HANDBOOK OF PERSPECTIVE

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BY

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FOREWORD

By A. M. CHISHOLM, ESQ., A.R.I.B.A.
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There have been many books written on perspective drawing. It is a subject that has proved a fascinating one from very early times, the art rather than the science of the subject having probably been first used in connexion with theatre scenery. The science seems to have been dealt with so exhaustively from the time when some of the principal constructions with which we are familiar to-day were, perhaps for the first time, discovered in the sixteenth century, that some explanation may seem necessary for the production of another book.

I am confident in saying that in spite of the many valuable text-books on the subject produced in recent years there is none, at least to my knowledge, that has presented the subject in so practical, clear, and comprehensive a way from the point of view of the Architectural Student and draughtsman, who desires to set up perspective drawings of all kinds, as does this work of Mr. Warren's.

The fundamental principles of perspective drawing are really very simple, and much of the difficulty that is so often experienced by students is due to lengthy and what seem to be involved explanations of the diagrams which, in themselves, often appear complicated. Some of this is unavoidable by the very nature of the subject treated. Mr. Warren, however, has reduced his letterpress, in the main, to brief, explanatory directions designed from the point of view of quick reference for constructions covering every kind of perspective drawing that is met with in practice.

The general principles involved in the constructions are set forth in a few introductory paragraphs, and when these are clearly understood each diagram becomes largely self-explanatory with the help of the directions on the accompanying page.

The author's treatment of the problem of bird's-eye views and its complementary one of views looking up and generally of making draw-

ings from any angle or height is set forth admirably, and the practical method of drawing perspectives with the aid of the perspective plan and measure points is demonstrated with great clarity. A very useful section is that which refers to the use of the centrelinead, and the information and table given in this connexion are very valuable.

I am convinced that this book meets a real need and should prove of the greatest assistance to those who require a book of reference which will be easily understood, and offers practical methods of solving every problem of perspective representation.

A. M. CHISHOLM

PREFACE

THERE are many books on Perspective.

The majority are in the nature of text-books, containing a wealth of detail and information or short methods of projection which have only a limited application; they are valuable in the manner that all good text-books are valuable. But the information supplied is so voluminous that the student needs help to interpret it and the experienced draughtsman has difficulty in finding the data he requires to clear up a difficult point.

The author has endeavoured to overcome this difficulty by producing a work of reference to cover all general cases in the briefest manner, a book of rules and formulae (for the drawing of a correct perspective is a technicality of draughting) that will aid the student and to which the experienced draughtsman may turn when in difficulties.

Thus the keynote will be found in *fundamental principles*, illustrated and explained, but not elaborated, and grouped and indexed.

The author desires to gratefully acknowledge the valuable criticism and encouragement given during the preparation of this book by the staff of the School of Architecture of the Auckland University College, New Zealand.

W. G. W.

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INTRODUCTION

PERSPECTIVE drawing is the method of representing pictorially that which we normally consider in plan, section and elevation, or in actuality.

Two things are essential:

(i) The imagination necessary first to visualize the appearance of the object from any viewpoint and so to choose the best. A few rough trials, sufficient to show the outline only, will help.

(ii) The knowledge and ability to set up a correct perspective drawing of the object from that particular viewpoint.

The second of these essentials is the purpose of this Handbook, that is, to show fundamentally the methods to be used in the actual setting-up of the drawing.

Draughting and rendering are, of course, outside the scope of this work.

THE THEORY OF PERSPECTIVE

PERSPECTIVE drawings are of the greatest aid in all illustrative work. They are not used as much as they should be, owing largely, it would seem, to the prevalent idea that they are difficult to draw. Such is not the case, however, since a fundamental conception of the theory is all that is necessary. The geometry follows simply and logically.

In considering the Theory of Perspective it is necessary to remember that any given view represented on paper is drawn as though the eye were *fixed on one point* of the object represented. *If the eye moves, a new set of vanishing points and construction lines is required.* The line along which the eye is focused is referred to in this work as the Central Line of Vision, or, more briefly, Centre of Vision (C.V.).

When we look at an object the rays of light reflected from its surface converge to the eye, and the further away an object is, the smaller it appears to be. That is, as parallel lines run into the distance they appear to converge to a point. This point, actually in infinity, is represented on the drawing as a Vanishing Point (V.P.).

It is obvious that all lines not parallel to a plane at right angles to the C.V. must vanish, and that, as such lines may have an infinite number of directions, there may be an infinite number of V.P's.

Somewhere between the Station Point (the position of the eye) and infinity a transparent plane is interposed. This plane, *which is always at right angles to the C.V.*, is called the Picture Plane (P.P.), because the view seen, both behind and in front, is drawn upon it.

Referring to the illustration on page 3 :

At 'A'. Since all parallel lines vanish to a point at infinity, a line drawn from the Station Point (S.P.) to this V.P. at infinity is parallel to all other lines vanishing at the same point. The point where this line cuts the P.P. is a V.P. in the P.P. which covers the V.P. at infinity. That is to say, if the V.P. at infinity is moved forward into the P.P., it must travel along this line towards the S.P.

At 'B' is shown the method of obtaining this V.P. in the P.P. in true plan.

This principle of locating V.P's. in the P.P. may be applied to lines running in any direction, as shown at '*C*'.

Line 'a' is inclined to the P.P. in plan only. The practical method of locating the Vanishing Point (V.P.) is discussed in Part Two, Section I and Fig. 2, and in Section II and Fig. 4, and is as shown at '*B*'.

Line 'b' is inclined to the P.P. in elevation only. The practical method of locating the Vanishing Point (V.P.2) is discussed in Part Three, Section I and Fig. 11, and in Section II and Fig. 13 and is similar to '*B*'.

Line 'c' is inclined to the P.P. in both plan and elevation. The practical method of locating the Vanishing Point (V.P.1) is given below and applied in Part Two, Section III and Fig. 6, and in Section VII and Fig. 10.

Refer to 'D'.

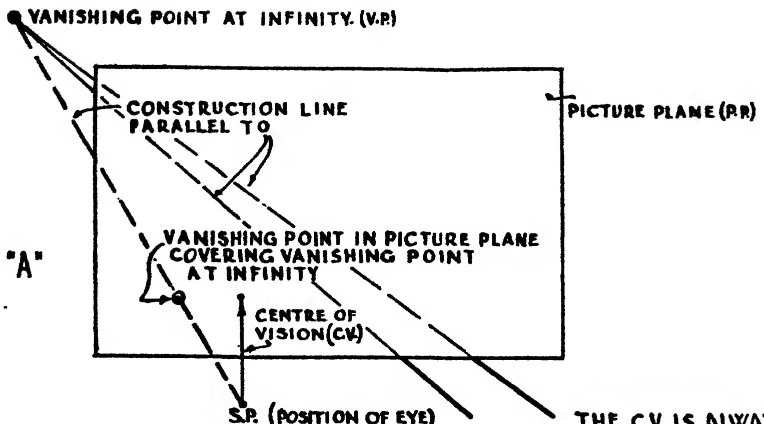
The V.P. for the line '*c*' in plan is first found, as at '*B*'. That is, the V.P. is the plan of the required V.P.1, the Vanishing Point of the inclined line.

Since the elevation is vertically projected from the plan, the V.P.1 will be vertically above the V.P. The vertical projection line up from the V.P. is the '*trace*' of the plane represented by the triangle S.P.–V.P.–V.P.1 with the P.P.

Using this trace as a hinge, the triangle S.P.–V.P.–V.P.1 is swung round to the P.P., that is, into *true elevation*, the point where the S.P. meets the P.P. being marked S.

Since the triangle is now in true elevation the true angle of inclination may be set out from S to locate the V.P.1 in the trace of the V.P.

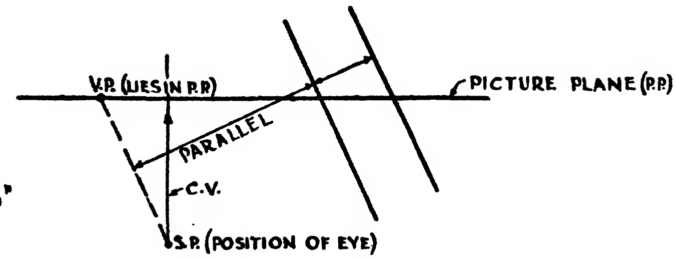
"A"



THE C.V. IS ALWAYS AT RIGHT ANGLES TO THE P.P.

ILLUSTRATION OF PARALLEL LINES VANISHING AT INFINITY

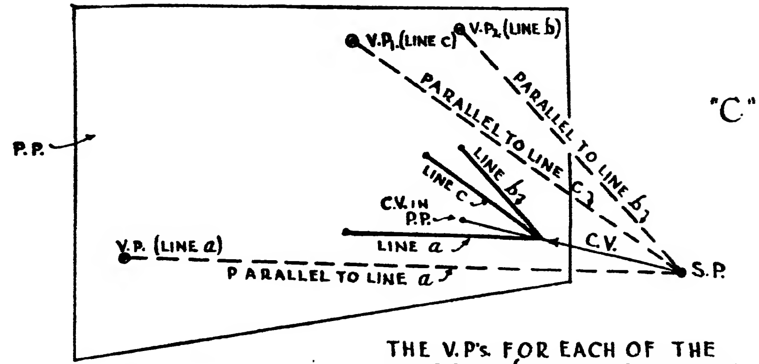
"B"



TRUE PLAN OF ABOVE ILLUSTRATION

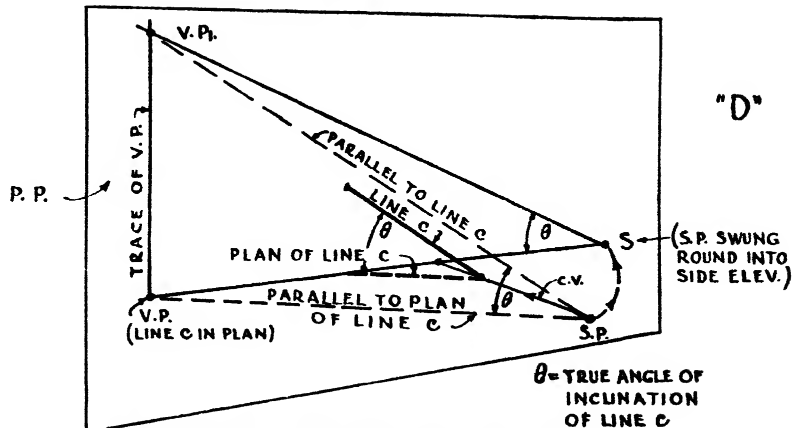
NOTICE THE METHOD OF FINDING THE V.P. IN THE P.P. TO COVER THE V.P. AT INFINITY. SEE FIGS. 2 & 4, ALSO 11 & 13.

"C"



THE V.P's. FOR EACH OF THE LINES *a*, *b*, *c* ARE FOUND BY DRAWING LINES PARALLEL TO THEM FROM THE S.P. TO THE P.P.

"D"



θ = TRUE ANGLE OF INCLINATION OF LINE c

METHOD OF FINDING V.P.1 FOR LINE *c*.
SEE FIGS. 6 & 10.

