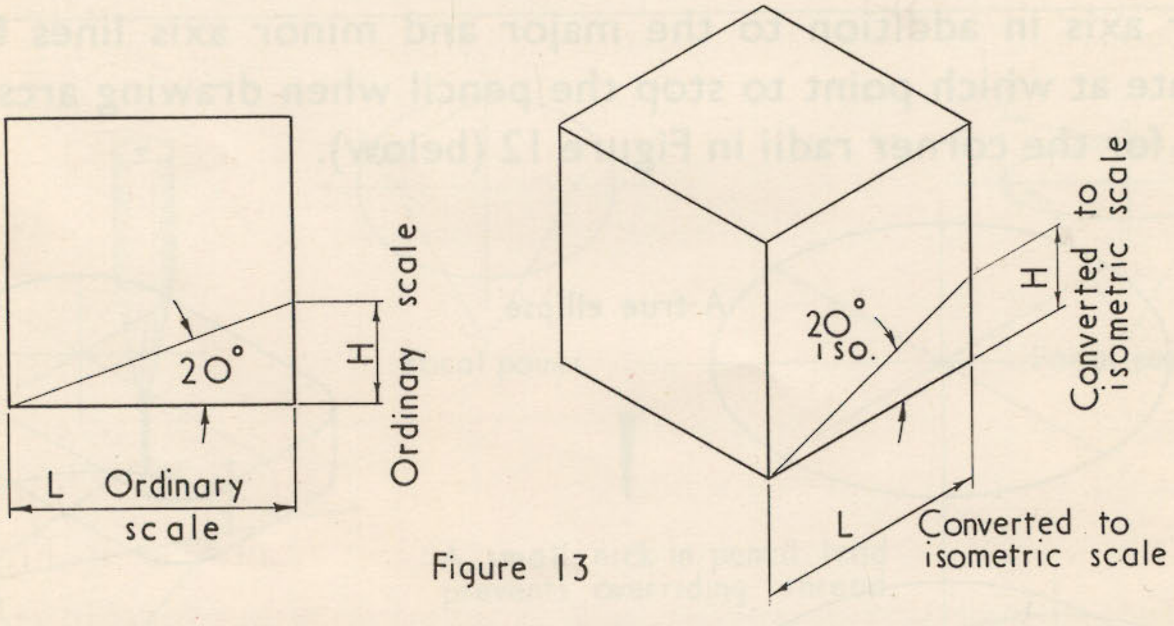


Figure 13

It is helpful to have the symbol cube before you, for it avoids confusion and shows from which datum the angle is to be measured. When setting out angles on trimetric planes, H and L are converted to the scale used for the particular direction concerned.

Angular Attitudes on Isometric Planes

The ellipse of correct proportion and at its correct orientation for its given plane provides an 'on the spot' means of measurement for foreshortened lengths in any direction on that plane if the measurements are made on lines from the ellipse centre or parallel with them. (Figure 14.) This rule applies to all planes, isometric or otherwise. It is essential to use an ellipse of the correct proportion for the plane in question.

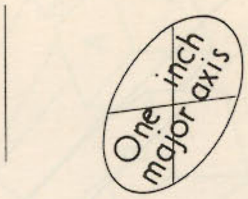


Figure 14

The length of any line across this ellipse, if drawn through its centre, represents one inch in the direction of that line

See also Figure 26

From these varying lengths it is now a simple matter to find the proportions of ellipses which represent circles around the radial lines, which now become axial centre lines.

A study of the drawing on page 19 will show you the following facts:

All cylinders can be measured across their parallel lines.

All major axes are at right angles to the cylinder centre lines.

Scales used for radial lengths vary with their angular attitude.

The proportions of cylinder lengths to minor axes are in inverse ratio.

By comparing a foreshortened length with its ordinary (flat) length as in Figure 15, we determine the sight angle, shown thus: ➤ and using this we obtain the minor axis for a known major axis.

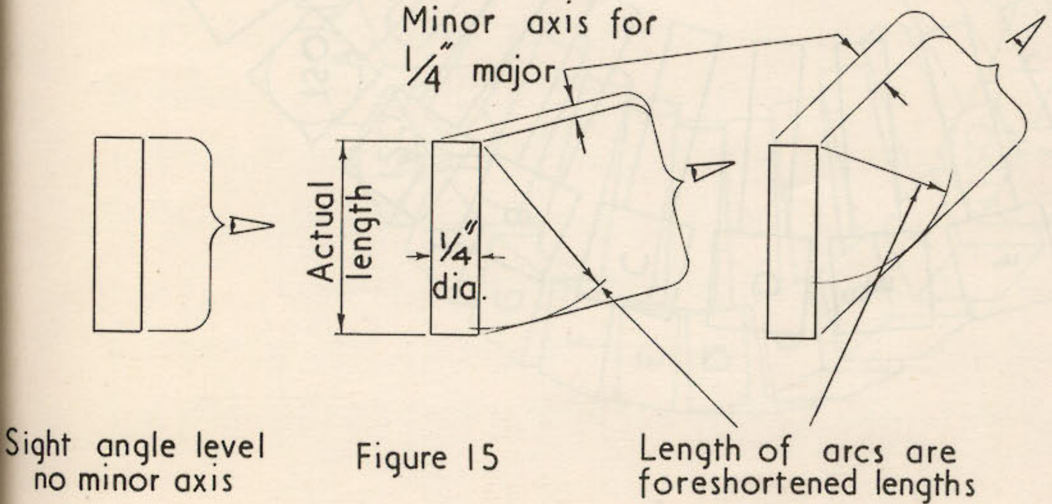


Figure 15

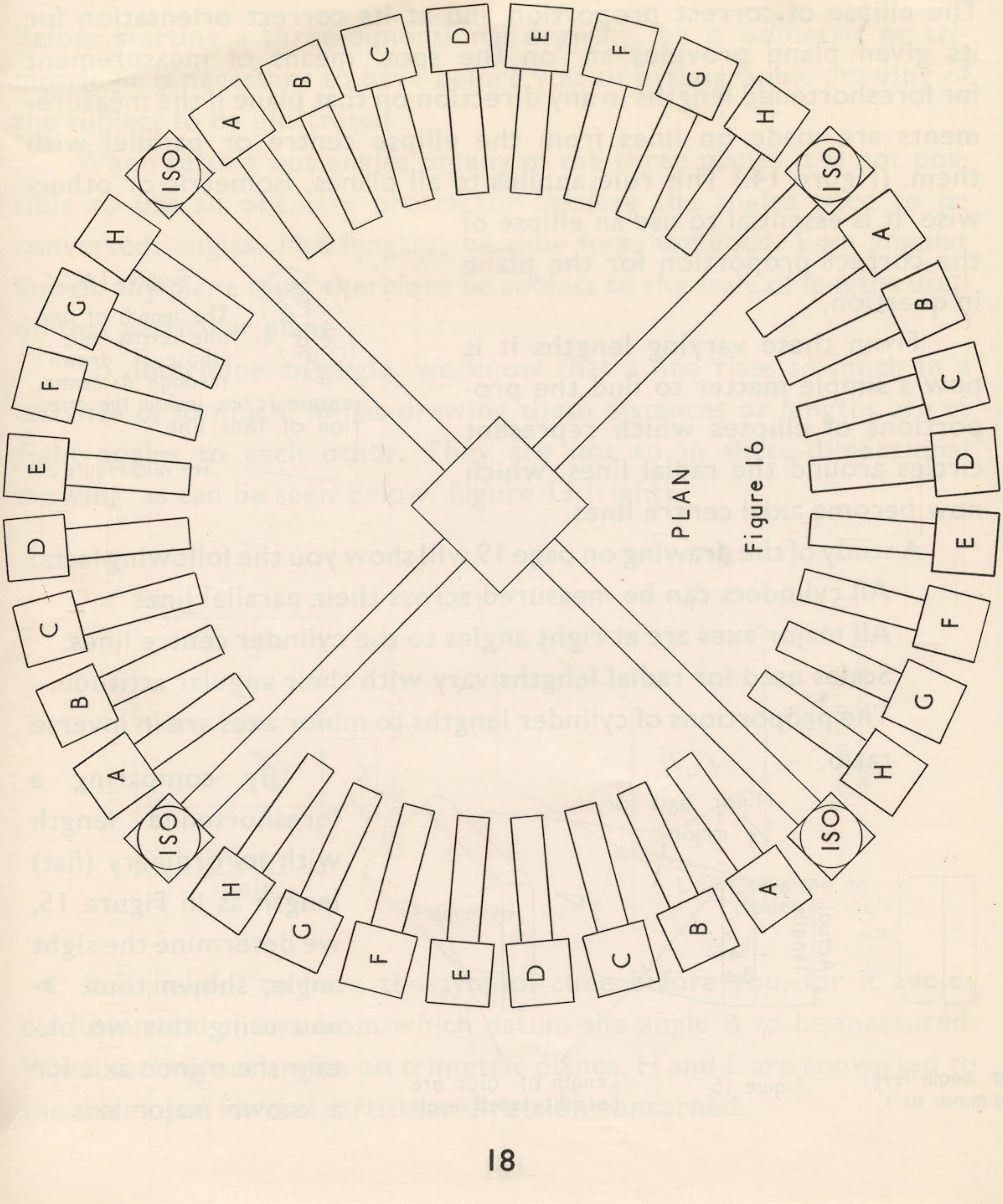


Figure 16

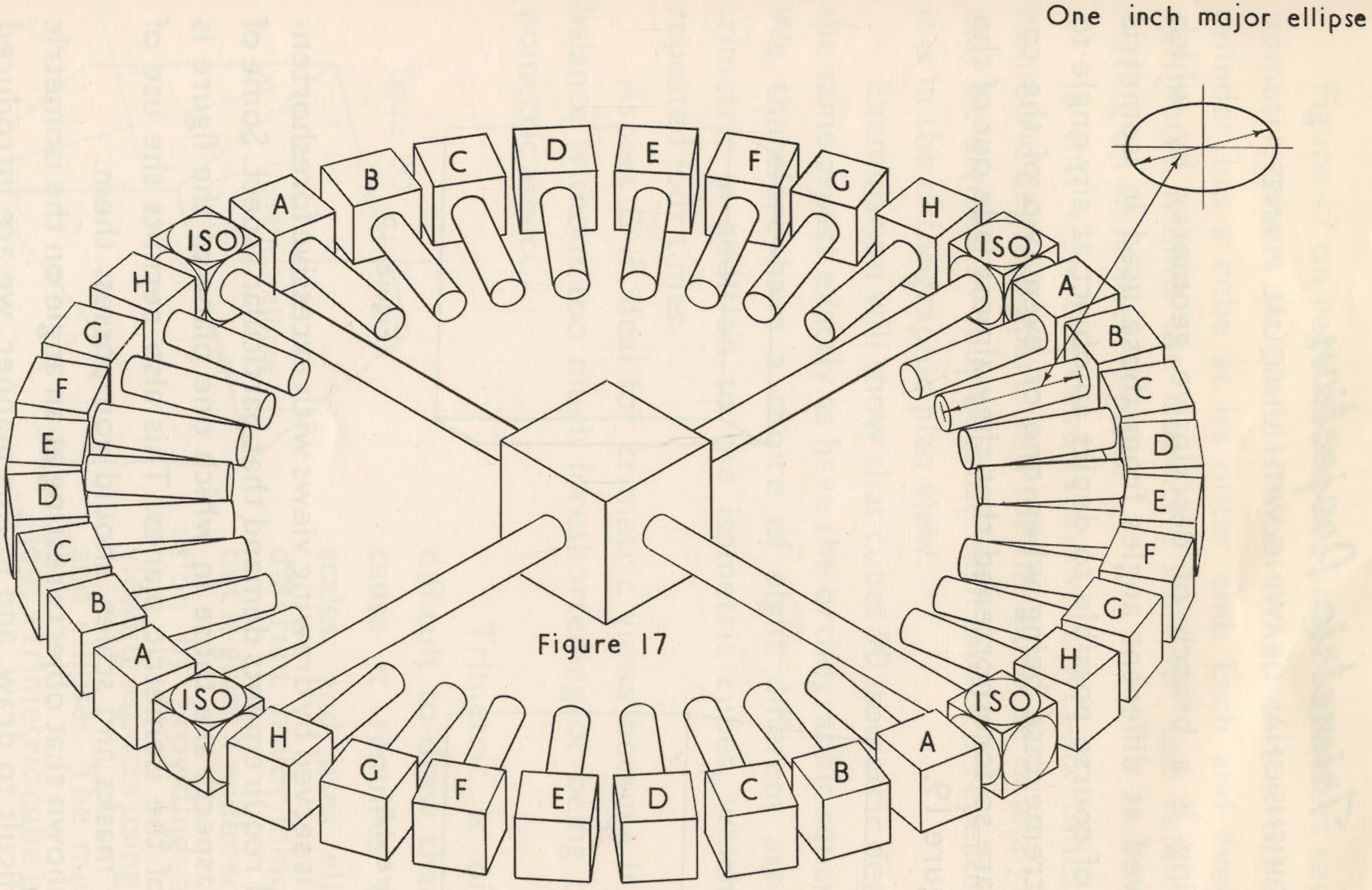


Figure 17

COMPLETE RING OF 36 CYLINDERS AND CUBES SET OUT ON THE TOP ISOMETRIC PLANE (10 ISOMETRIC DEGREES APART)

Cylinders 1 in. long x $\frac{1}{4}$ in. diameter

Cubes $\frac{1}{2}$ in. Centre cube 1 in.