PART ONE
GENERAL

Section One
GEOMETRICAL POINTS

THE following is a summary of the essential geometrical points, &c., to be always observed. Standard abbreviations are shown in brackets.

(i) *Station Point* (S.P.).* This is the *position of the eye* of the spectator. It is the viewpoint from which the perspective is taken. This may be *at any distance away and at any height*, subject to the limits of the Cone of Vision.

(ii) *Cone of Vision.** The object and surroundings must lie within a 'visual cone' whose angle at the apex does not exceed 60°. This includes height and width. To exceed 60° causes distortion. *See* Fig. 1.

(iii) *Centre of Vision* (C.V.). This is the path along which the eye is focused and is the vertical *axis* of the Cone of Vision, Fig. 1. *It may lie at any angle horizontally and vertically to the bounding planes of the object. It is always at right angles to the Picture Plane*, both in plan and in elevation.

(iv) *Picture Plane* (P.P.).* The rays of light reflected from the object converge towards the eye of the beholder. The limits of these rays, that is, the amount of 'surface' that can be viewed *without moving the eye*, is a circle bounded by the sloping surface of the Cone of Vision. The Picture Plane is a plane cutting this cone at right angles to the *Centre of Vision*. *See* Fig. 1.

The Picture Plane contains all Vanishing Points.

(v) *Vanishing Points* (V.P.). *All lines not at right angles to the C.V. vanish to definite points.* These are the Vanishing Points. *They are always in the Picture Plane.*

(vi) *Horizon Line* (H.L.). This is a line in which vanish all lines inclined to the P.P. lying in horizontal planes. *It is always at the eye-height and horizontal*, even when the C.V. is inclined. *See* Figs. 11 to 15. *It is always in the Picture Plane.*

(vii) *Measuring Points* (M.P.). These are most commonly used to obtain the Perspective Plan. They are obtained geometrically from the V.P's. as described in Part Two, Section II.

* See Appendix

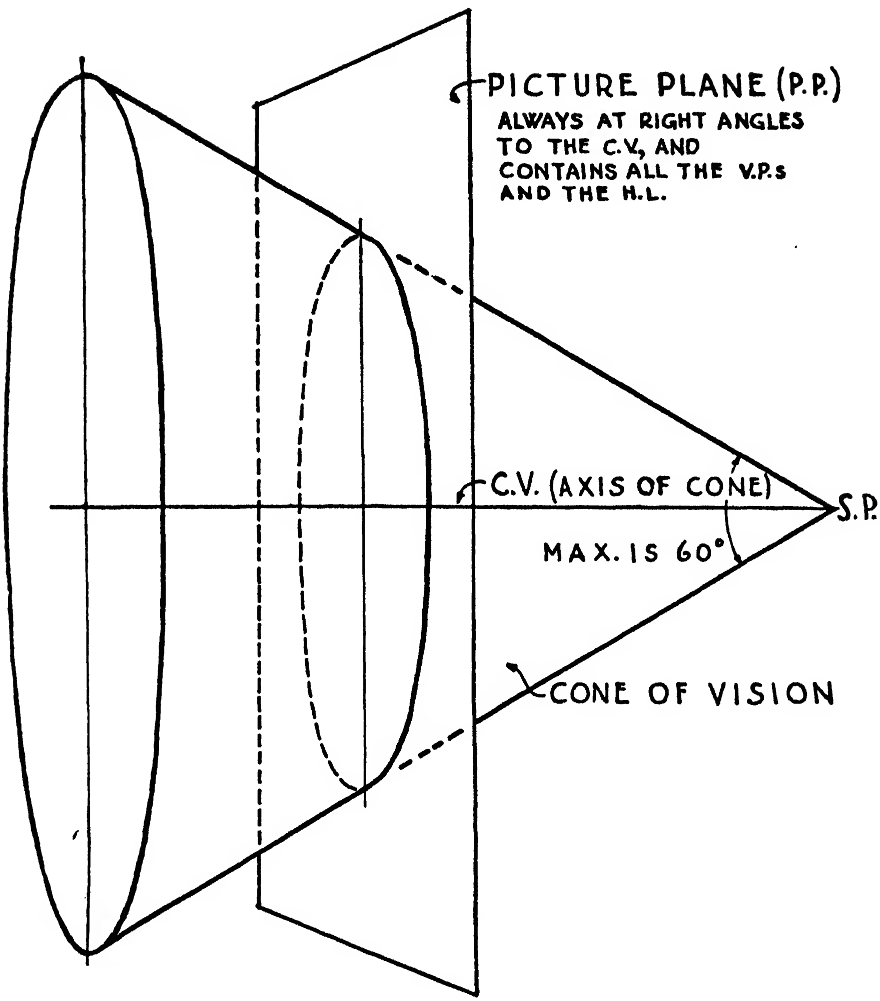


FIG. I

CONE OF VISION, ETC., & PICTURE PLANE

Section Two

KINDS OF PERSPECTIVE

PERSPECTIVE may be divided into *two* principal classes:

(i) **In which the C.V. is Horizontal.**

Vertical lines do not vanish.

Heights are true to scale only in the P.P.

This includes:

(*a*) *Angular Perspective* in which the horizontal lines are inclined to the P.P.

(*b*) *Parallel Perspective* in which the horizontal lines are either parallel to the P.P. or at right angles to it, i.e., parallel to the C.V.

(*c*) *Perspective of Inclined Planes.*

(ii) **In which the C.V. is Inclined.**

Vertical lines vanish.

Heights are nowhere true to scale.

This includes:

(*a*) *Angular Perspective* in which both horizontal and vertical lines are inclined to the P.P.

(*b*) *Parallel Perspective* in which the vertical lines are inclined to the P.P. but the horizontal lines are either parallel to the H.L. or at right angles to it.

Section Three

METHODS OF SETTING OUT*

THERE are *two* methods of setting out all perspectives.

(i) **Without measuring points.**

This is the fundamental method of setting out all perspectives.

(ii) **With measuring points.**

Except for Parallel Perspective, this is the method generally used for all but the simplest cases as it has the following advantages :

(*a*) Dimensions may be taken direct from other drawings and so it is unnecessary to trace outline plans. No time is saved, however, as the plan must be set up in perspective.

(*b*) Except for locating the V.P's. and M.P's. the S.P. is not required.

(*c*) No S.P. and few construction lines are required on the final sheet, an important point when preparing a drawing for rendering.

(*d*) It is the only general method available when dimensions have to be measured from the actual object.

(*e*) It is the only practical method of dealing with buildings or other objects of intricate and detailed plan.

* See Appendix

PART TWO

THE CENTRE OF VISION IS HORIZONTAL

Section One

ANGULAR PERSPECTIVE

WITHOUT MEASURING POINTS

Setting out. Refer to Fig. 2.

(*a*) Draw P.P. cutting the ***plan*** of object where desired.* Draw the C.V. and set off the S.P.

(*b*) From the S.P. draw two lines ***parallel to the sides of the object in plan.*** The points where these lines cut the P.P. are the V.P's.

(*c*) Project all the angles and points on the plan which will give vertical lines in the Perspective Elevation into the P.P. by drawing lines from them to the S.P. These points in the P.P. are the positions of the vertical lines.

All points such as apices of roofs may be so treated unless treated as under Section III.

Perspective Elevation. Refer to Fig. 2.

(*a*) Draw the H.L. and project on to it the V.P's. and C.V. ***Remember the H.L is the level of the eye at the S.P.***

(*b*) Project the points found under (*c*) above, down through the H.L. We now require the heights of these lines.

(*c*) ***All heights are correct to scale only in the P.P.*** Therefore any height which cannot be conveniently 'run round' from the two or three points where the P.P. cuts the plan must be found by the method next given.

* See Appendix

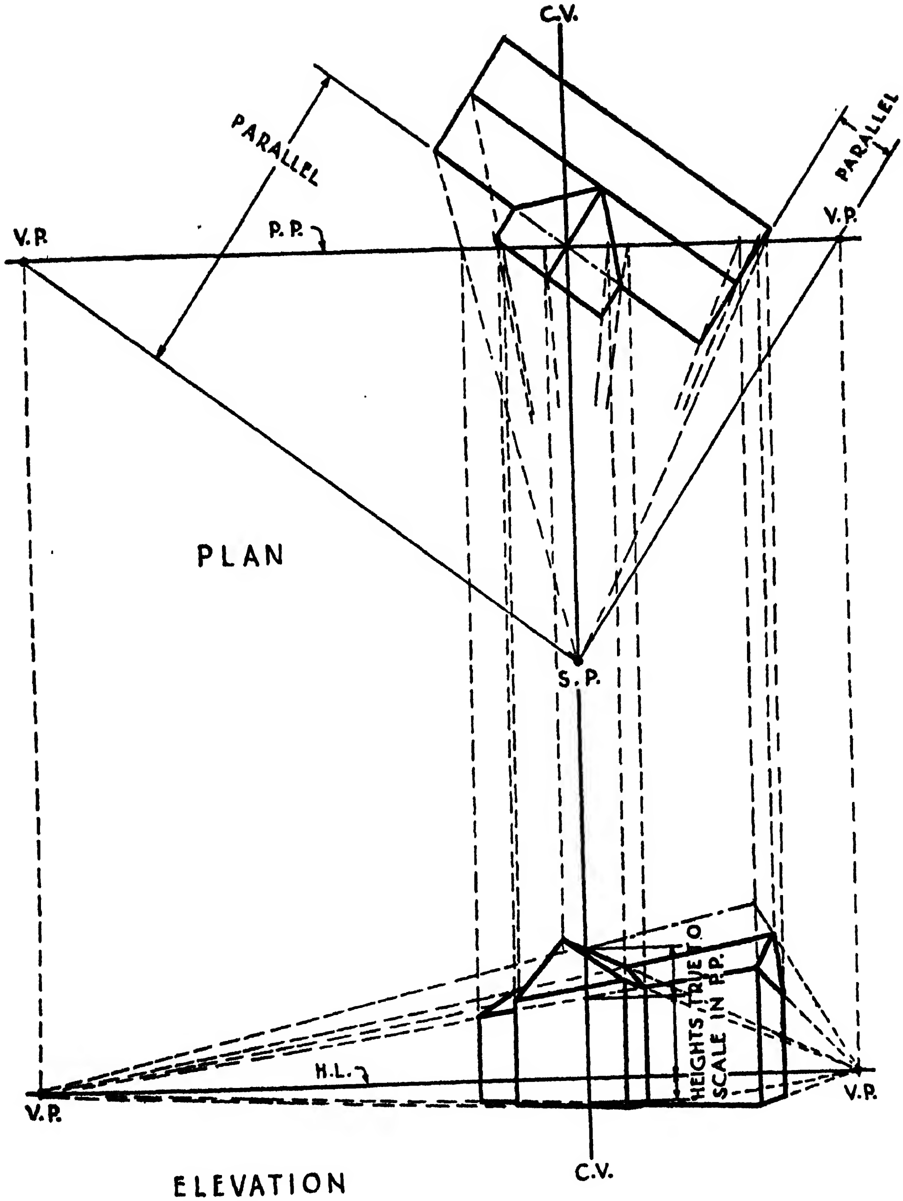


FIG. 2

ANGULAR PERSPECTIVE

Method of Setting-out (without M.P's.)

To obtain additional Height Lines in the P.P. Refer to FIG. 3.

Project lines to the P.P., these lines coinciding with the sides of the object, &c., from which they are projected. Observe that height lines may also be drawn from any point where the P.P. cuts the object.

Several height lines are shown, but heights are most conveniently obtained by using special height lines only where most expedient and carrying these heights round, by means of the V.P's., to the positions desired.

Heights *above the eye level* are measured *above the H.L.*

Heights *below the eye level* are measured *below the H.L.*

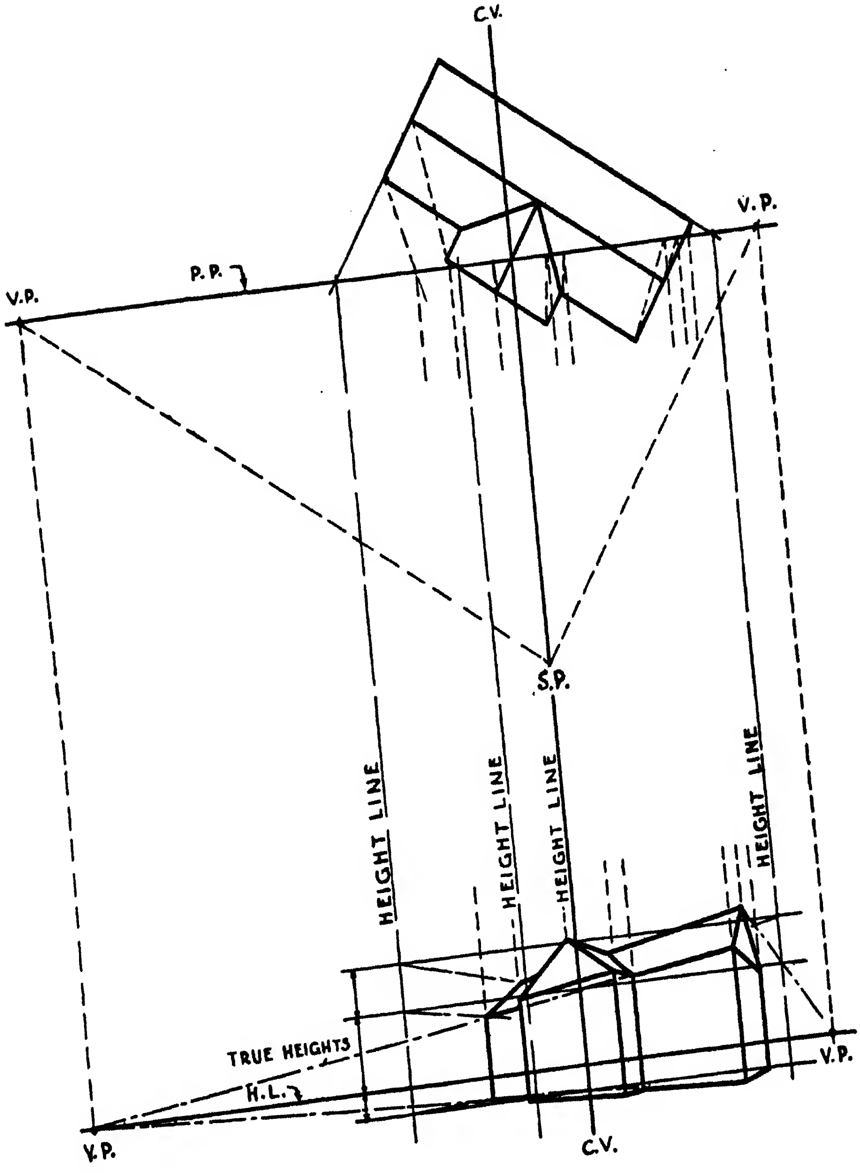


FIG. 3

ANGULAR PERSPECTIVE

Method of obtaining additional height lines in P.P.

Section Two

ANGULAR PERSPECTIVE

MEASURING POINT METHOD

THIS method is sometimes known as the 'Perspective Plan Method'.

The essential difference of this method to the preceding is the manner of obtaining the locations of the vertical lines of the Perspective Elevation.

It is not necessary to use a plan to project from. *All* dimensions may be taken direct from the plan and elevation, or from the object itself. *See* Fig. 5.

Setting out. Refer to FIG. 4.

(*a*) Set out the P.P., S.P., and C.V. as for the previous method.

(*b*) Where the C.V. cuts the P.P. draw a line parallel to the face of the object and one parallel to the side of it (*x–x* and *y–y* respectively). From the S.P. draw two lines to the P.P. *parallel to x–x and y–y*, and so obtain the V.P's. If one or both the V.P's. fall off the drawing-board, this setting out may be done to a small scale, enlarging again for the Plan and Elevation and using a Centrelinead.

(*c*) *To locate the M.P's.* Measure the distances from the V.P's. to the S.P. and set out the same distances from the V.P's. along the P.P., as indicated by the arcs. (*See* page 14 for Theory of M.P's.)

We now have the P.P., on which are marked the C.V., V.P's., and M.P's.

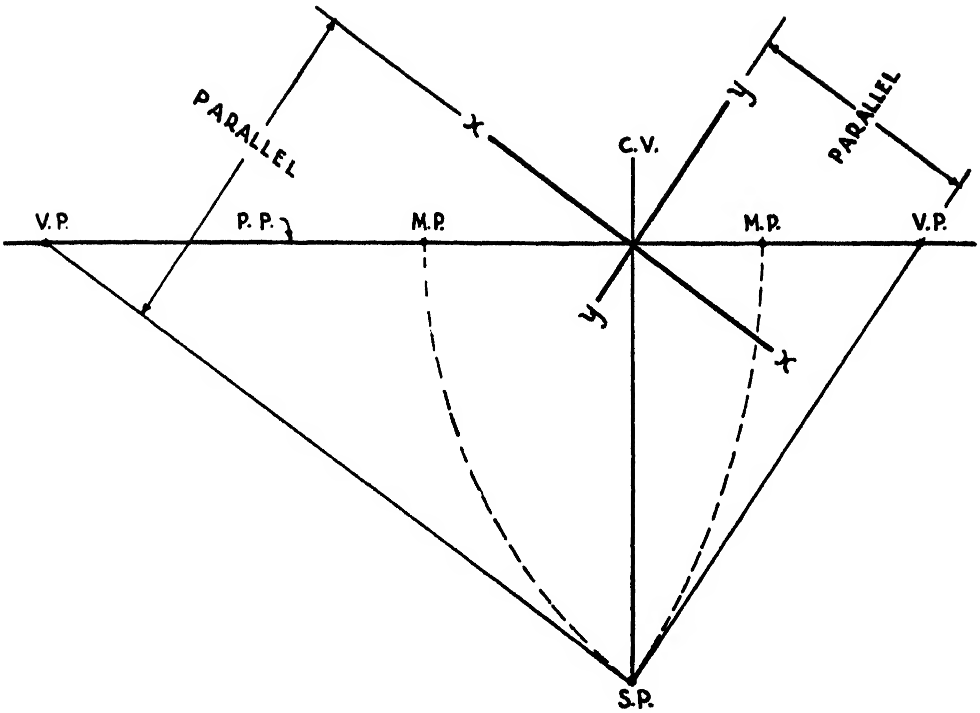


FIG. 4

ANGULAR PERSPECTIVE

Setting-out for M.P. method

THE PERSPECTIVE PLAN

By putting the plan in perspective we obtain the positions of the vertical lines in the Perspective Elevation. The Elevation is set up direct on the final sheet as described in Section IV and Fig. 7.

Refer to FIG. 5.

(*a*) From Fig. 4 we have the V.P's., M.P's., and C.V.

(*b*) Draw the H.L. and C.V. and set out on the H.L. the V.P's. and M.P's. The S.P. is no longer required. Draw the *P.P.* at *any* convenient distance from the H.L., preferably so that the angle between the lines running to the V.P's. is not too obtuse, i.e., the P.P. should not be too close to the H.L.

NOTE. *In all subsequent figures in which the perspective plan has been used the H.L. for the perspective plan has been superimposed on the P.P. for the true plan, as indicated by the symbols (P.P.)–H.L.*

(*c*) Where the C.V. and the P.P. intersect draw x'–x' and y'–y', i.e., x–x and y–y (Fig. 4) in perspective.

(*d*) *All distances in plan are measured on the P.P.* and are all projected from the P.P. to the principal vanishing lines x'–x' and y'–y' by means of the M.P's., as shown.

Theory of Measuring Points.

This may be explained as follows :

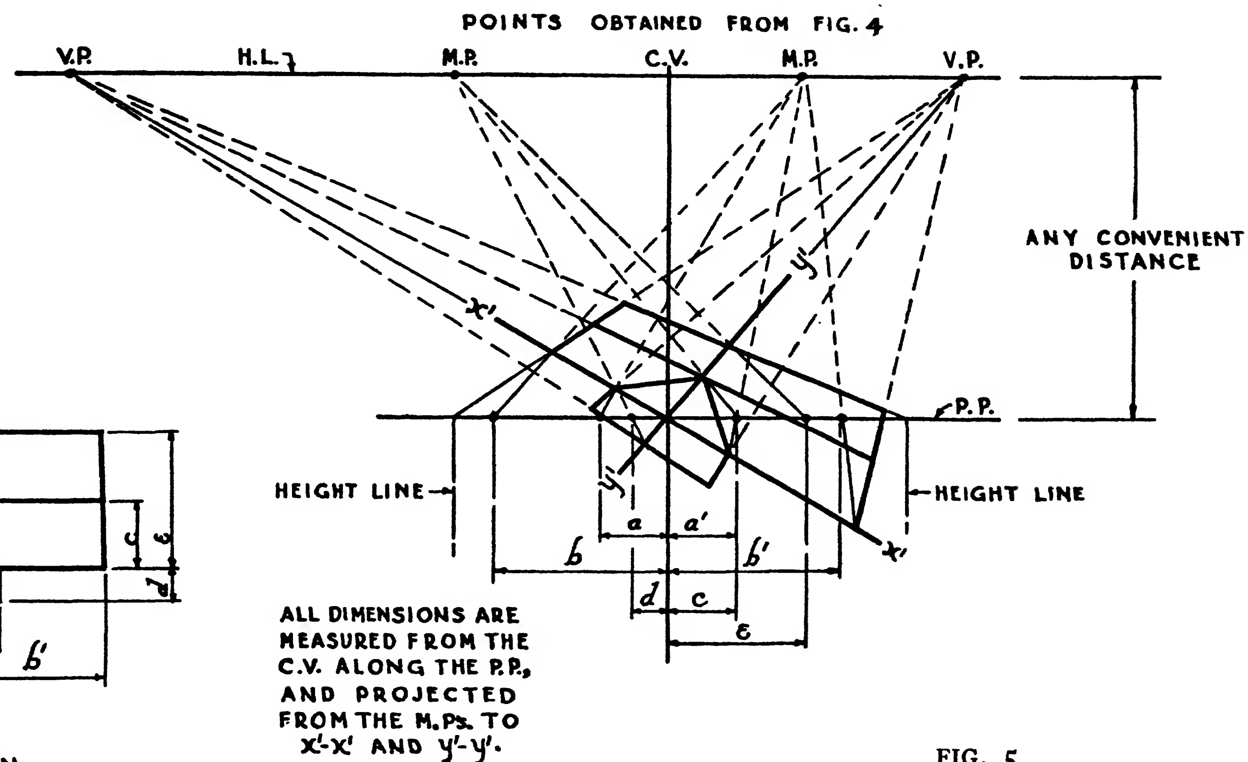
In perspective, distances along a line inclined to the P.P. cannot be measured to scale. A scale of measures in the P.P. in reference to this line must, then, be constructed. Now, *in true plan*, as these distances are equal to the same distances measured along the P.P., a series of similar isosceles triangles may be formed, the apex of the triangles being the point of intersection of the line on which the distances are to be marked off, and the P.P.