Trimetric Projection

THREE DIMENSIONAL DRAWING WITH UNEQUAL PLANES

Trimetric drawing is a branch of descriptive geometry by which objects are viewed at different angles from those used in isometric projection. It is of course possible to depict an object at any angle to the eye, the extreme case being when one or even two of the co-ordinate planes are so foreshortened that they almost fade out of the picture, as in Figure 19.

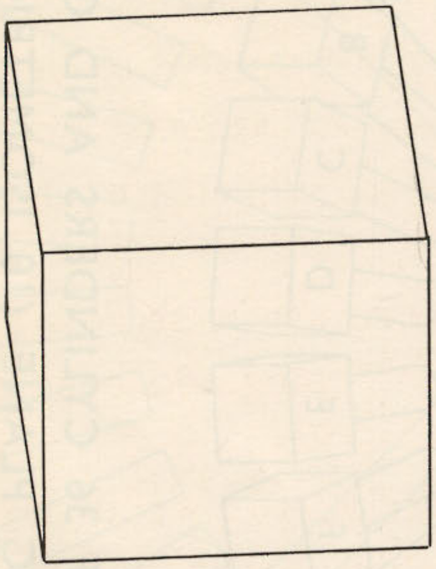


Figure 18

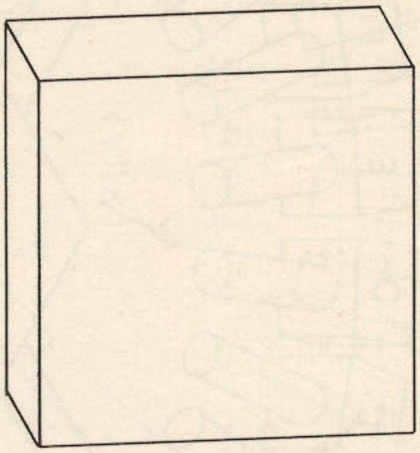


Figure 19

No purpose is served by drawing views with excessive foreshortening unless special requirements demand that particular aspect. Some of the most useful aspects are those in which one plane of the figure is parallel to one of the isometric planes. This also permits the use of isometric ellipse masks and scales, should you possess them.

It has been shown that objects resting at an angle on the isometric plane are not difficult to draw, and in this manner, we are introduced to Trimetric aspects.

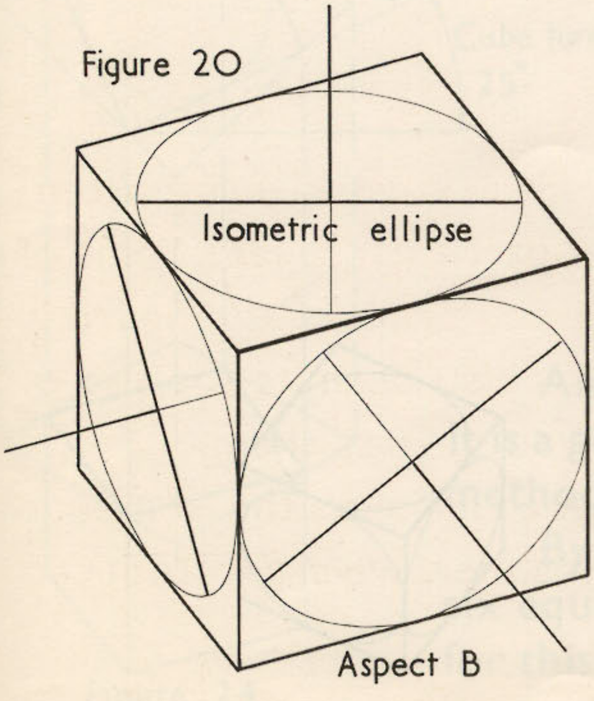
Figure 17 on page 19 shows a ring of cylinders set out on the top isometric plane, (it could be on either of the other planes); each cylinder has a cube at its outer end. Each and every cube on the perimeter retains the isometric scale for the vertical lines as it is resting on an isometric plane.

In this view the cube is shown thirty-six times, i.e. spaced 10 isometric degrees apart, and for the purpose of analysis, this number may be divided by four because each aspect is repeated four times, as it is in the orthographic plan view.

Examination will show that cubes 90 isometric degrees apart have the same aspect exactly as have the orthographic squares in Figure 16. We therefore have a choice of eight different aspects which are trimetric in addition to the isometric cubes, which are of course repeated four times.

Aspect B is ideal for trimetric views because it strikes a good balance without too much foreshortening or being too near to the isometric aspect.

Figure 20



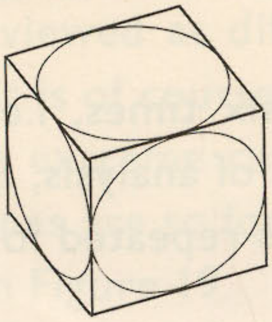
Aspect B

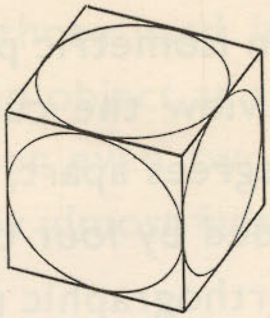
Trimetric is of course more difficult to draw than isometric because it requires three different scales, and uses ellipses of three different major/minor proportions, but it gives a wider scope for expression by providing a choice of six viewing aspects using the same scales and ellipses. The method of setting out a trimetric cube is shown on page 23. Such a cube provides you with the angles and foreshortened scales.

Six aspects of a I-inch cube using the same three scales and the same ellipses.

In addition six upward views can be made.

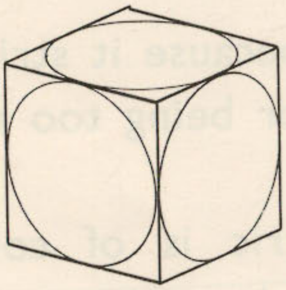
Figure 21

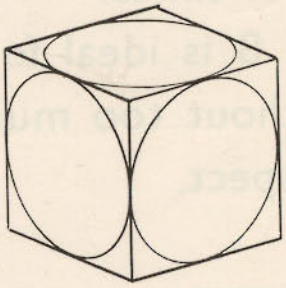




Isometric top plane

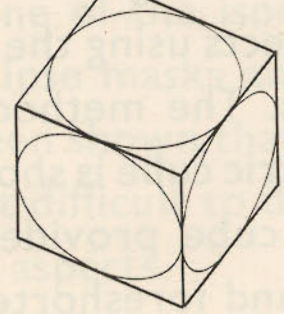
Figure 22

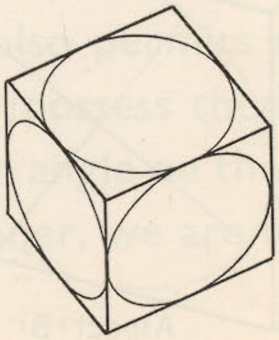




Isometric inward plane

Figure 23





Isometric outward plane

Setting out a Trimetric Cube

To draw a Trimetric cube with its top plane at the Isometric angle of sight: Draw a plan of the top plane rotated to the attitude required. Surround it with an embracing square, drawn with a 45° set square, as shown by fine lines in Figure 24. Project the corners of the embracing square downwards and set out its isometric translation. This diamond shaped form is drawn with a 30° set square, and is therefore a normal top isometric plane. The corners of the inner square projected down to the diamond will give the four points from which the trimetric top plane can be drawn. The vertical edges of the trimetric cube are drawn to isometric scale so that the trimetric cube may be completed.

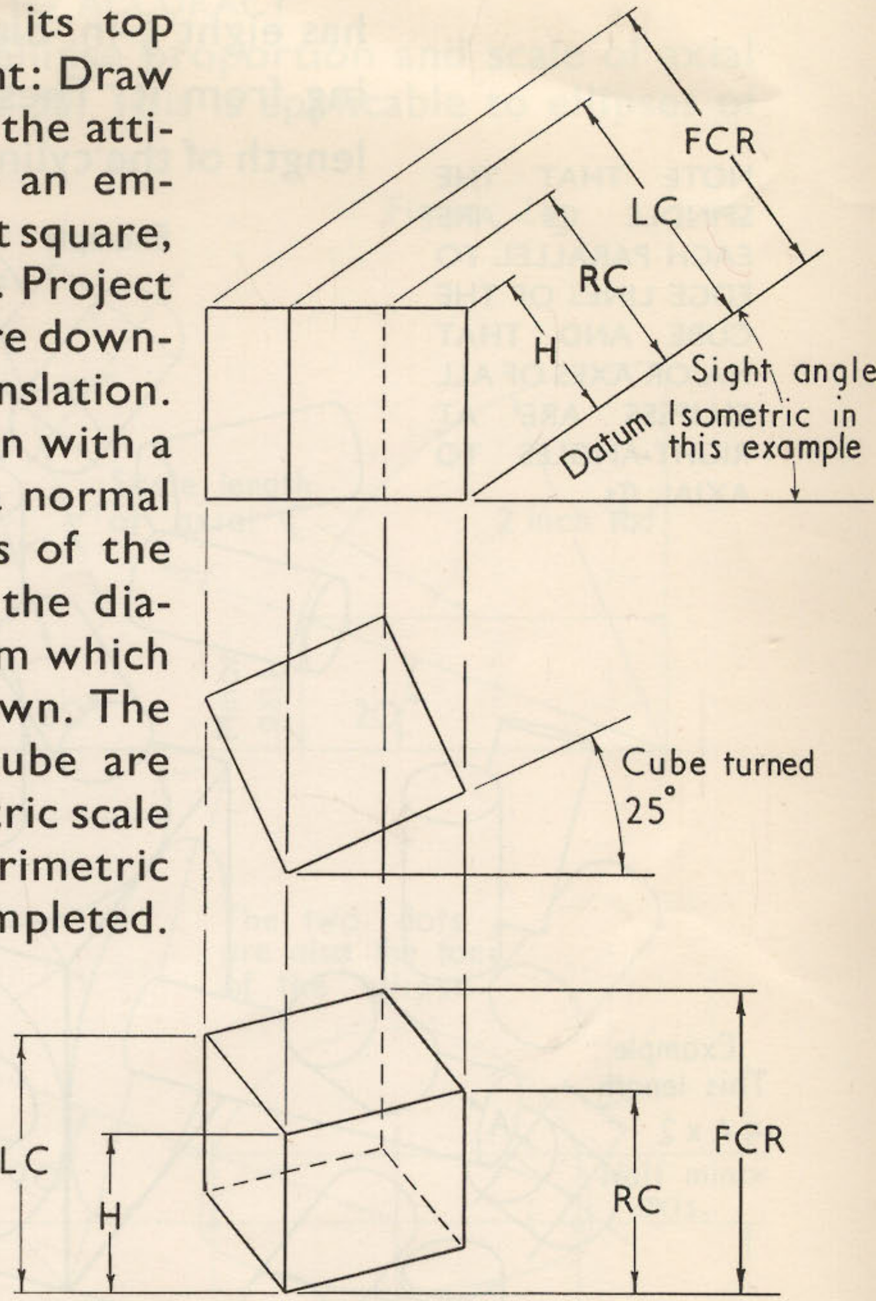


Figure 25

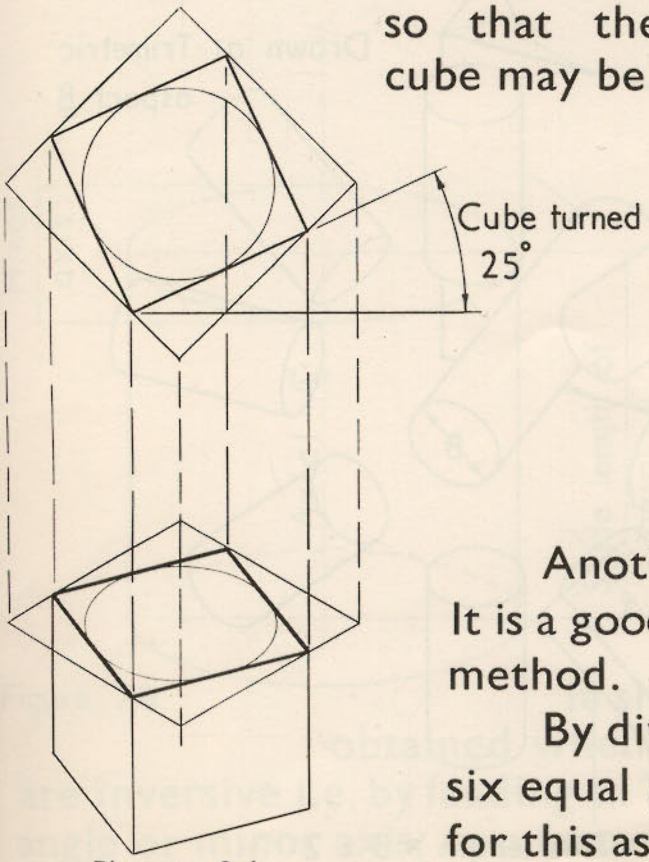


Figure 24

Another method is shown in Figure 25 above. It is a good plan to draw a six-inch cube using this method.

By dividing one of each of the edge lines into six equal parts you have the three scales needed for this aspect.

A 2-in. cube with three ½-in. diameter spindles projecting 2 in. from faces (aspect B). Each spindle has eight ½-in. diameter cylinders I in. long radiating from it. These are spaced 45° apart. The scale length of the cylinders on each plane can be obtained from the spindle ellipse on its own plane.

NOTE THAT THE SPINDLE ℄s ARE EACH PARALLEL TO EDGE LINES OF THE CUBE AND THAT MAJOR AXES OF ALL ELLIPSES ARE AT RIGHT-ANGLES TO AXIAL ℄s.

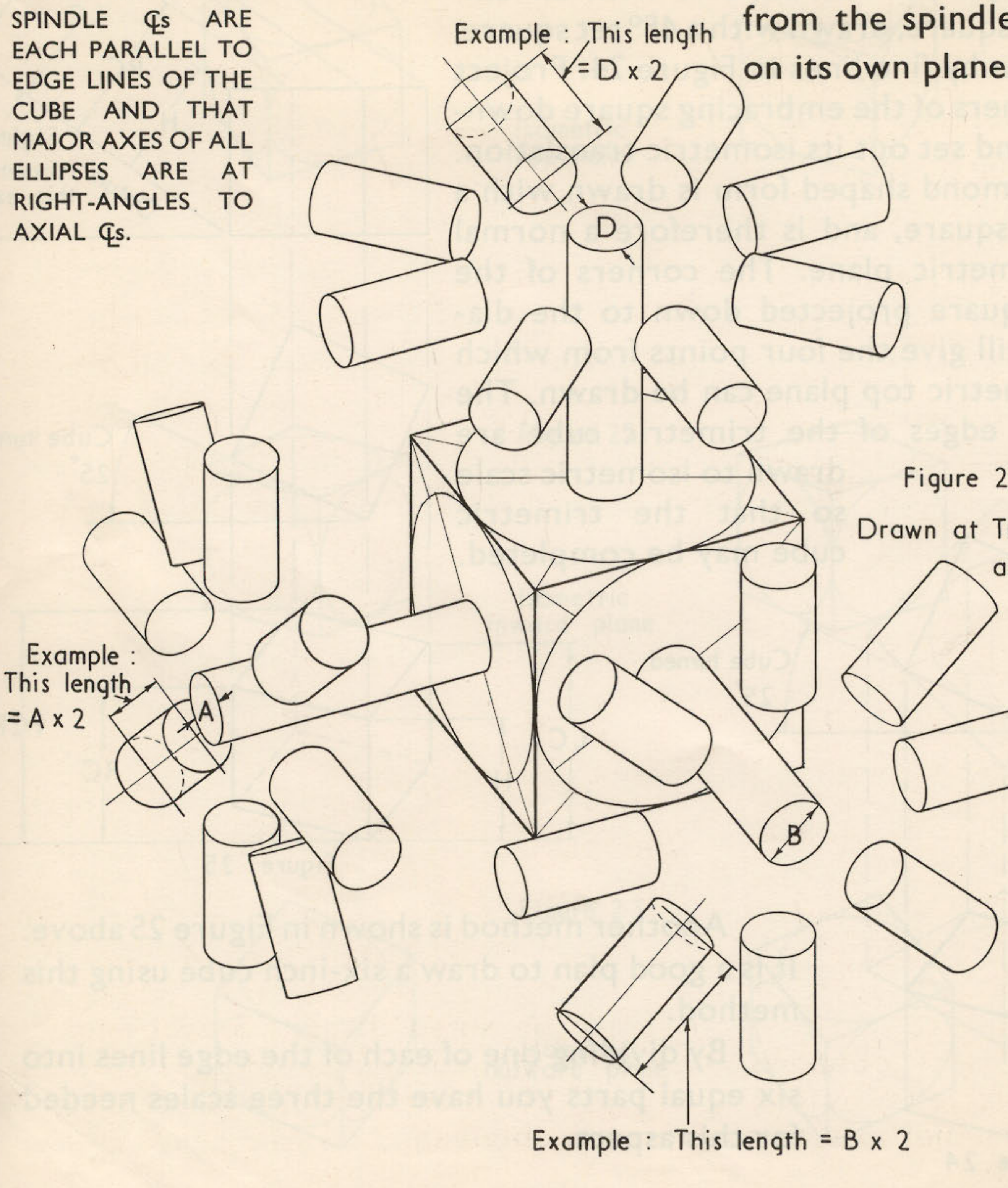


Figure 26

Drawn at Trimetric aspect B

Useful Facts about the Ellipse

SHORT CUTS TO ACCURACY

Three methods of correlàtion of ellipse proportion and scale of axial centre line, Figures 27, 28, 29 and 30. This is applicable to ellipses of any proportion.

Figure 27

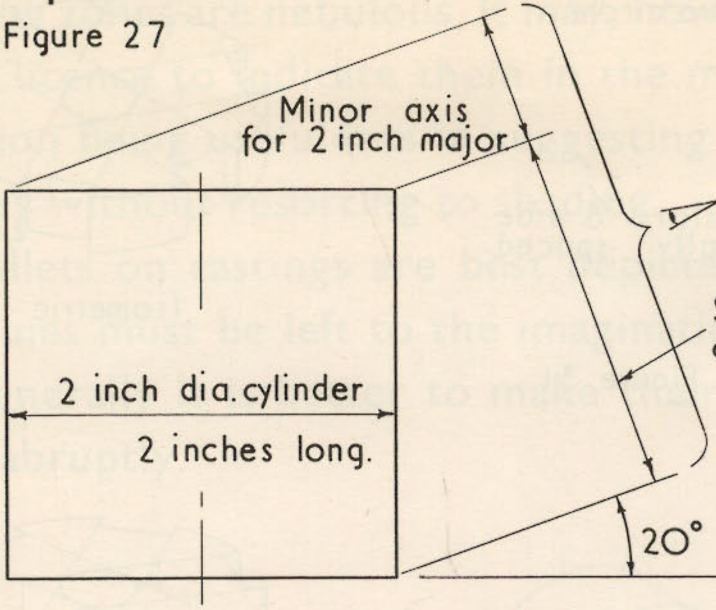
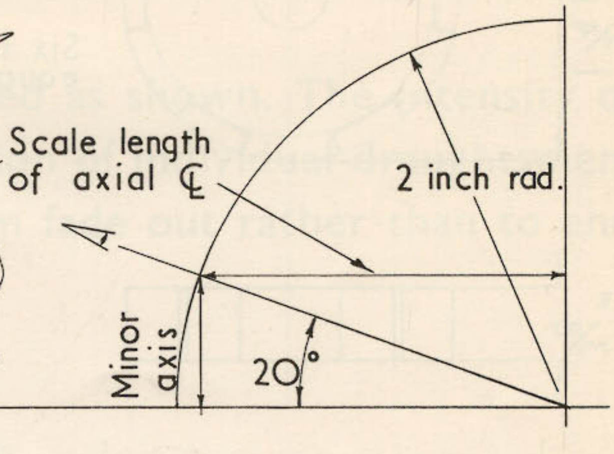


Figure 28



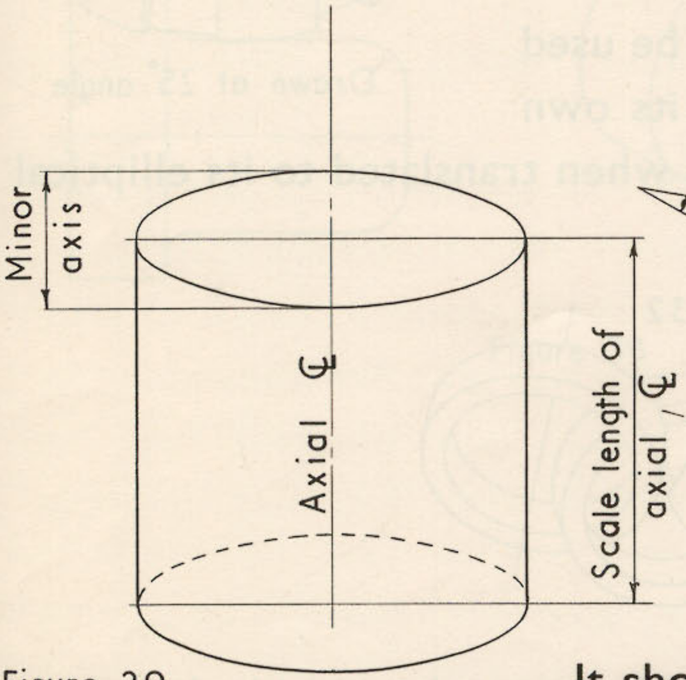


Figure 29

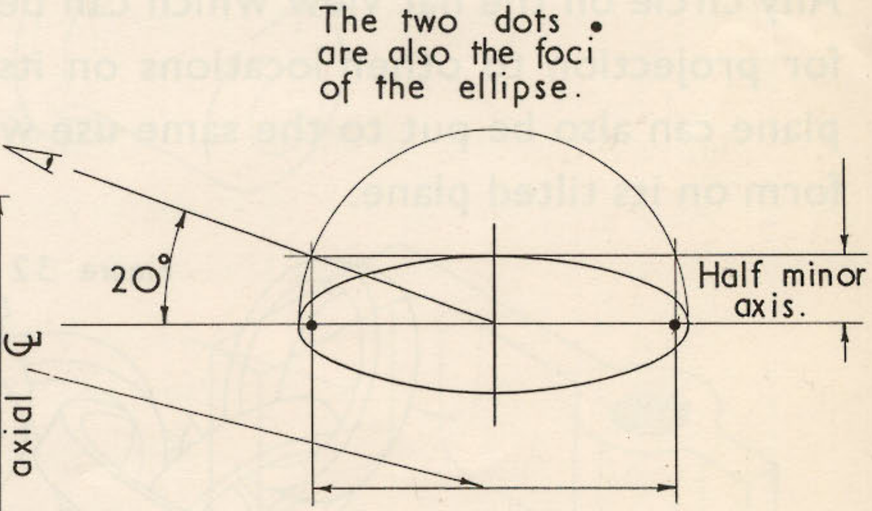
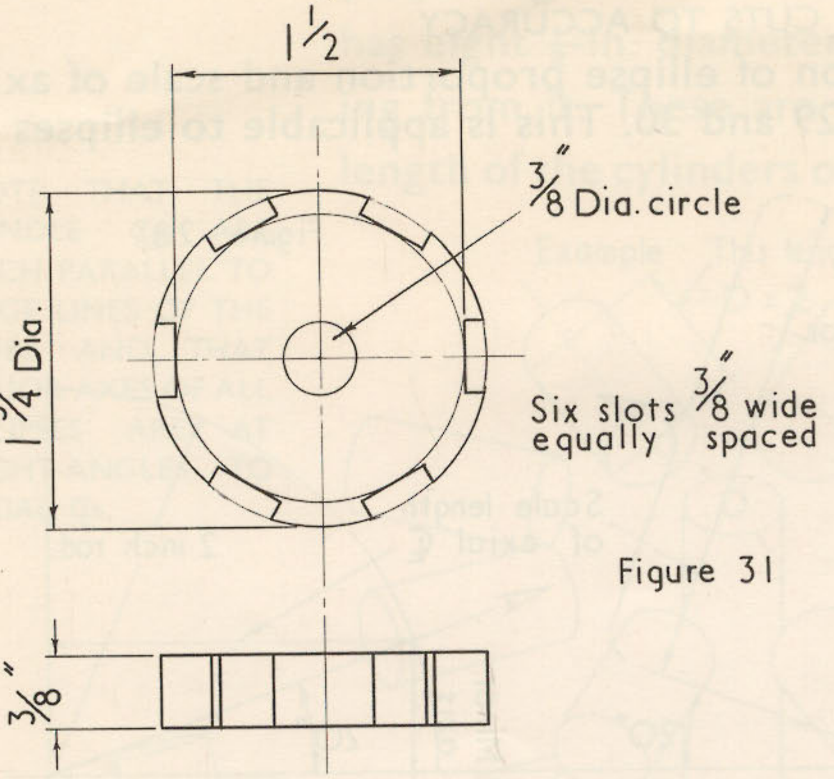


Figure 30

It should be noted that the measurements obtained when using the method shown in Figure 28 are inversive i.e. by feeding in one known factor, be it axial scale, sight angle or minor axis, two factors are obtained.