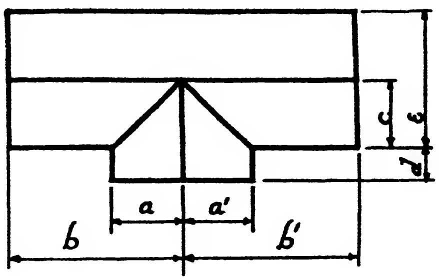
In other words, distances measured along the P.P. may be projected back to a line inclined to the P.P. by the bases of similar isosceles triangles.

To effect this projection in perspective it is necessary to find a vanishing point for the bases of these isosceles triangles.

Since by Fig. 4 and page 12 at (*c*), the lines S.P.–V.P. and V.P.–M.P. are of equal length, they constitute two sides of an isosceles triangle, the third side of which is S.P.–M.P. Moreover, the method of obtaining the V.P. (page 12 at (*b*)) renders this isosceles triangle similar to the series referred to above.

That is, the Measuring Point (M.P.) is the Vanishing Point required for the bases of this series of isosceles triangles.





TRUE PLAN
SHOWING DIMENSIONS

FIG. 5
ANGULAR PERSPECTIVE
Plan in perspective (M.P. method)

Section Three

ANGULAR PERSPECTIVE

INCLINED PLANES

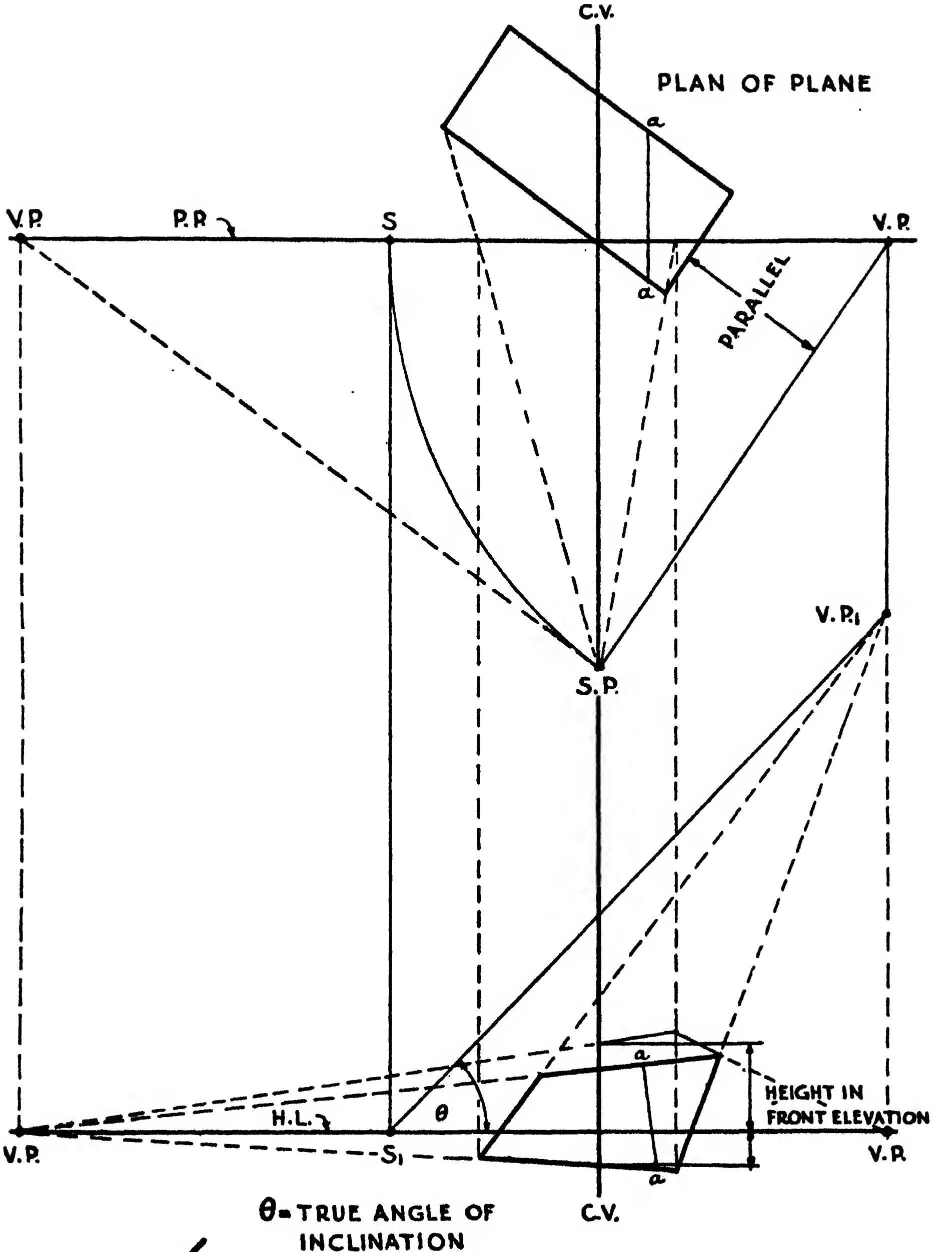
Setting out. Refer to Fig. 6.

(*a*) Set out the plan of the plane in the usual manner. With centre V.P. and radius V.P.–S.P. describe an arc cutting the P.P. at S (the same as to obtain a M.P.).

(*b*) Project S down to S1 in the H.L., and from S1 draw a line up to cut the V.P., projected down, at V.P.1, making the angle θ equal to the true angle of inclination of the plane in elevation.

(*c*) The perspective is drawn in the usual way from the plan, V.P's. and V.P.1.

Note. It is to be carefully observed that the angle θ is really the true angle of inclination of the plane and therefore, in this instance, of the end bounding line of the plane. If the end of the plane is cut off at an angle ***other than a right angle*** (as at *a–a*) the ***true angle of inclination of the end edge of the plane must be determined.*** This is done as shown at '*B*', Fig. 21.



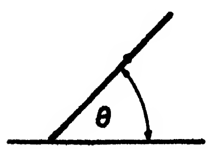


FIG. 6

ANGULAR PERSPECTIVE

Method of obtaining V.P's. for inclined planes

Section Four

ANGULAR PERSPECTIVE

COMPLETE SETTING OUT

FIG. 7 shows a complete setting out by the M.P. method. It is a combination of Figs. 4, 5, and 6. Observe particularly the way in which the planes of the roof are found. They may also be obtained by the 'Height and Plan' method, as in Figs. 2 and 3.

The Perspective Elevation. Refer to FIG. 7.

This is set up on the final sheet by drawing the H.L., C.V., V.P's., and Height Lines only. The perspective plan is pinned above or below and the vertical lines projected downwards or upwards respectively.*

Heights are found as described in Section I, p. 10, but the Height Lines in plan are in perspective as in Fig. 5.

* See Appendix

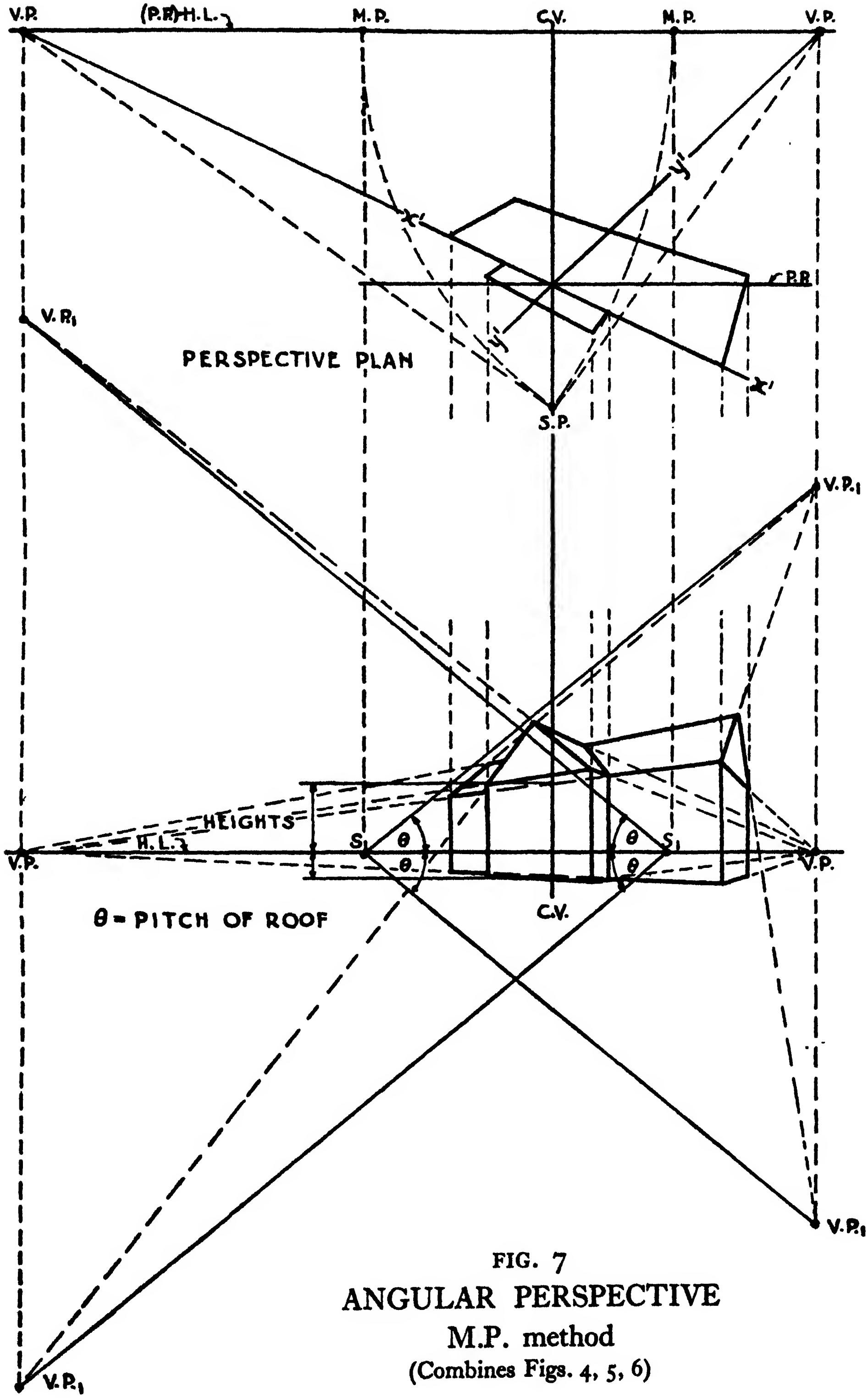


FIG. 7

ANGULAR PERSPECTIVE

M.P. method

(Combines Figs. 4, 5, 6)

Section Five

PARALLEL PERSPECTIVE

WITHOUT MEASURING POINTS

Setting out. Refer to Fig. 8.

(*a*) Draw the P.P. to cut the plan where desired.

(*b*) Draw the C.V.

(*c*) Mark the S.P. and project the angles, &c., in the plan from the S.P. into the P.P.

(*d*) Draw the H.L.

(*e*) The V.P. lies at the intersection of the C.V. and H.L.

(*f*) Draw the *True Section* as cut by the P.P., having regard to the heights above and below the H.L.

(*g*) Project downwards the vertical lines whose locations have been found under (*c*), above.

(*h*) Using the V.P., draw in perspective the horizontal lines parallel to the C.V. Lines parallel to the P.P., whether horizontal or inclined, do not vanish.

(*i*) *Heights* are measured in the P.P., i.e., at the true section, and carried round as shown for the door.

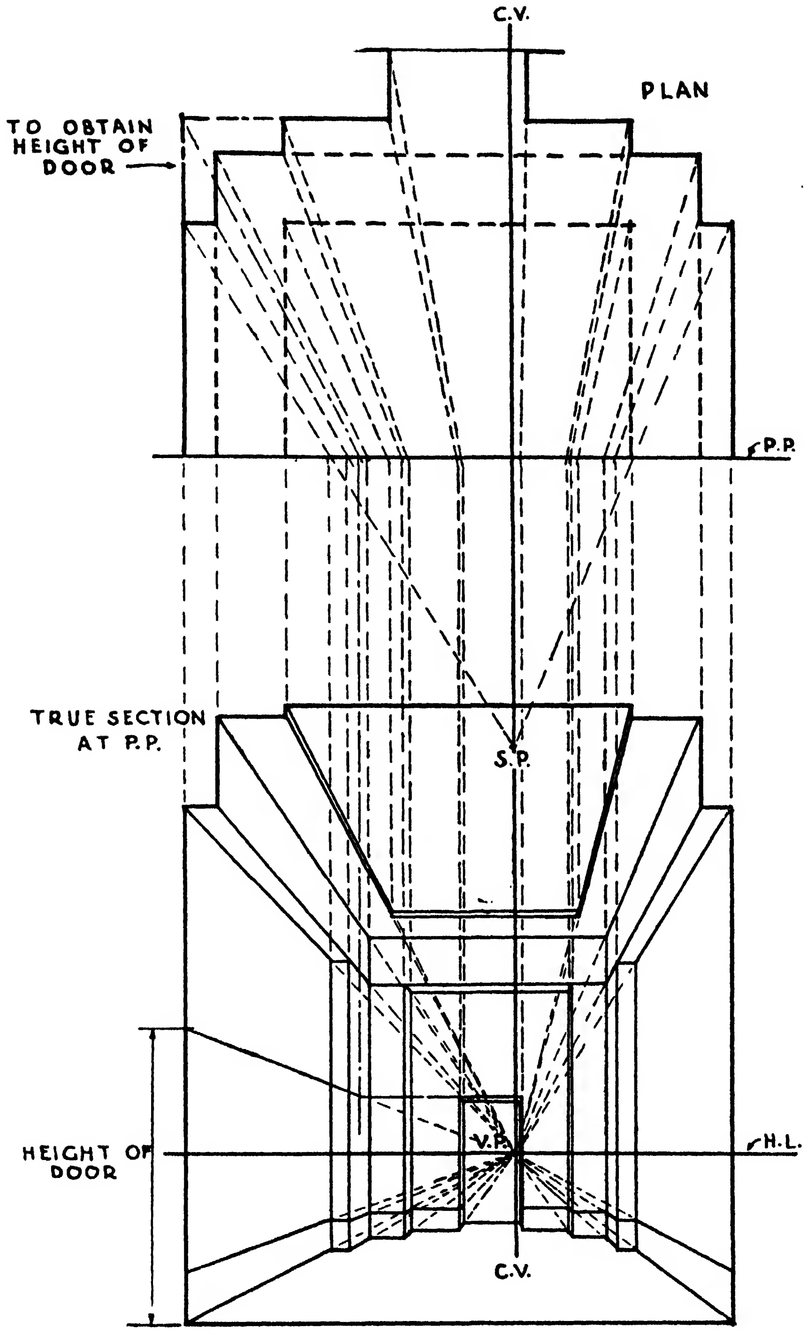


FIG. 8

PARALLEL PERSPECTIVE

(Without M.P.)

Always one V.P., in C.V.

Section Six

PARALLEL PERSPECTIVE

MEASURING POINT METHOD

Setting out. Refer to FIG. 9.

(*a*) Draw the H.L. and the C.V. and at their intersection mark the V.P.

(*b*) Mark the S.P. in the C.V.

(*c*) With radius V.P.–S.P. and centre V.P. describe an arc cutting the H.L. in M.P.

This is the Measuring Point.

The M.P. may be on either side of the C.V. It is the V.P. for lines inclined in plan at 45° to the C.V. and P.P.

(*d*) At a convenient distance below the H.L. draw the P.P.

(*e*) Draw x'–x' (coincides with the P.P.) and y'–y' (coincides with the C.V.). (*Also see* Figs. 4 and 5.)

(*f*) Mark the dimensions which, in the plan, are parallel to the C.V., along the P.P. and project these points into y'–y' by means of the M.P.

Since x'–x' coincides with the P.P. dimensions which, in the plan, are parallel to the P.P. require no M.P. Further, such a M.P. coincides with the V.P.

(*g*) Complete the plan as shown. Lines parallel to the P.P. remain parallel.

(*h*) Draw the elevation as described in Section Five, (*d*) to (*i*).

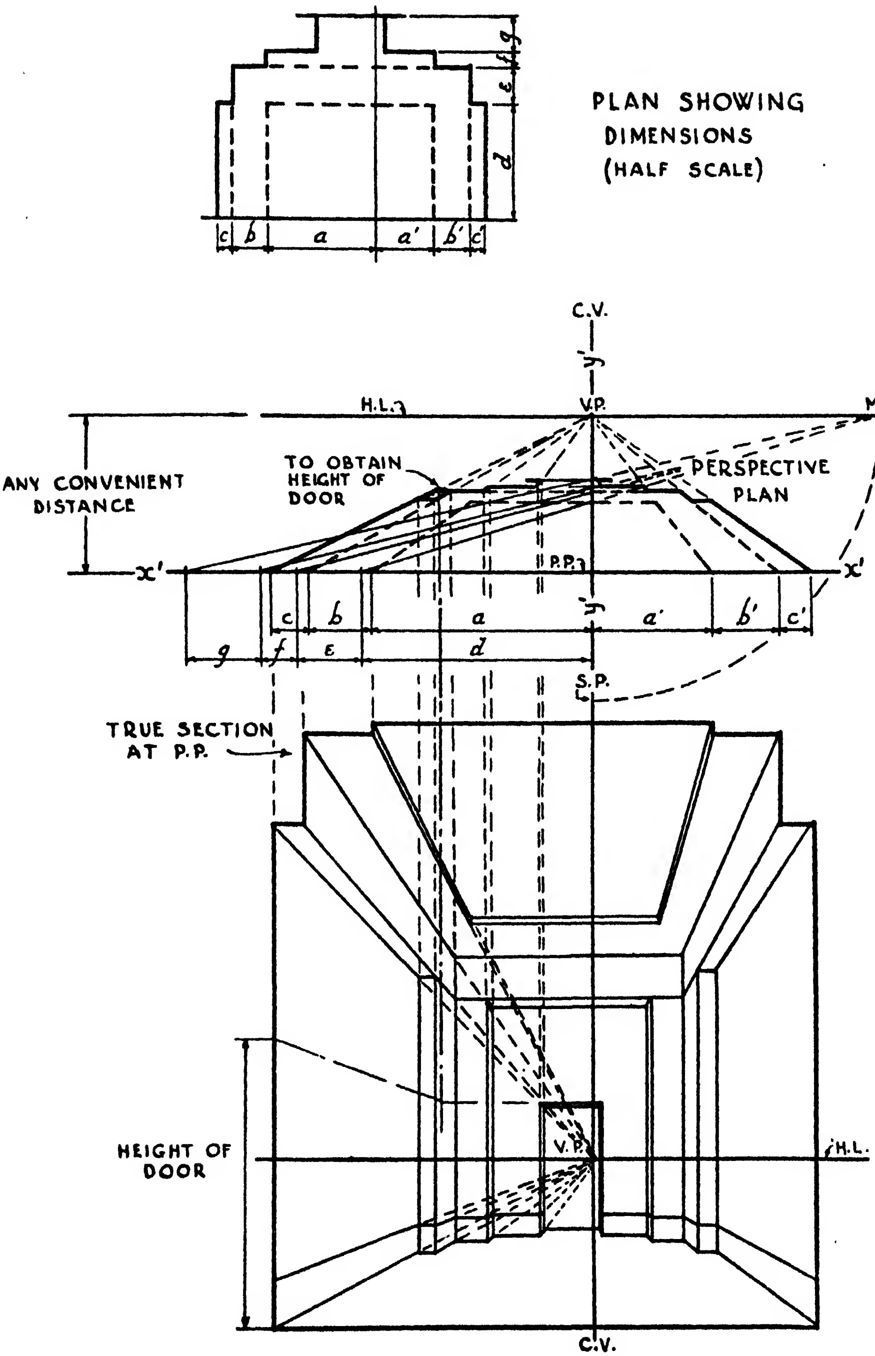


FIG. 9

PARALLEL PERSPECTIVE

(M.P. method)

Always one V.P., in C.V.

Section Seven

PARALLEL PERSPECTIVE

INCLINED PLANES

Setting out. Refer to FIG. 10.

Two planes are shown, both inclined at the same angle. The diagonal is in angular perspective and is horizontal.

(*a*) Set out the plan of the planes in the usual way.

(*b*) Draw the P.P. and C.V. and mark off the S.P.

(*c*) From the S.P. draw a line parallel to the diagonal in the plan to cut the P.P. in V.P.

(*d*) Locate S as shown by the arc.

(*e*) Draw the H.L. and C.V.

(*f*) Project the V.P. down to the H.L.

(*g*) *Inclined lines at right angles to the P.P in plan.*

(i) Project S down to S1 in the H.L.

(ii) At S1 on either side of the H.L. set out the angles θ' to cut the C.V. in V.P.1.