Other uses of the Ellipse



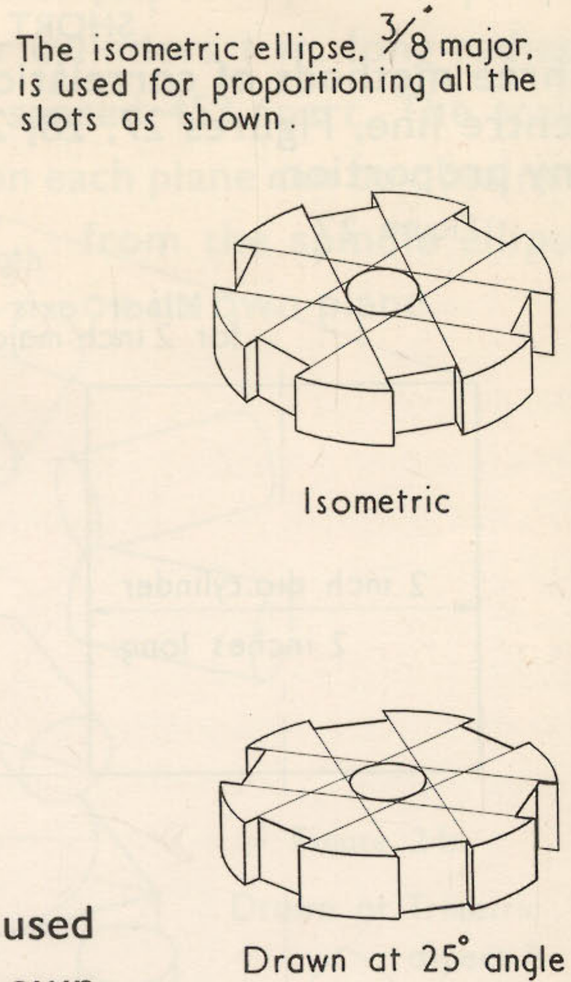
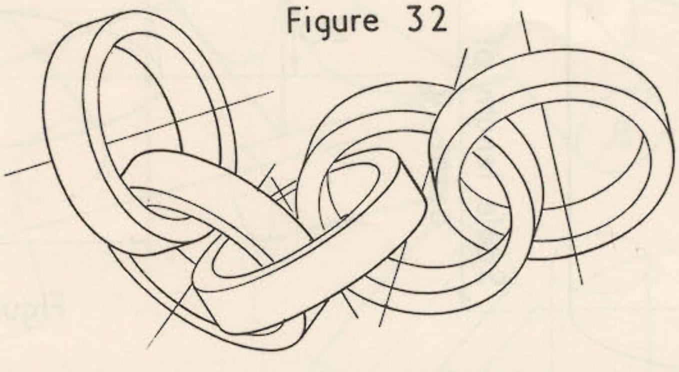


Figure 31

Any circle on the flat view which can be used for projection to other locations on its own plane can also be put to the same use when translated to its elliptical form on its tilted plane.

Figure 32



The five rings are all $1\frac{1}{4}$-in. outside diameter, 1 in. inside diameter, and $\frac{1}{4}$ in. thick. Although they have been tilted haphazardly, it was a simple matter to determine their foreshortened thickness.

Conventional Method of showing nebulous Features

External and internal radii are difficult to indicate because their merging zones are nebulous. It may, however, be considered draughtsman's licence to indicate them in the manner shown below, the sole criterion being usefulness in suggesting what is otherwise difficult to portray without resorting to shading.

Fillets on castings are best depicted as shown. The intensity of such lines must be left to the imagination of individual draughtsmen, but generally it is better to make them fade out rather than to end them abruptly.

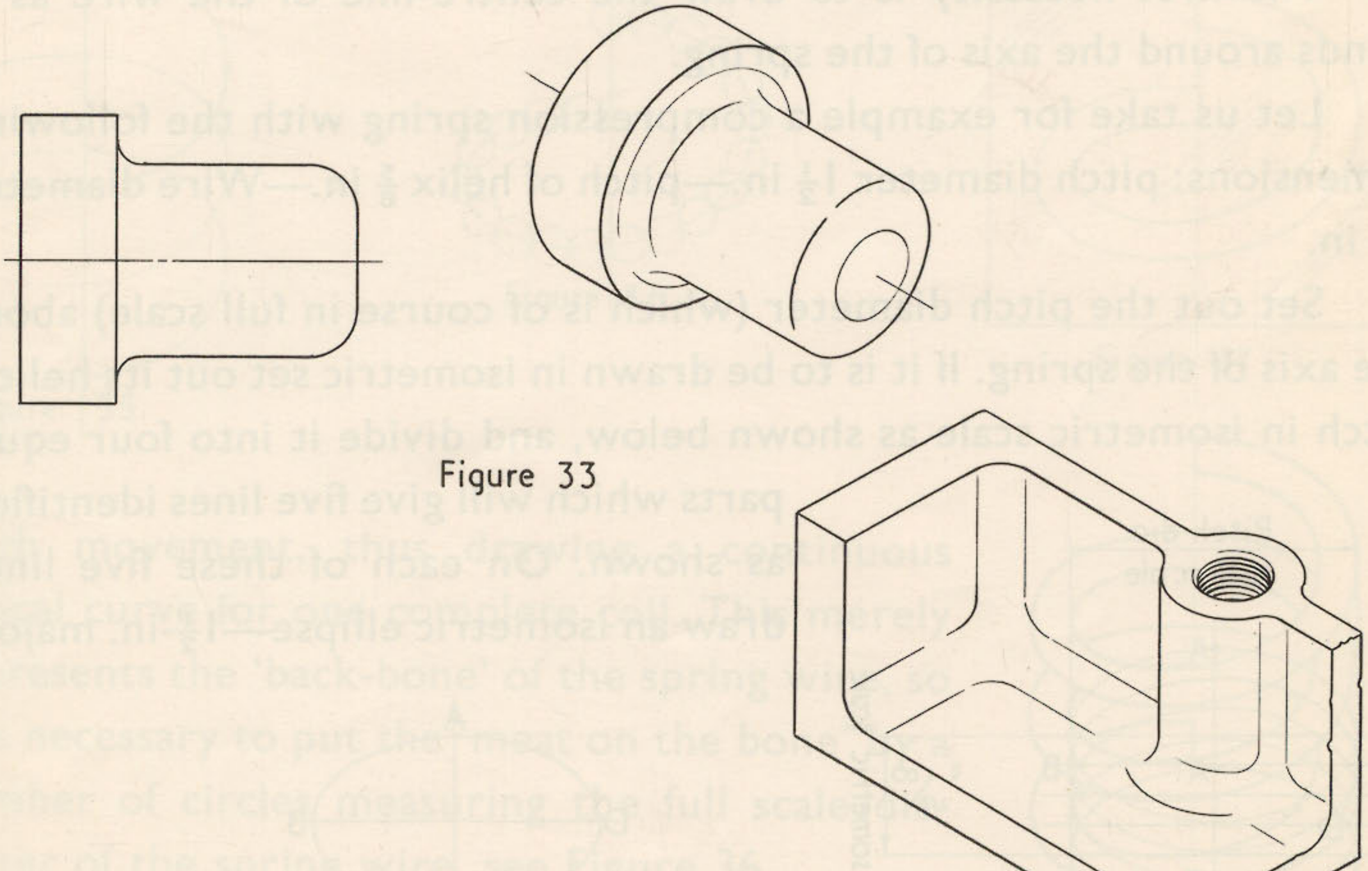


Figure 33

Helical Springs

The drawing of helical springs on any three-dimensional drawing appears at first glance to be a formidable task but if tackled in the right way does not present great difficulty.

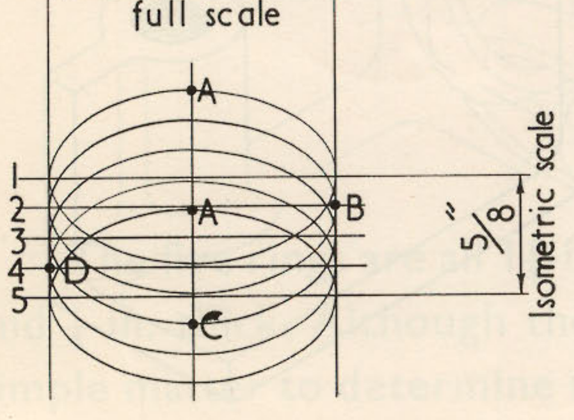
As the shape of a helical spring is repetitive along its length, great economy of drawing time can be brought about by the use of a stencil mask. This can be made from good quality thin cardboard or from thin transparent plastic sheet.

Only one turn of the spring need be cut in the stencil mask (see Figure 37) as it can be moved along the edge of the set-square in such a manner as to produce the outline of a spring with as many turns or coils as are required.

The first necessity is to draw the centre-line of the wire as it winds around the axis of the spring.

Let us take for example a compression spring with the following dimensions: pitch diameter $1\frac{1}{2}$ in.—pitch of helix $\frac{5}{8}$ in.—Wire diameter $\frac{3}{16}$ in.

Set out the pitch diameter (which is of course in full scale) about the axis of the spring. If it is to be drawn in isometric set out its helical pitch in isometric scale as shown below, and divide it into four equal parts which will give five lines identified as shown. On each of these five lines draw an isometric ellipse—$1\frac{1}{2}$-in. major.



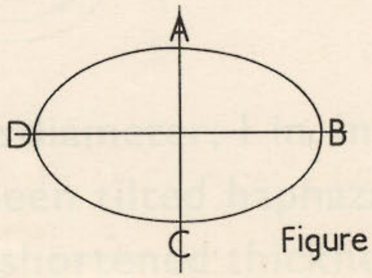


Figure 34

Consider that the major and minor axes are identified as shown opposite, Figure 34 right.

The next stage is to mark a point on each of the five ellipses starting at the top A and progressing downwards one line at a time, the points being a quarter of the helical pitch and a quarter of a turn of the diameter apart. Thus 1–A, 2–B, 3–C, 4–D, and finally 5–A.

Two points 1–A and 5–A are therefore one helical pitch apart, and the five dots are points on the helix which is yet to be drawn.

With practice it is possible to slide the elliptical mask downwards at a steady speed and at the same time move a pencil point around the ellipse so as to synchronize each quarter of a turn with one quarter

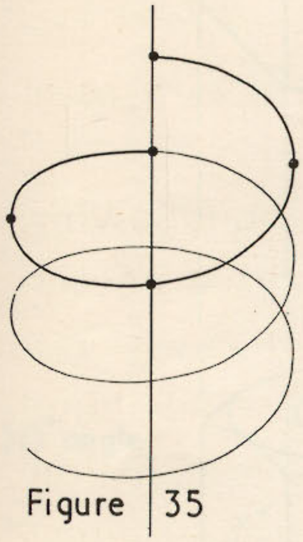


Figure 35

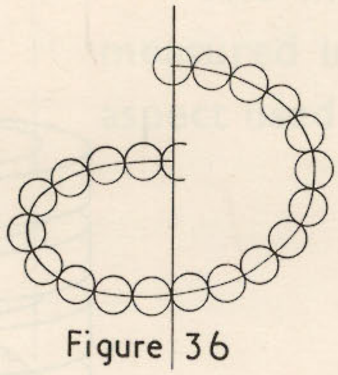


Figure 36

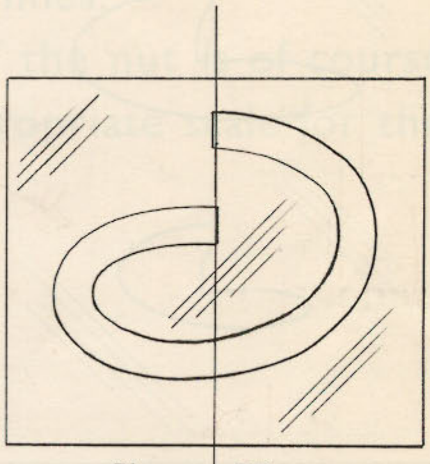
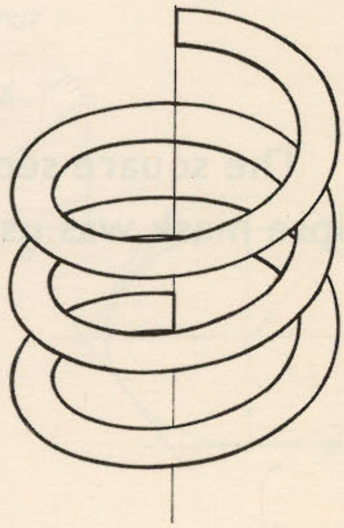


Figure 37



pitch movement, thus drawing a continuous helical curve for one complete coil. This merely represents the 'back-bone' of the spring wire, so it is necessary to put the 'meat on the bone' by a number of circles measuring the full scale diameter of the spring wire, see Figure 36.

Think of them as spherical beads. A curve touching their diameters gives a true silhouette outline of the spring coils.

Thin wire springs may be represented by a single thick helical line drawn with the aid of a simple mask or directly on to the drawing using the slowly sliding ellipse mask. See page 37 for an example.

SQUARE SECTION SPRINGS

The outline curves of these springs (both inside and outside) are helices of the same pitch, but naturally of different diameters. These are most conveniently drawn with a mask as shown in Figure 38, using two separate openings so that by superimposing the two curves upon each other the final outline is obtained as in Figure 39.

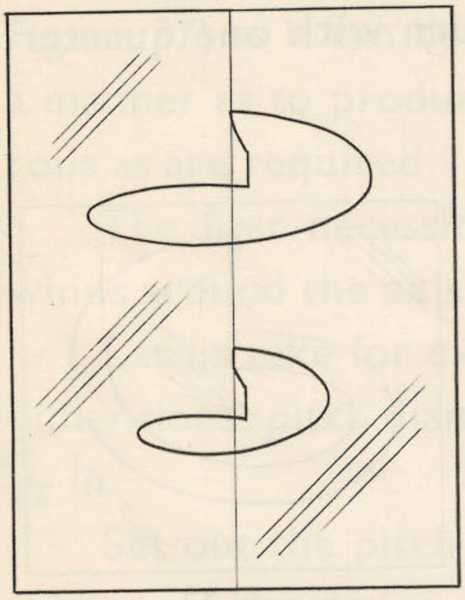


Figure 38

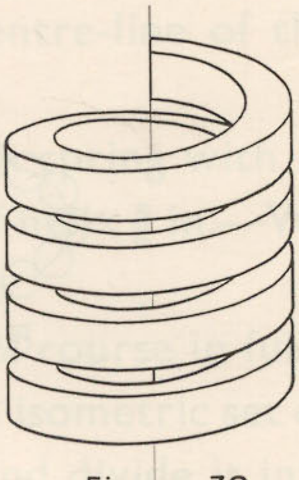


Figure 39

The square section spring is viewed at a 20° angle therefore a 20° ellipse mask was used for setting out the helices.

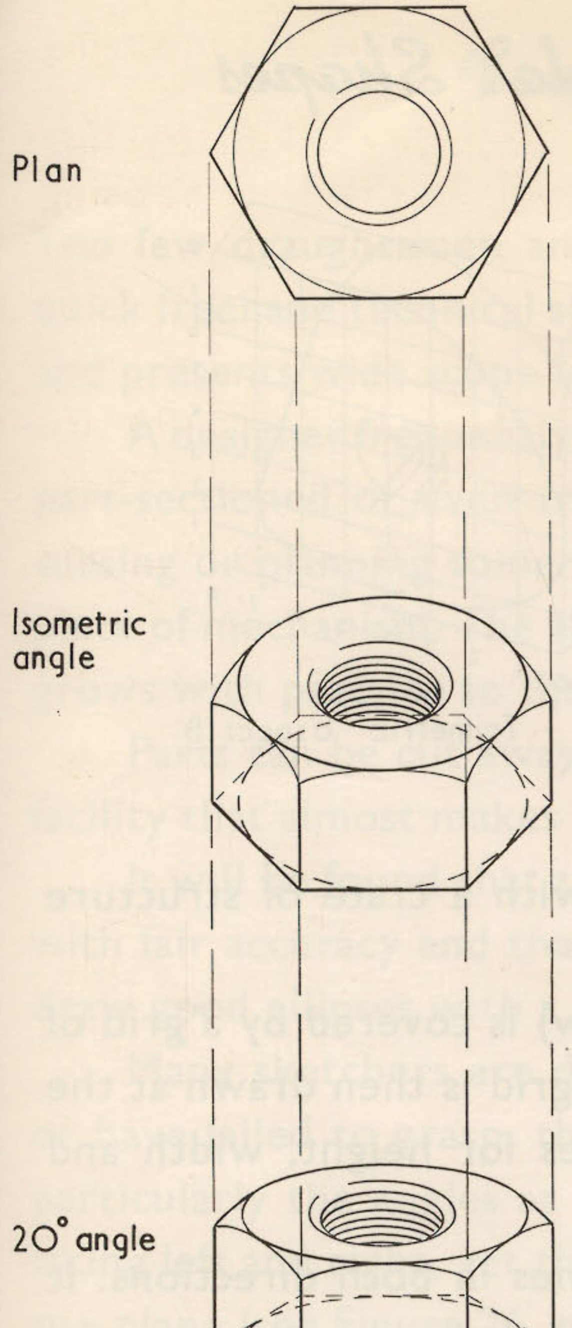
Drawing Hexagon Nuts pictorially

Hexagon nuts are best depicted at the aspect shown i.e. with three flats showing.

Here again, the ellipse (at its correct tilt) is of great use for determining the angles of the sloping side faces.

In the bottom view the method of deciding the base angles is shown with general construction lines.

The thickness of the nut is of course measured in the appropriate scale for the aspect used.



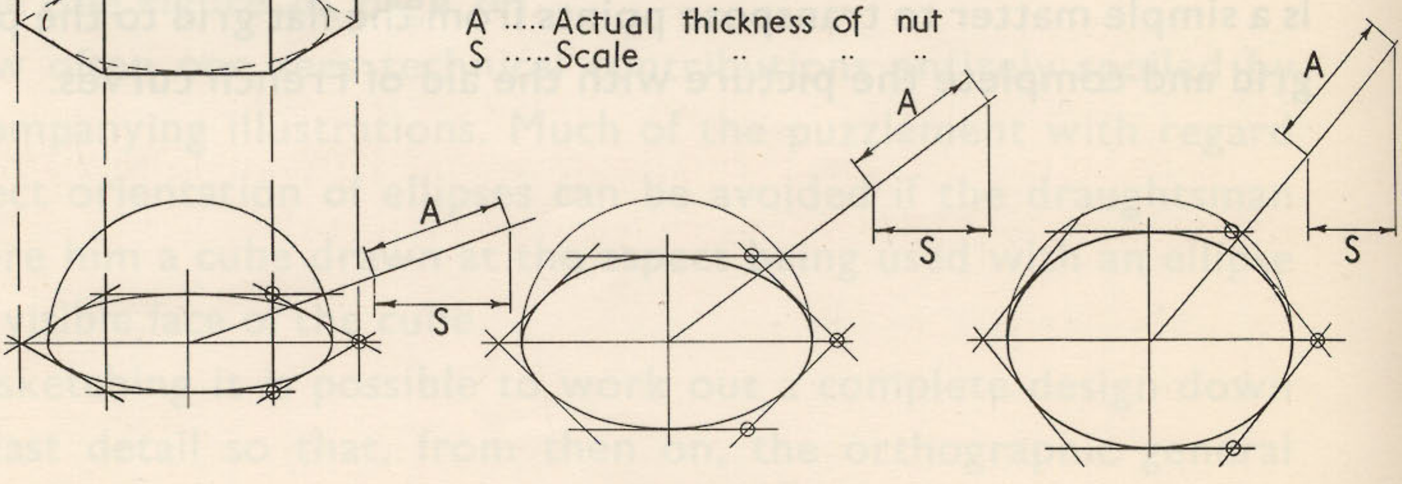


Figure 40

The Projection of irregular Shapes

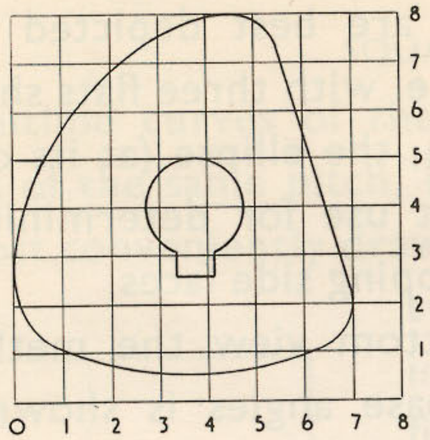
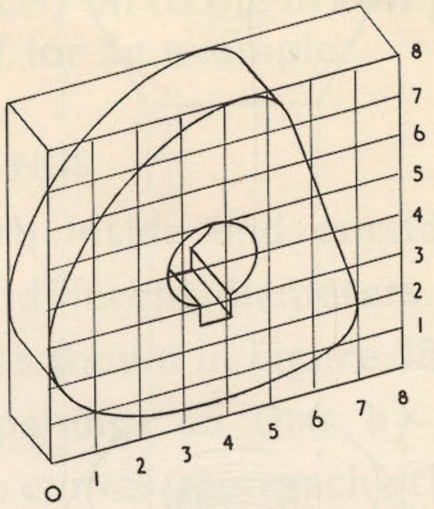


Figure 41



Trimetric aspect B

Objects of irregular shape may be drawn with a crate of structure lines as shown above, Figure 41.

The shape to be translated (the flat view) is covered by a grid of lines equally spaced in both directions. This grid is then drawn at the aspect required using the appropriate scales for height, width and thickness used for that aspect.

To avoid confusion, number the grid lines in both directions. It is a simple matter to transpose points from the flat grid to the pictorial grid and complete the picture with the aid of French curves.

Freehand Drawing

Too few draughtsmen and designers possess the ability to produce quick freehand technical sketches, yet it offers a good many advantages and presents wide scope for quick and clear expression.

A designer frequently wishes he could have before him a sectioned, part-sectioned or even transparent model when demonstrating, discussing or planning some modification or improvement to an existing piece of mechanism. The ability to sketch with confidence and accuracy grows with practice so that this wish can be gratified.

Parts can be cut away or ghosted in by the practised hand with a facility that almost makes a pencil into a magic wand.

It will be found that the 30 and 60 degree angles can be estimated with fair accuracy and that after a little practice it will be possible to draw good ellipses with a single freehand sweep of the pencil.

Many sketchers are discouraged because they have never learnt, or have failed to grasp, the basic rules of three-dimensional drawing, particularly the angles at which the ellipses are drawn on the planes facing left and right, yet they are confident when drawing those on the top plane (see Figure 26, page 24).

How often one sees technical contributions entirely spoiled by the accompanying illustrations. Much of the puzzlement with regard to correct orientation of ellipses can be avoided if the draughtsman has before him a cube drawn at the aspect being used with an ellipse on each visible face of the cube.

By sketching it is possible to work out a complete design down to the last detail so that, from then on, the orthographic general arrangement can be set down with great overall saving of time.

As the student progresses through the pages of this book he may become aware of a certain amount of repetition and of the fact that many of the problems can be solved in more than one way. This is done to foster a fuller understanding of the subject as a whole.

The very fact that alternative methods are possible shows that the answers are exact geometrical solutions of a given problem and not convenient compromises.

In practice the draughtsman will naturally use the method most suited to the particular task in hand.

Starting an Isometric Drawing

On page 40 a specially devised object is shown in orthographic views followed by its three-dimensional translations. It is not a drawing of any particular component but has been designed solely for use as an exercise.

Effort has been made to embody difficult features which might daunt the draughtsman as yet unversed in pictorial drawing.

Three-dimensional translations of this exercise-piece will be built up stage by stage, with page numbers given so that the reader may refer to the geometry embodied in that particular stage.

Freehand Sketching

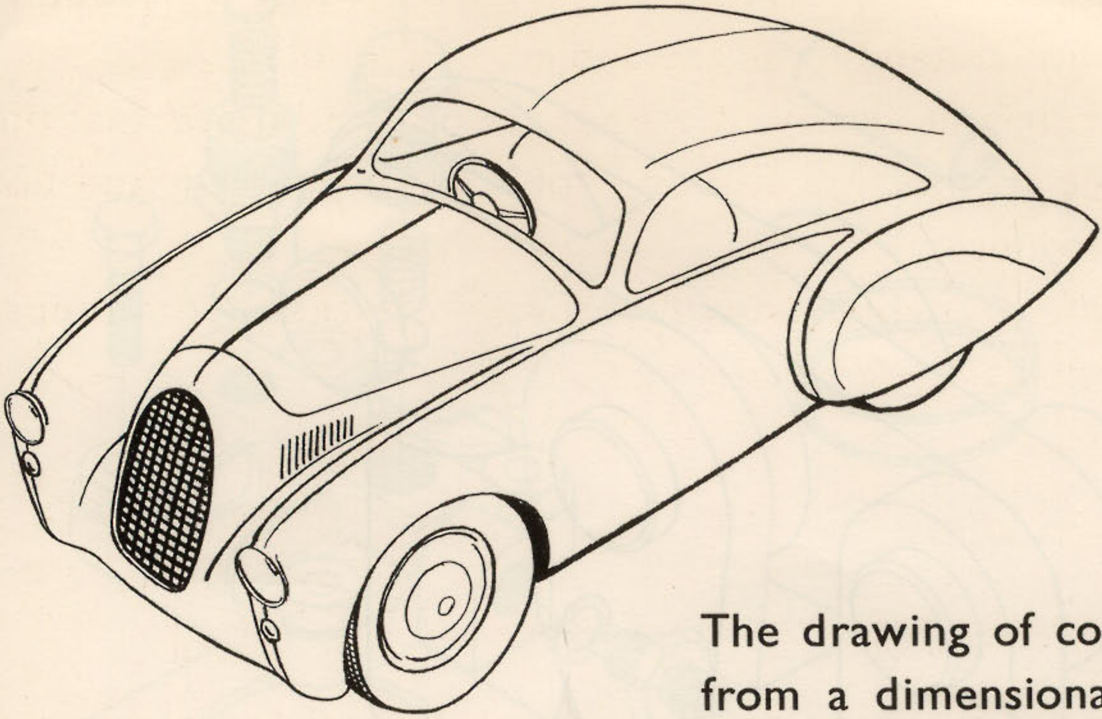
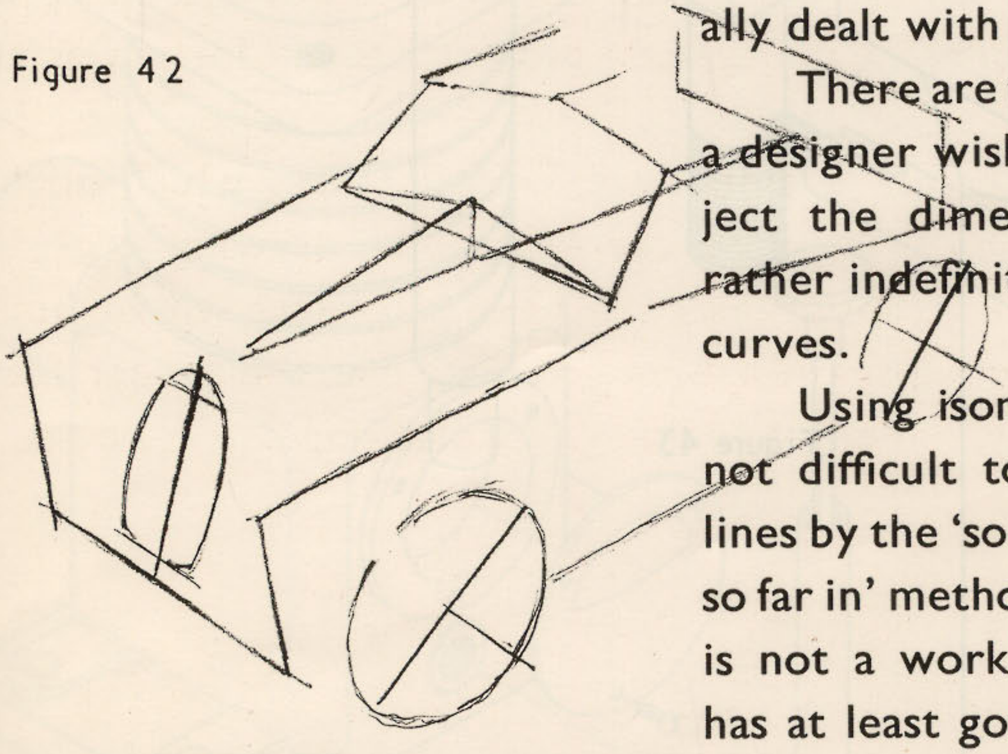


Figure 42



The drawing of complicated shapes from a dimensional point of view, such as a complete car, is not normally dealt with in isometric drawing.