(*h*) *Inclined lines parallel to the P.P. in plan. These lines have no vanishing points.* Provided the C.V. is horizontal, the angle θ is actual and constant, as shown by the two positions of the Perspective Elevation.

(*i*) Set out the diagonal in perspective and complete the elevation, as shown.

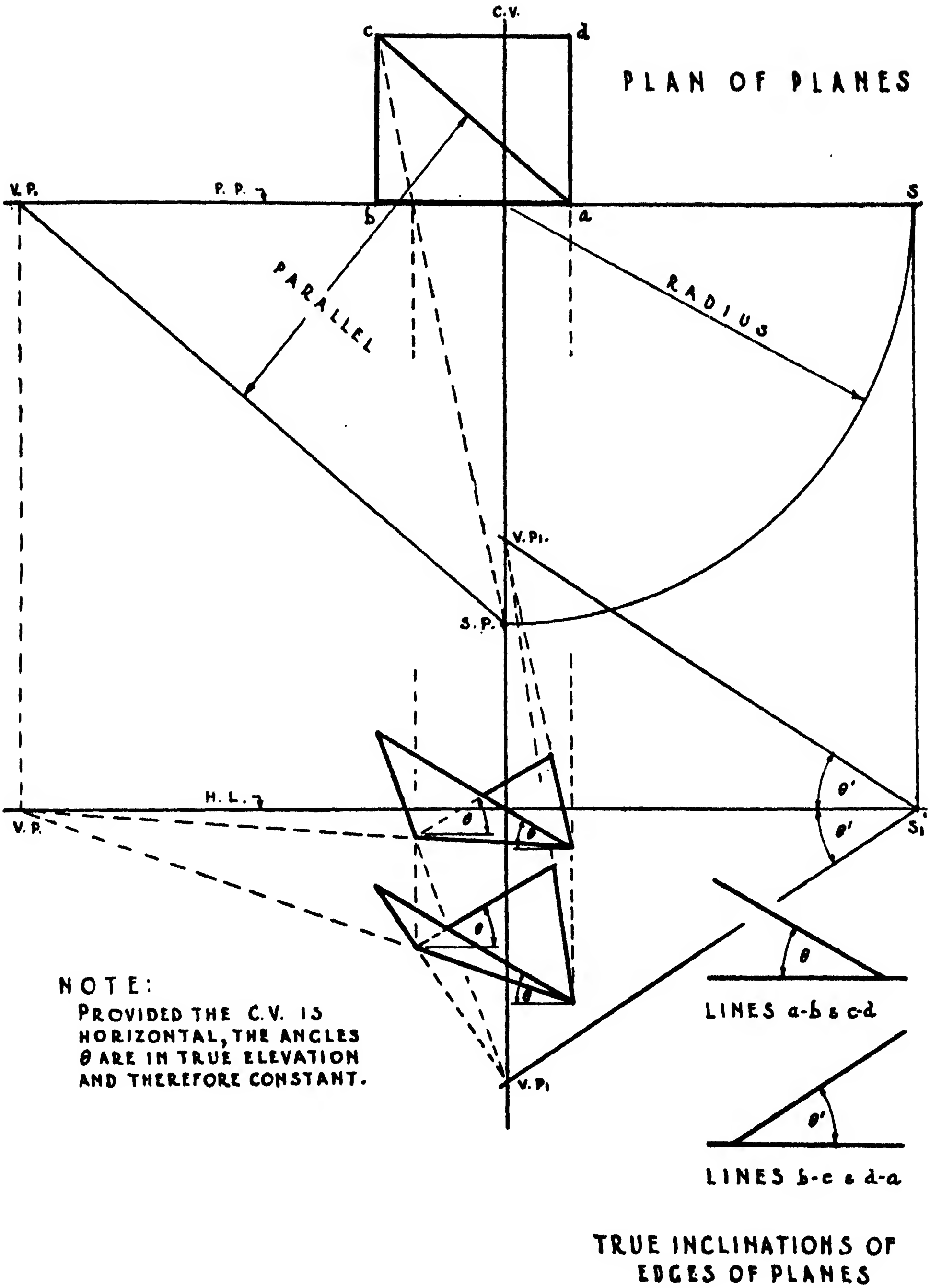


FIG. 10

PARALLEL PERSPECTIVE

Method of obtaining V.P1's. for inclined planes

PART THREE

THE CENTRE OF VISION IS INCLINED

Section One

ANGULAR PERSPECTIVE

THE C.V. INCLINED UPWARDS

ALL vertical lines vanish upwards to the V.P.2.

To find V.P.2. Refer to FIG. 11 at '*B*'.

(*a*) Draw the line *c–c parallel to the sides of the object.*

(*b*) Set out the C.V. and S.P.

(*c*) Where the C.V. cuts *c–c* draw the P.P. *at right angles to the C.V.*

(*d*) From the S.P. draw a line parallel to *c–c*, upwards to intersect the P.P. at V.P.2.

To find the H.L. Refer to FIG. 11 at '*B*'.

Draw a horizontal line through the S.P. to intersect the P.P. This point of intersection is the position of the H.L.

Note. Compare Fig. 11 at '*B*' with Fig. 2 and note the similarity of the methods used to find the vanishing points in elevation and plan.

Heights. Refer to FIG. 11 at '*A*'.

(*a*) Draw *c–c* at least the true height of the object to scale and mark upon it a scale of feet and inches.

(*b*) Set out the S.P. and C.V.

(*c*) Where the C.V. and *c–c* intersect draw the P.P. at right angles to the C.V.

(*d*) Project the scale on *c–c* from the S.P. into the P.P.

(*e*) Draw *c′–c′* parallel to *c–c*.

(*f*) Carry the scale in the P.P. across horizontally into *c′–c′*.

The scale now marked on *c′–c′* is the scale to be used for the heights in the Perspective Elevation (*see* Fig. 12).

Note. Compare Fig. 11 at '*A*' with Fig. 2 and note the similarity of the methods used, i.e., the location of the horizontal lines in the former and of that for finding the locations of the vertical lines in the latter.

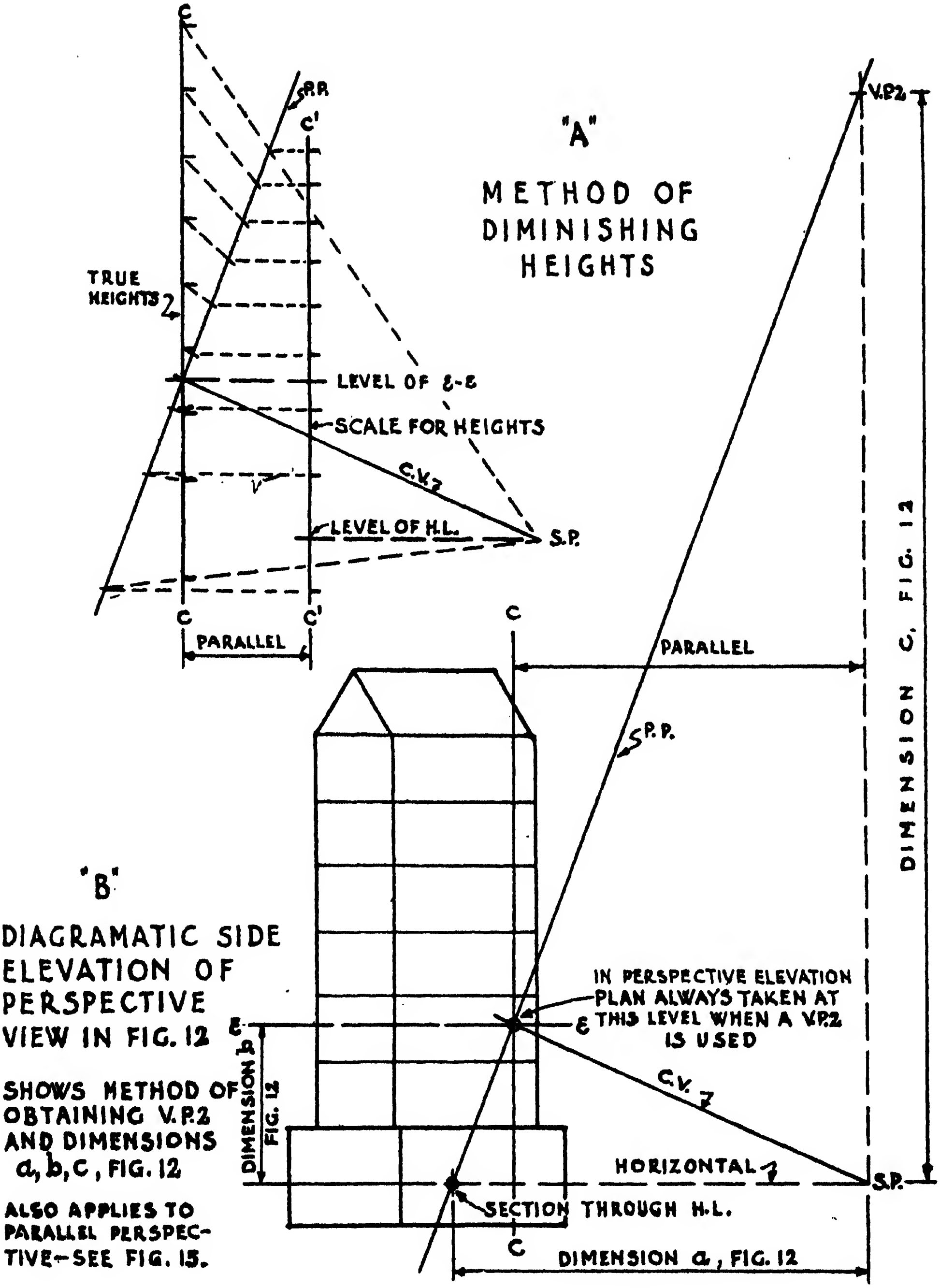


FIG. 11

ANGULAR PERSPECTIVE

C.V. is inclined upwards

See also Fig. 12

Section One (cont.)

TO SET UP THE PERSPECTIVE

Refer to FIG. 12.

Plan.

(*a*) Draw the P.P. and C.V.

(*b*) Set off the S.P. distant *dimension* '*a*', Fig. 11, at '*B*' from the P.P.

(*c*) Find the V.P's. in the usual way. (*See* Figs. 2 and 4.)

(*d*) Locate the M.P's. in the usual way. (*See* Fig. 4.)

(*e*) Set up the Perspective Plan in the usual way (*see* Fig. 5), or a true plan and no M.P's. (*See* Fig. 2.)

Elevation.

(*a*) Draw the H.L. and C.V. and bring down the V.P's.

(*b*) In the C.V. projected up, locate the V.P.2 *dimension* '*c*', Fig. 11 at '*B*', above the H.L.

(*c*) Draw *e–e dimension* '*b*', Fig. 11 at '*B*', above the H.L.

(*d*) Commencing at the point where *e–e* intersects the C.V. projected up, draw the ***plan*** in perspective, projecting its angles down from the Perspective Plan in the usual way, or from the intersection of the convergent rays and the P.P. if the method shown in Fig. 2 is used.