There are times, however, when a designer wishes to visualize a subject the dimensions of which are rather indefinite because of its many curves.

Using isometric as a basis, it is not difficult to build up the guide lines by the 'so far along—so far up—so far in' method. Even if the product is not a work of art, the designer has at least got something down on paper for his own critical analysis, and so produces a basis for continued study and experiment.

Isometric View of Rocker Gear

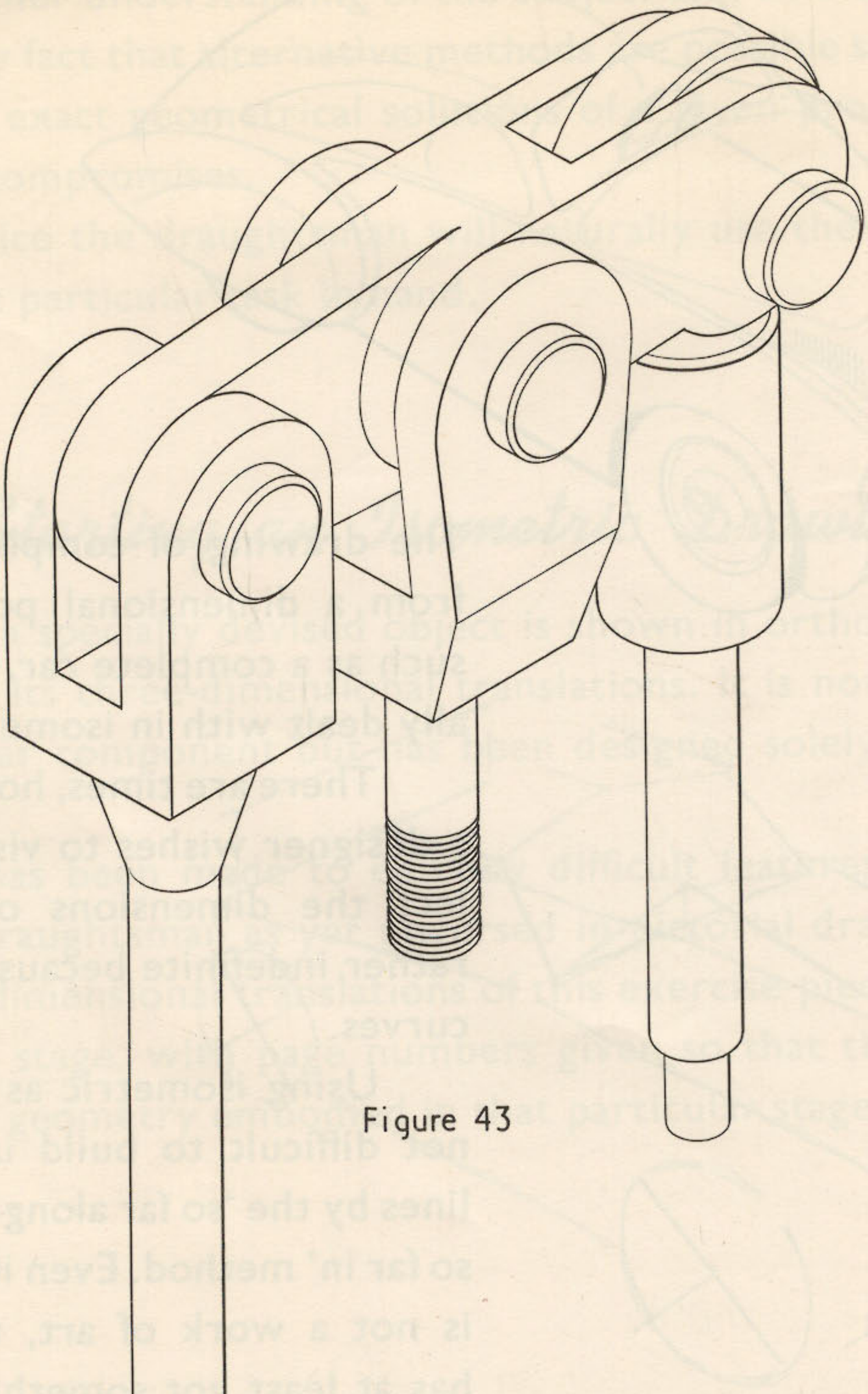
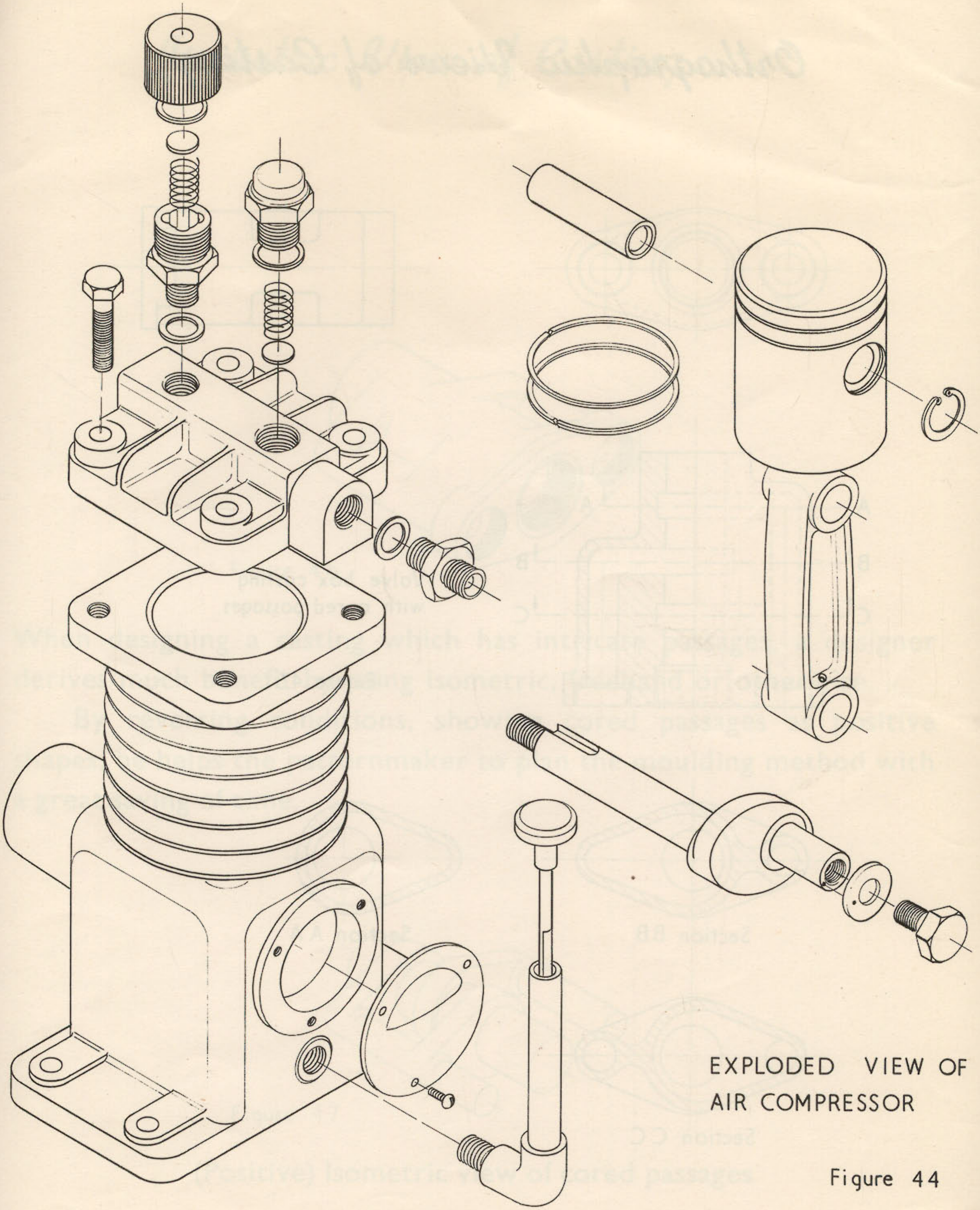


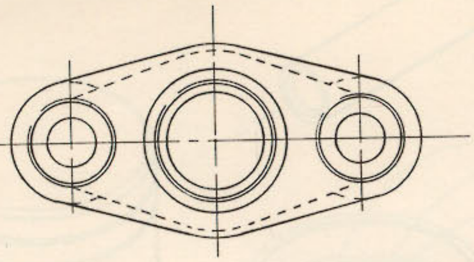
Figure 43

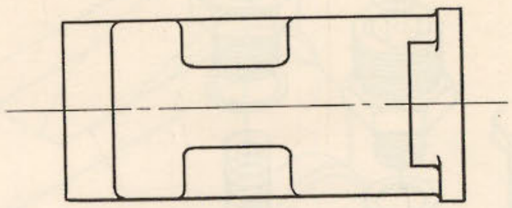


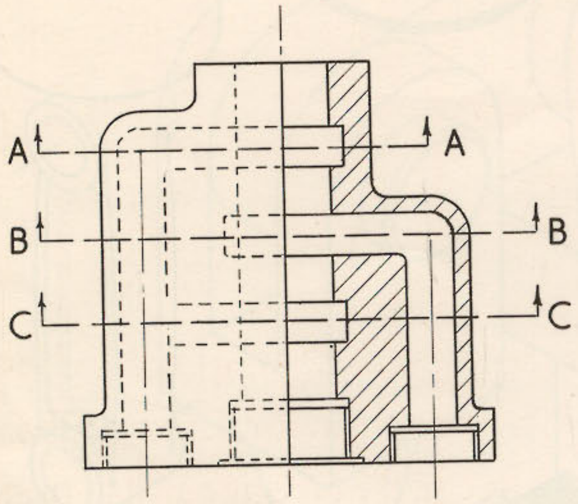
EXPLODED VIEW OF AIR COMPRESSOR

Figure 44

Orthographic Views of Casting

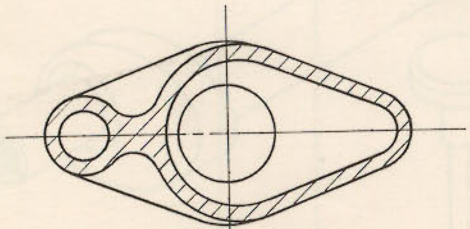




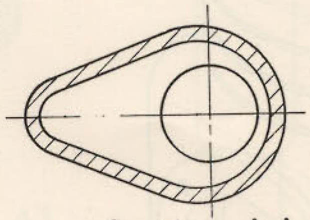


Valve box casting
with cored passages.

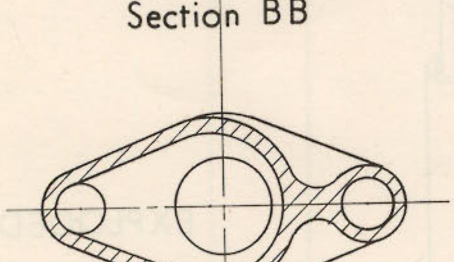
Figure 45



Section BB



Section AA



Section CC

Isometric View of Casting

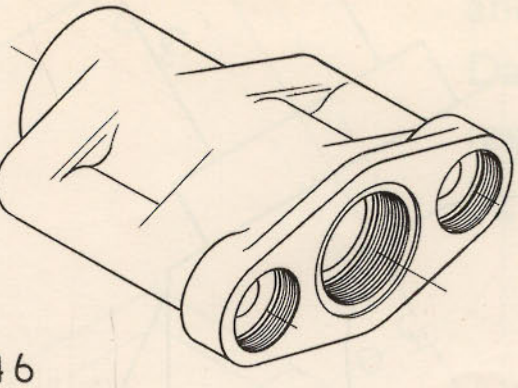


Figure 46

When designing a casting which has intricate passages, a designer derives much benefit by using isometric, freehand or otherwise.

By reversing conditions, showing cored passages as positive shapes, he helps the patternmaker to plan the moulding method with a great saving of time.

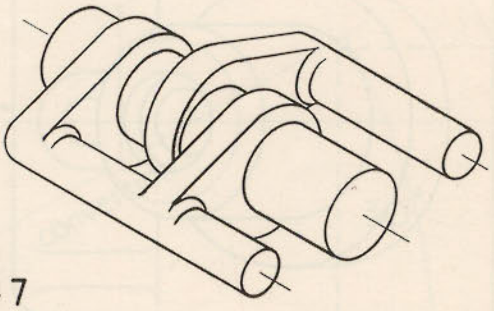
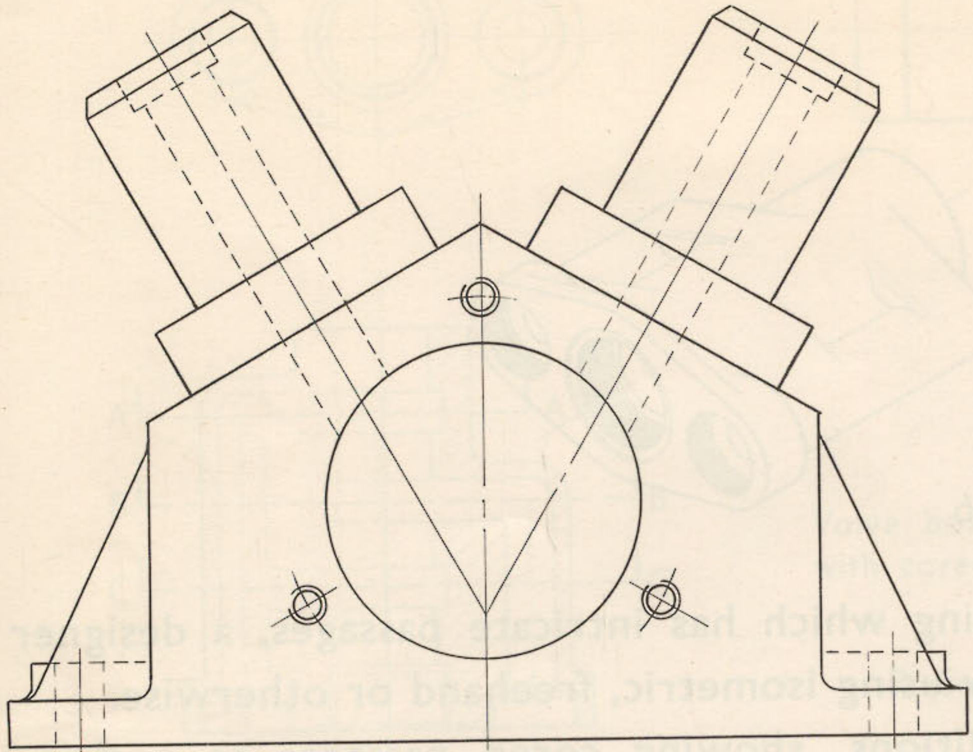


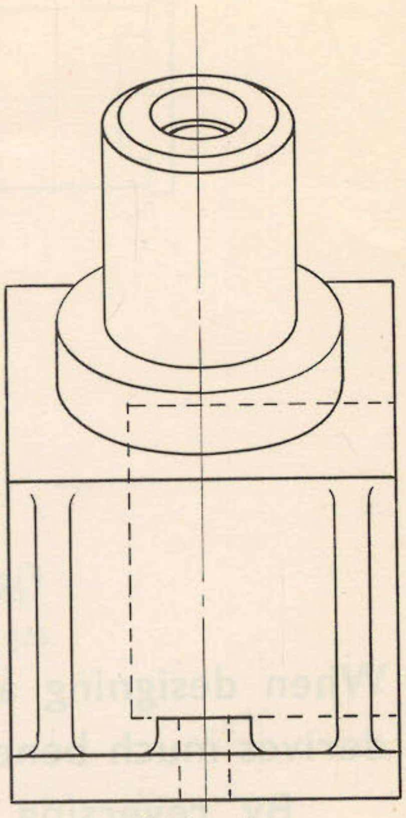
Figure 47

(Positive) Isometric view of cored passages

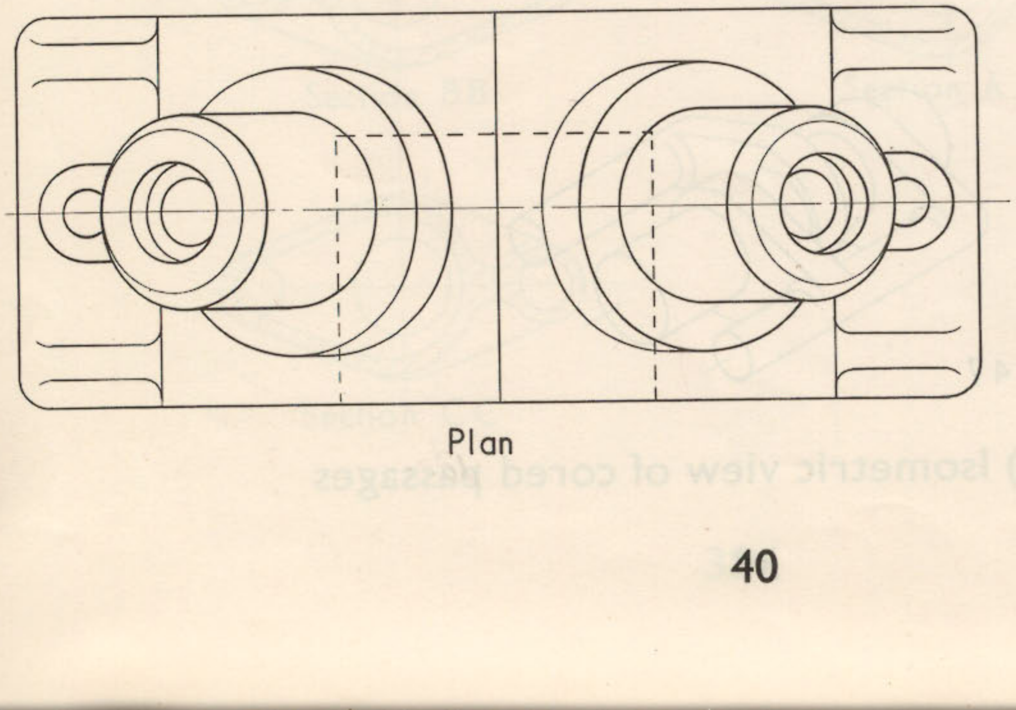
ORTHOGRAPHIC VIEWS
OF EXERCISE PIECE



Front view



End view



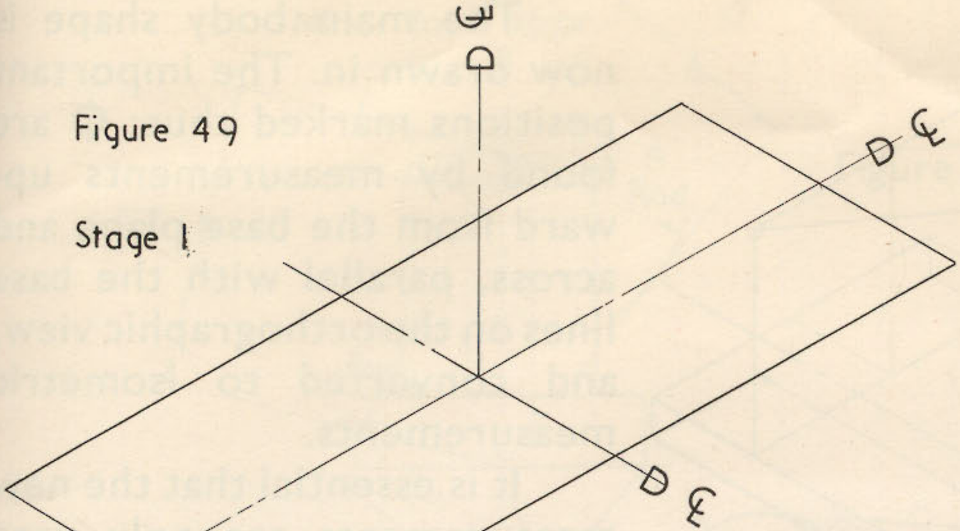
Plan

Figure 48

Dimensions have been omitted for clarity.

Figure 49

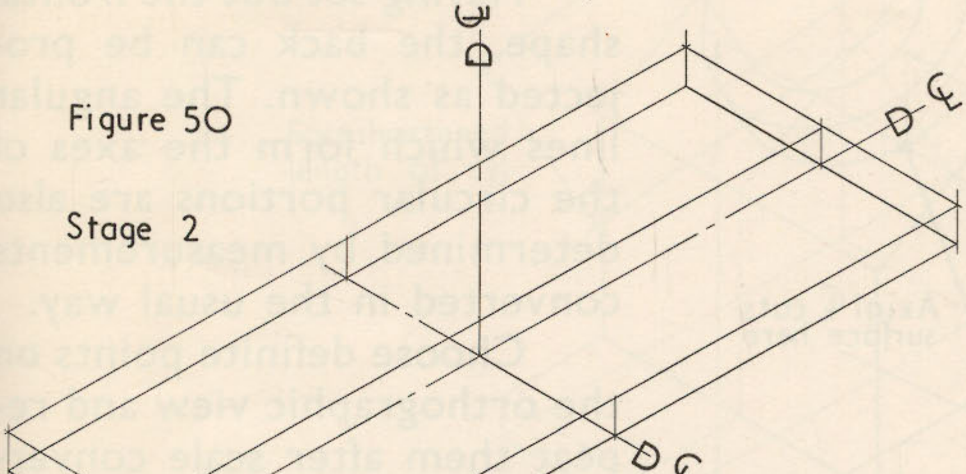
Stage 1



Draw Datum centre lines which should be marked to ensure clear identification. Convert lengths taken from orthographic views, see Figure 51 below, to isometric lengths and set them out on the Datum lines. Draw in isometric base shape, using light pencil lines.

Figure 50

Stage 2



Draw thickness of flange above base, isometric scale.

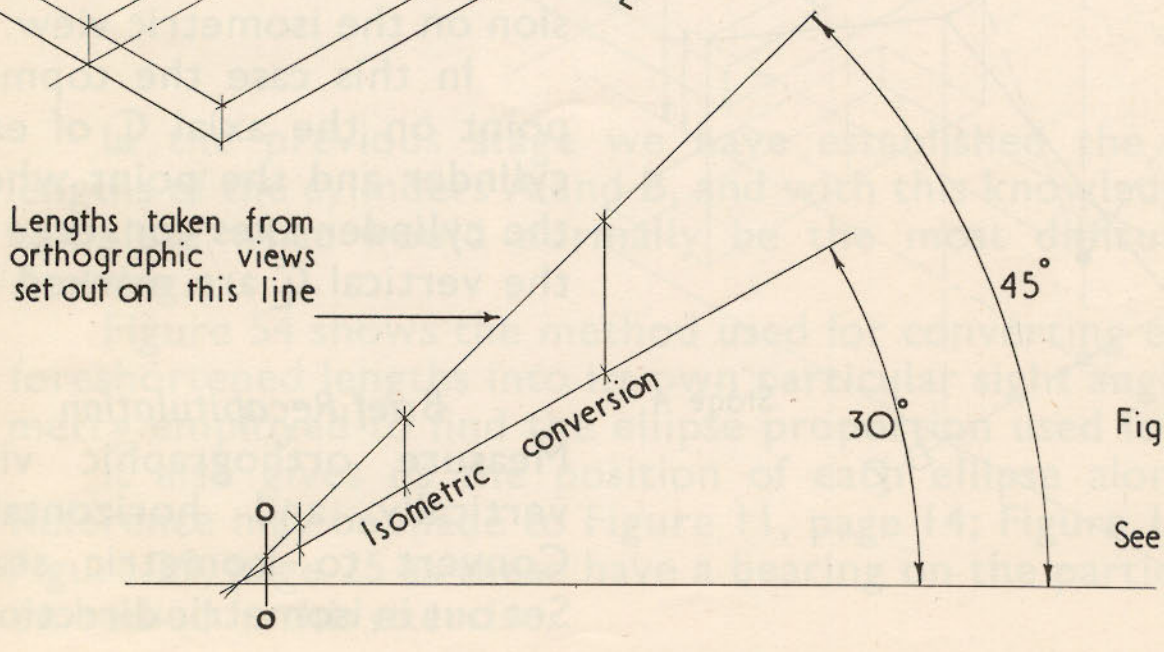
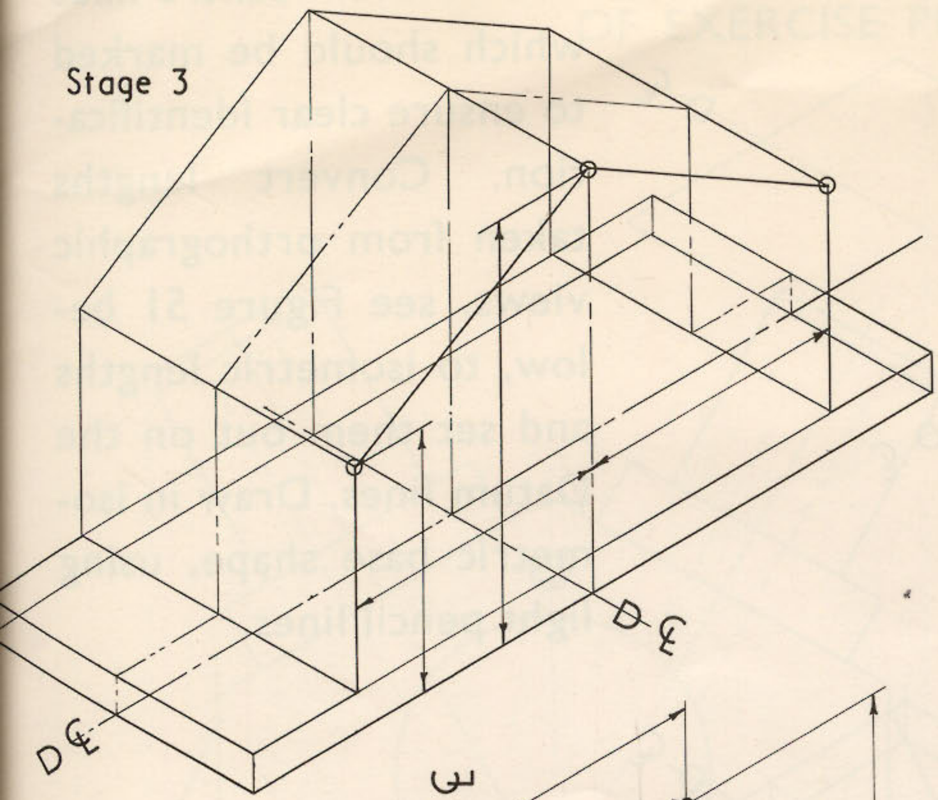