(*e*) From V.P.2 project the angles of the new plan upwards and downwards. These projection lines are coincident with the vertical lines of the object in perspective.

Heights.

The scale of heights must be applied *vertically* and may be applied directly through the intersection of the C.V. and P.P.

Additional height lines may be found in plan as shown in Figs. 3 and 5 and projecting their intersections with the P.P. down to *e–e*, *or*, they may be located at any point where *e–e* intersects any point of the plan found under (*d*) above or any side of it produced. From V.P.2 project these intersections of the plan with *e–e* upwards and downwards. These projection lines are the height lines in perspective. As the scale of heights must be applied vertically it is necessary to project horizontally from the scale to these additional height lines. One height line found by the above methods is shown in Fig. 12.

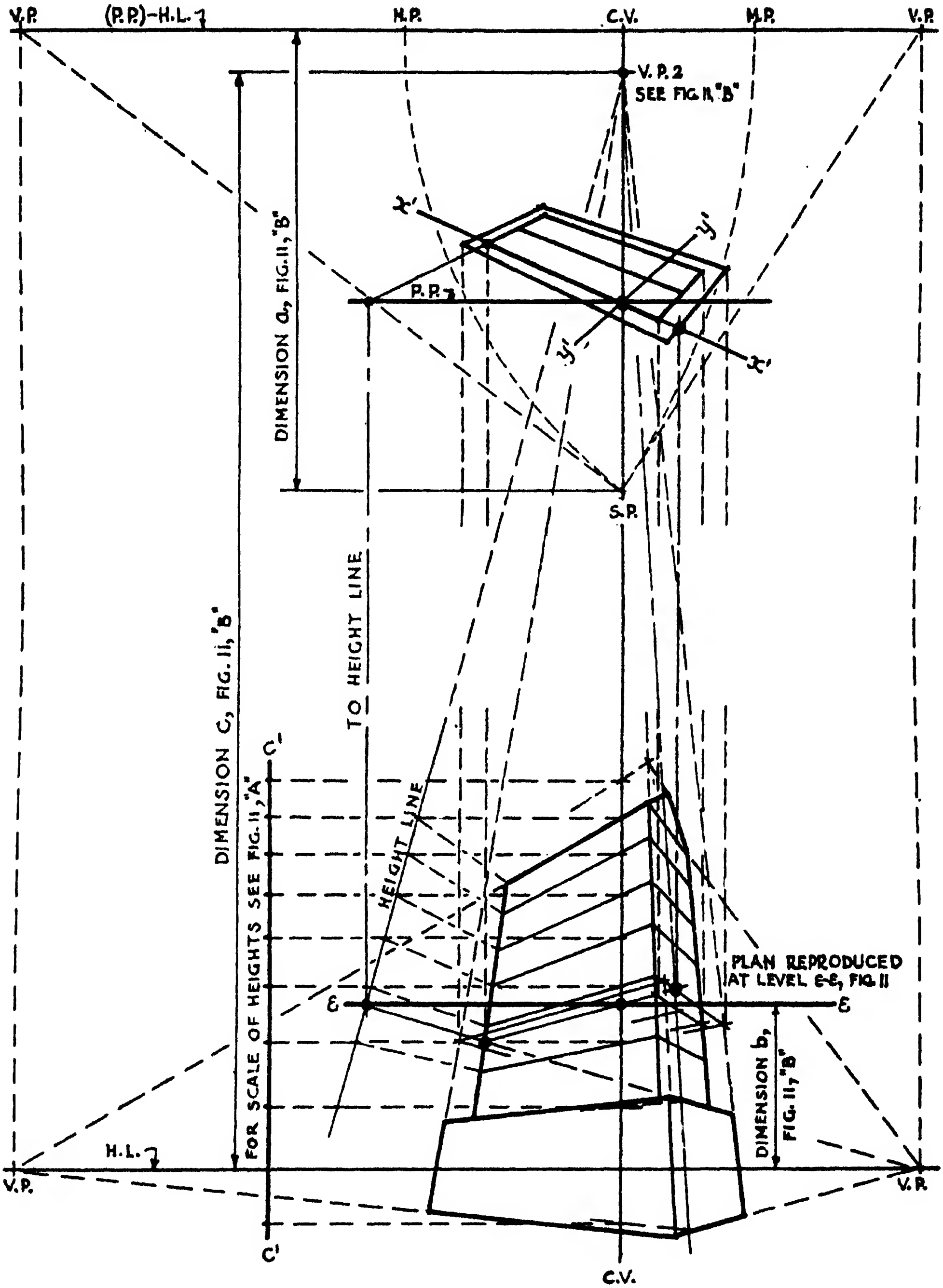


FIG. 12

ANGULAR PERSPECTIVE

C.V. is inclined upwards

See also Fig. 11

Section Two

ANGULAR PERSPECTIVE

THE C.V. INCLINED DOWNWARDS

(Bird's-Eye View)

For any case in which the C.V. is not much inclined, the object is low and the limits of the Cone of Vision are not nearly approached the V.P.2 *may* be omitted (i.e., vertical lines need not vanish) without causing an unpleasant departure from correct representation. Otherwise a V.P.2 should be used.* This V.P.2 will be *below* the H.L. It is located on the same principle as in Fig. 11 at '*B*' and as shown in Fig. 13 at '*B*'.

To find the H.L. Refer to Fig. 13 at '*B*'.

(*a*) Draw the C.V. and mark off the S.P.
(*b*) Draw the P.P. where desired *at right angles* to the C.V.
(*c*) Draw a horizontal line through the S.P. to intersect the P.P. This point of intersection is the position of the H.L.

Dimension '*a*' is the distance from the S.P. to the H.L.

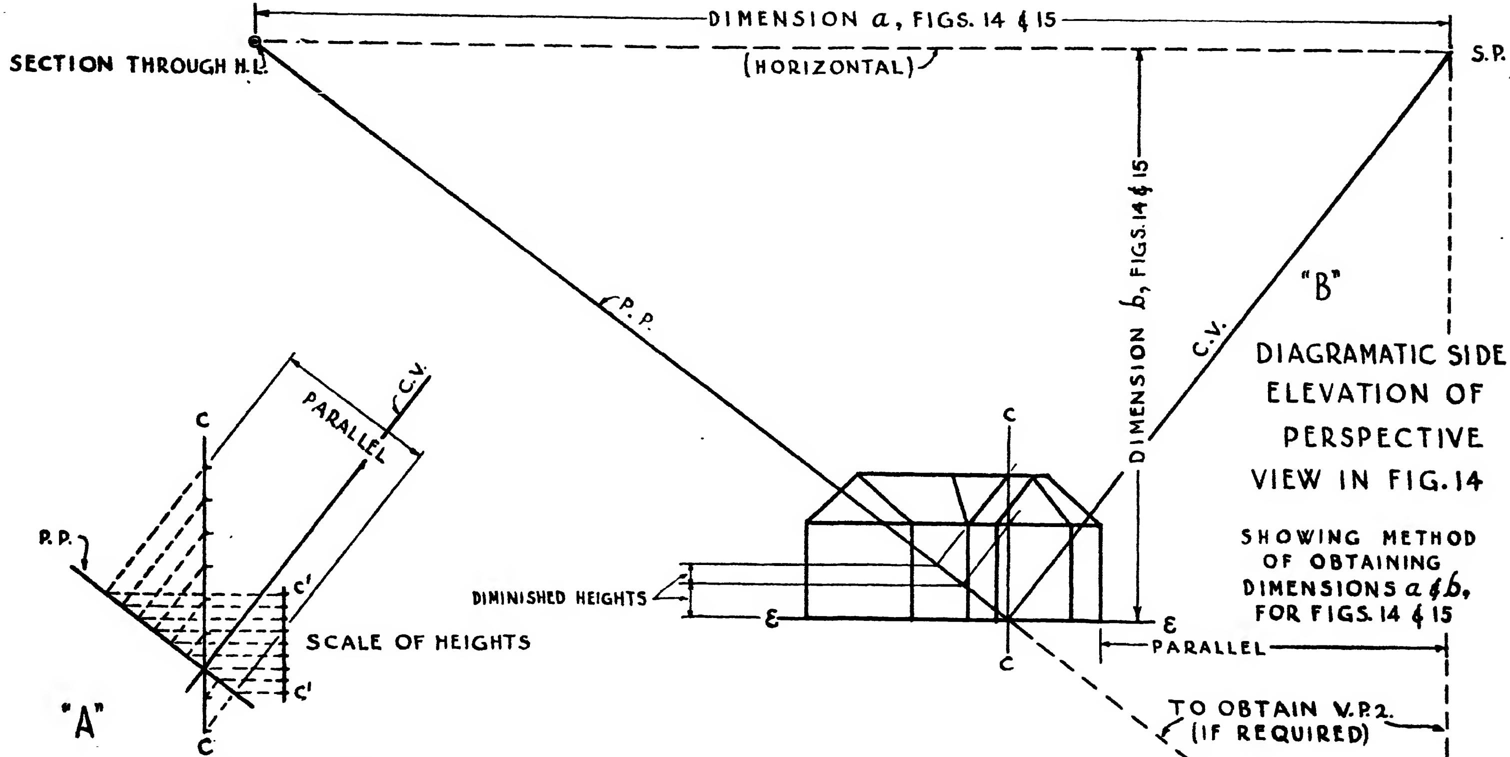
Dimension '*b*' is the distance *e–e* is below the H.L.

Heights. Refer to Fig. 13 at '*A*'.

Note. This method is only to be used when vertical lines are not made to vanish.

(*a*) Set up *c–c* at least the true height of the object to scale and mark upon it a scale of feet and inches.
(*b*) Draw the C.V.
(*c*) Where the C.V. and *c–c* intersect draw the P.P. *at right angles to the C.V.*
(*d*) With lines parallel to the C.V. project the scale on *c–c* into the P.P.
(*e*) Draw *c′–c′* parallel to *c–c*.
(*f*) Carry the scale in the P.P. across horizontally into *c′–c′*.
The scale now marked on *c′–c′* is the scale to be used for heights in the Perspective Elevation.

* See Appendix



METHOD OF DIMINISHING HEIGHTS WHEN VERTICAL LINES DO NOT VANISH

Also applies to parallel perspective

FIG. 13

ANGULAR BIRD'S-EYE PERSPECTIVE

C.V. is inclined downwards

See also Figs. 14 & 15

TO SET UP THE PERSPECTIVE

Refer to FIG. 14.

Plan.

(*a*) Draw the P.P. and C.V.
(*b*) Set off the S.P. distant ***dimension*** '*a*', Fig. 13 at '*B*', from the P.P.
(*c*) Find the V.P's. in the usual way. (*See* Figs. 2 and 4.)
(*d*) Locate the M.P's. in the usual way. (*See* Fig. 4.)
(*e*) Set up the Perspective Plan in the usual way (*see* Fig. 5), or use true plan and no M.P's. (*see* Fig. 2).

Elevation.

(*a*) Draw the H.L. and C.V. and bring down the V.P's.
(*b*) Draw ***e–e dimension*** '*b*', Fig. 13 at '*B*', below the H.L.
(*c*) Project the angles of the plan down into ***e–e***. *If* a V.P.2 is used, commencing at the point where *e-e* intersects the C.V. projected down, draw the plan in perspective and proceed as for Section one, Elevation, (*d*) and (*e*).