Figure 51

See also Figures 8 and 9

Figure 52

Stage 3



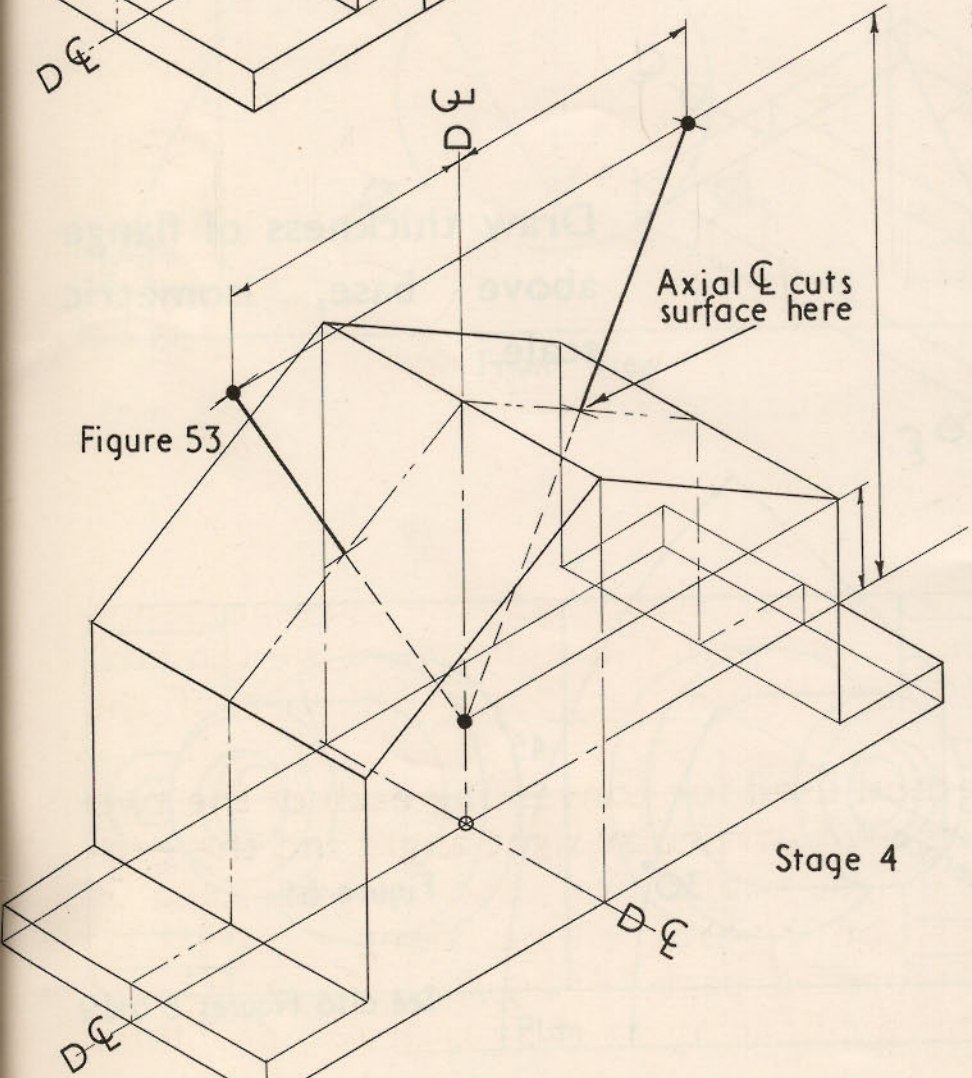


Figure 53

Stage 4

The main body shape is now drawn in. The important positions marked thus: Φ are found by measurements upward from the base plane and across, parallel with the base lines on the orthographic view, and converted to isometric measurements.

It is essential that the new measurements are only used vertically or on the lines drawn with the 30° set square.

Having set out the frontal shape, the back can be projected as shown. The angular lines which form the axes of the circular portions are also determined by measurements converted in the usual way.

Choose definite points on the orthographic view and repeat them after scale conversion on the isometric view.

In this case the topmost point on the axial ℄ of each cylinder and the point where the cylinder axes converge on the vertical ℄ are marked ● .

Brief Recapitulation

Measure orthographic view vertically and horizontally. Convert to isometric scale. Set out in isometric directions.

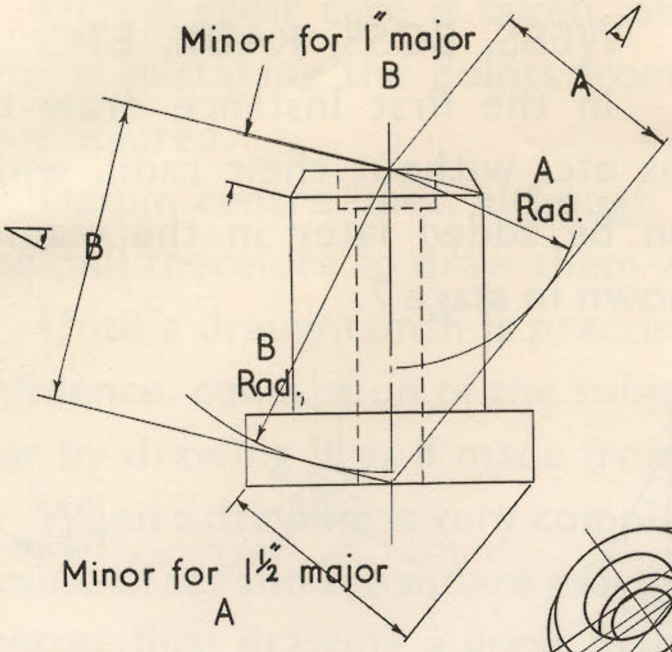


Figure 54

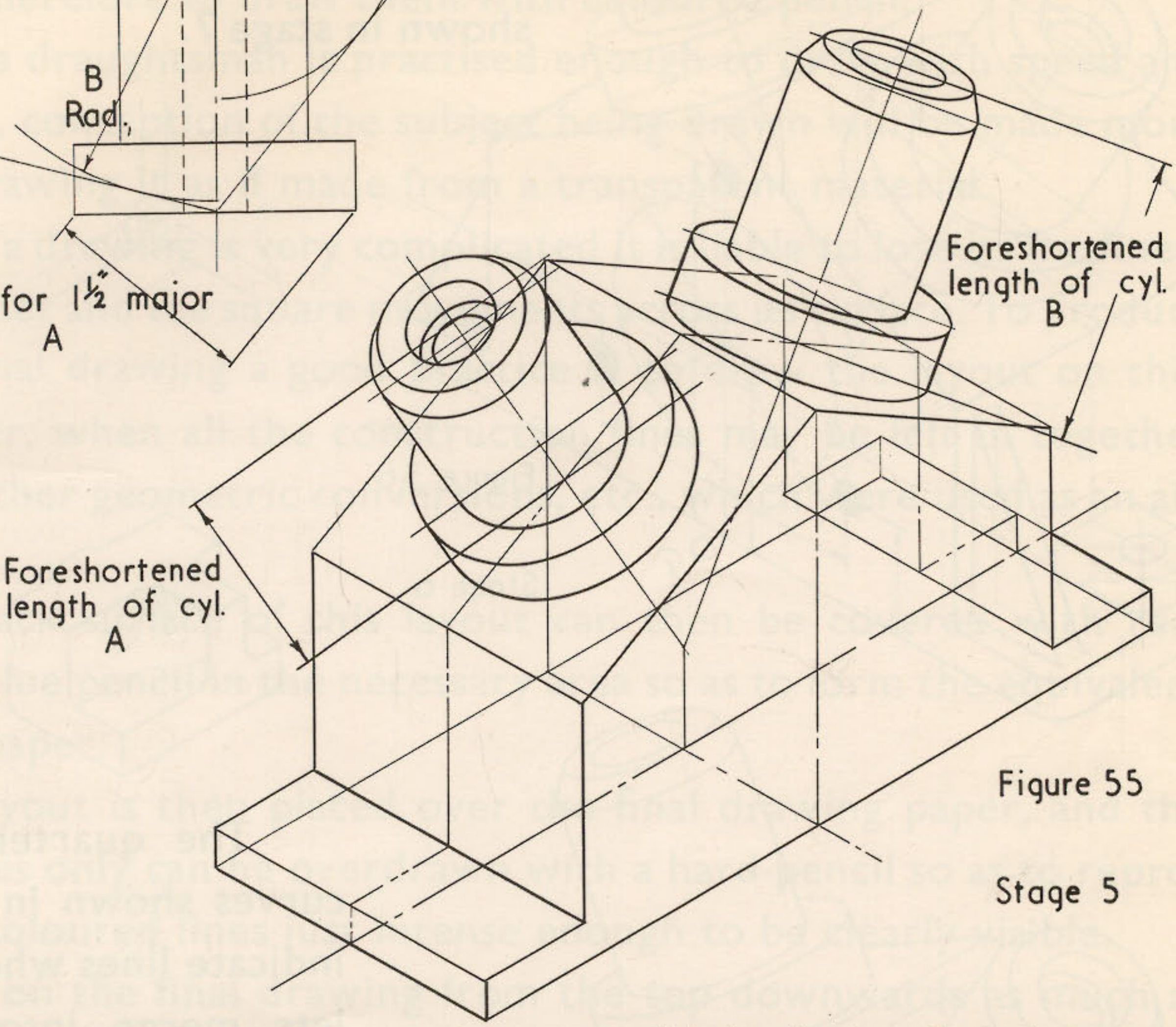


Figure 55

Stage 5

In the previous stage we have established the foreshortened lengths of the cylinders A and B, and with this knowledge we can now complete what would normally be the most difficult part of the drawing.

Figure 54 shows the method used for converting each of the two foreshortened lengths into its own particular sight angle and the geometry employed to find the ellipse proportion used for each axial ℄.

It also gives us the position of each ellipse along its axial ℄. Reference may be made to Figure 11, page 14; Figure 15, page 17 and Figure 29, page 25 as these have a bearing on the particular problems embodied in this exercise.

NOTES

ISOMETRIC AND TRIMETRIC DRAWING

The value of isometric drawing as a means of illustrating such things as instructional handbooks has long been recognized, and greater use is now being made of it in workshop drawings, either to supplement, or occasionally as a substitute for, the more conventional orthographic views. However, as the author shows in this book, the usefulness of isometric and trimetric drawing does not end here. It can be a most valuable tool for the designer himself.

Many otherwise experienced draughtsmen have in the past been deterred from trying their hands at this form of drawing by a mistaken belief that there is something mysterious or complicated about it; a belief which has been perpetuated by the lack of any simple and practical work dealing with the subject. The present book sets out to remedy this deficiency, and shows that isometric and trimetric drawing are geometrically pure forms of drawing, well within the scope of the average draughtsman, using only standard drawing office techniques.

The treatment is essentially practical; theory and basic principles are introduced as needed, and being linked to the immediate problem of producing a drawing, are quickly and easily grasped, even by the novice. After explaining the basis of isometric projection, the author goes on to discuss the isometric scale and its construction. The important subject of drawing ellipses rapidly and accurately is next dealt with, and the knowledge already gained is then applied to the drawing of angular subjects and attitudes. This leads naturally to the consideration of the isometric aspects, through which the student is introduced to trimetric projection. More advanced work with the ellipse follows, and the problems of drawing some specific subjects are then considered—helical springs, hexagon nuts, and irregular shapes are all dealt with in detail. Freehand drawing and sketching form the subjects of the next sections, and here it is shown how three-dimensional drawing can aid the designer in his work. Finally, following some examples of actual isometric drawings, a carefully designed exercise piece is presented, and the problems of drawing it are discussed in detail.

The work is copiously illustrated, preference being given at all times to clear drawings rather than wordy explanations of the points under discussion. A large page size has been chosen, so that the illustrations can be reproduced in full scale. Many valuable hints and tips, the fruit of the author's own experience, are given, and this information, most of which has never previously been published, makes the book of value alike to the experienced draughtsman and to the student.

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