Heights.

The usual rules apply (*see* Figs. 2, 3 and 5) except that the scale for diminished heights, Fig. 13, is used. *If* the vertical lines are made to vanish the scale for diminished heights ***must*** be prepared as in Fig. 11 at '*A*' and the directions given on page 28 observed.

This latter method of diminishing heights may always be used as it is correct, and not an approximation as is the former.

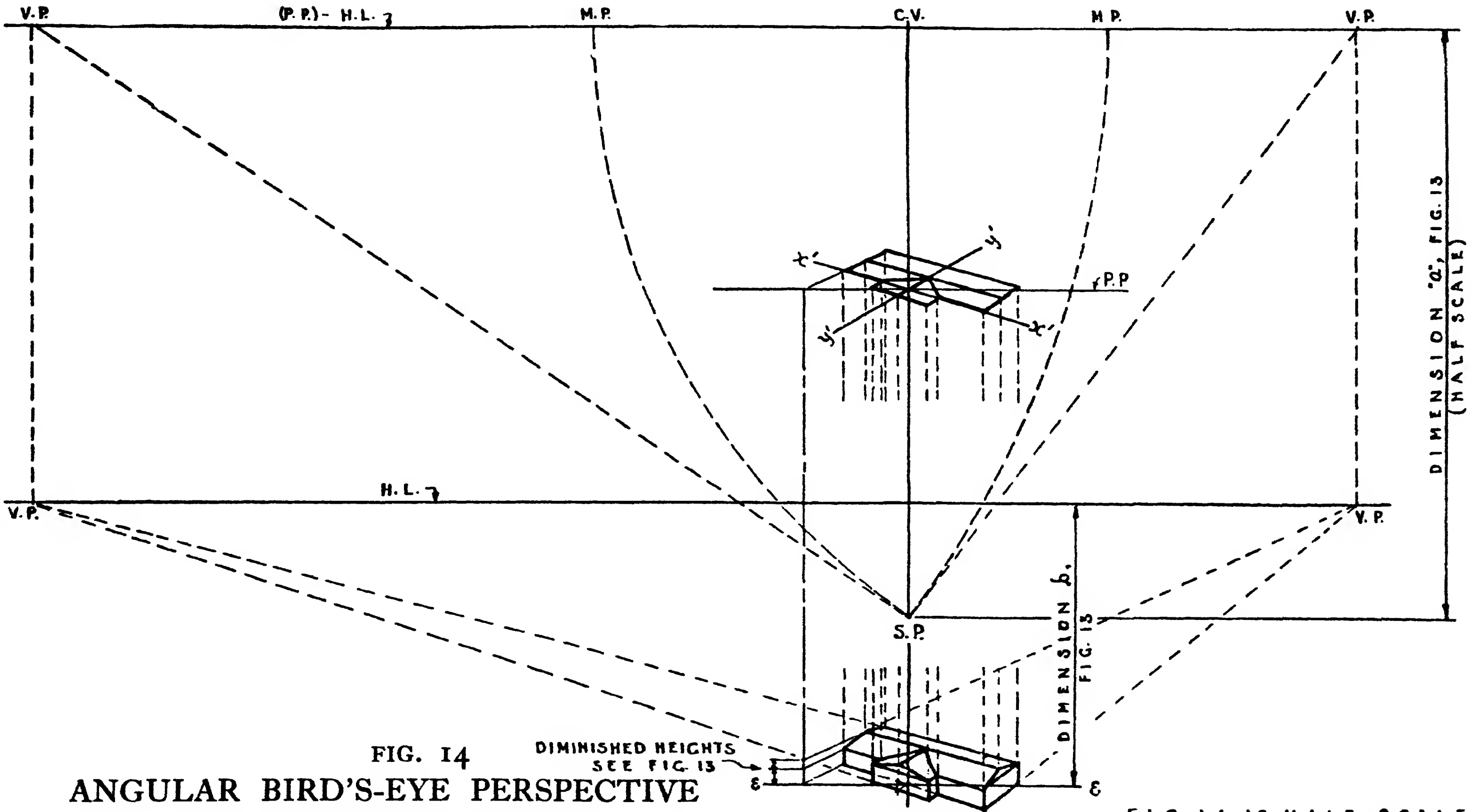


FIG. 14

ANGULAR BIRD'S-EYE PERSPECTIVE

C.V. is inclined downwards

See also Fig. 13

Section Three

PARALLEL BIRD'S-EYE PERSPECTIVE

INCLINED C.V.

Refer to FIG. 15.

The C.V. is inclined downwards.

This figure is exactly the same as Fig. 14, but in parallel perspective. Fig. 13 also applies. Also refer to the first paragraph of Section Two, p. 30.

TO SET UP THE PERSPECTIVE

Plan.

(*a*) Draw the plan, P.P. and C.V.
(*b*) Set off the S.P. ***dimension*** '*a*', Fig. 13 at '*B*', below the P.P.
(*c*) Project the angles in the plan from the S.P. into the P.P. as in Fig. 8.

(The M.P. Method may be used as in Fig. 9. ***See also*** note at top of Fig. 15.)

Elevation.

(*a*) Draw the H.L. and C.V.
(*b*) The V.P. for the horizontal lines is at the intersection of the H.L. and C.V.
(*c*) Draw ***e–e dimension*** '*b*', Fig. 13 at '*B*', below the H.L.
(*d*) Project the points of the plan, in the P.P. down through *e–e*. *If* a V.P.2 is used, commencing at the point where *e–e* intersects the C.V. projected down, draw the plan in perspective and proceed as for Section One, Elevation (*d*) and (*e*).

Heights.

The usual rules apply (*see* Figs. 2, 3 and 5) except that the scale for diminished heights, Fig. 13, is used. *If* the vertical lines are made to vanish the scale for diminished heights ***must*** be prepared as in Fig. 11 at '*A*' and the directions given on page 28 observed.

This latter method of diminishing heights may always be used as it is correct, and not an approximation as is the former.

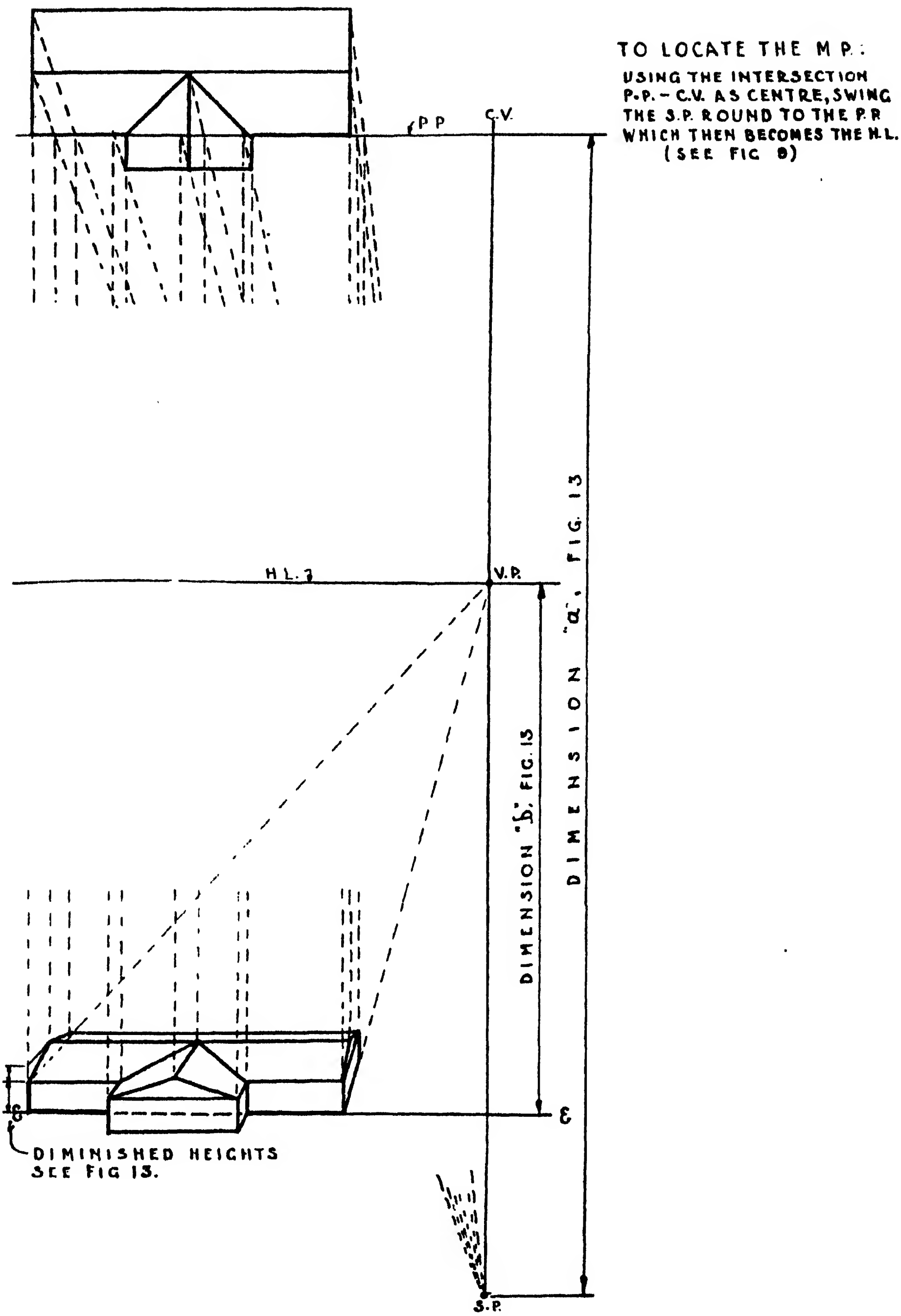


FIG. 15

PARALLEL BIRD'S-EYE PERSPECTIVE

C.V. is inclined downwards

See also Fig. 13

PART FOUR

REFLECTIONS, SHADOWS, CURVES, THE CENTRELINEADS, ALTERNATIVE CONSTRUCTIONS

Section One

REFLECTIONS

Theory of Reflections. Refer to FIG. 16 at '*A*', in which the laws of specular reflection are illustrated.

(i) *The angle of the incident ray to the normal is equal to the angle of the reflected ray to the normal.*

(ii) *The image is the object reversed in the reflecting surface and is the same distance behind it as the object is in front.*

To obtain the Reflection.

Find the image and bring this into perspective. The inclination of the C.V. is of no special significance.

(*a*) *Horizontal reflecting surface.*
Refer to FIG. 16 at '*B*'.
For reflections:
Use the same V.P's. as for the object.
Reverse vertically all V.P.1's.
The reflection is the same height *below the reflecting surface* as the object is above.*

(*b*) *Vertical reflecting surface parallel to the C.V.*
Refer to FIG. 16 at '*C*'.
For reflections:
Reverse horizontally all V.P's. and V.P.1's.
The reflection is the same height as the object.

* See Appendix

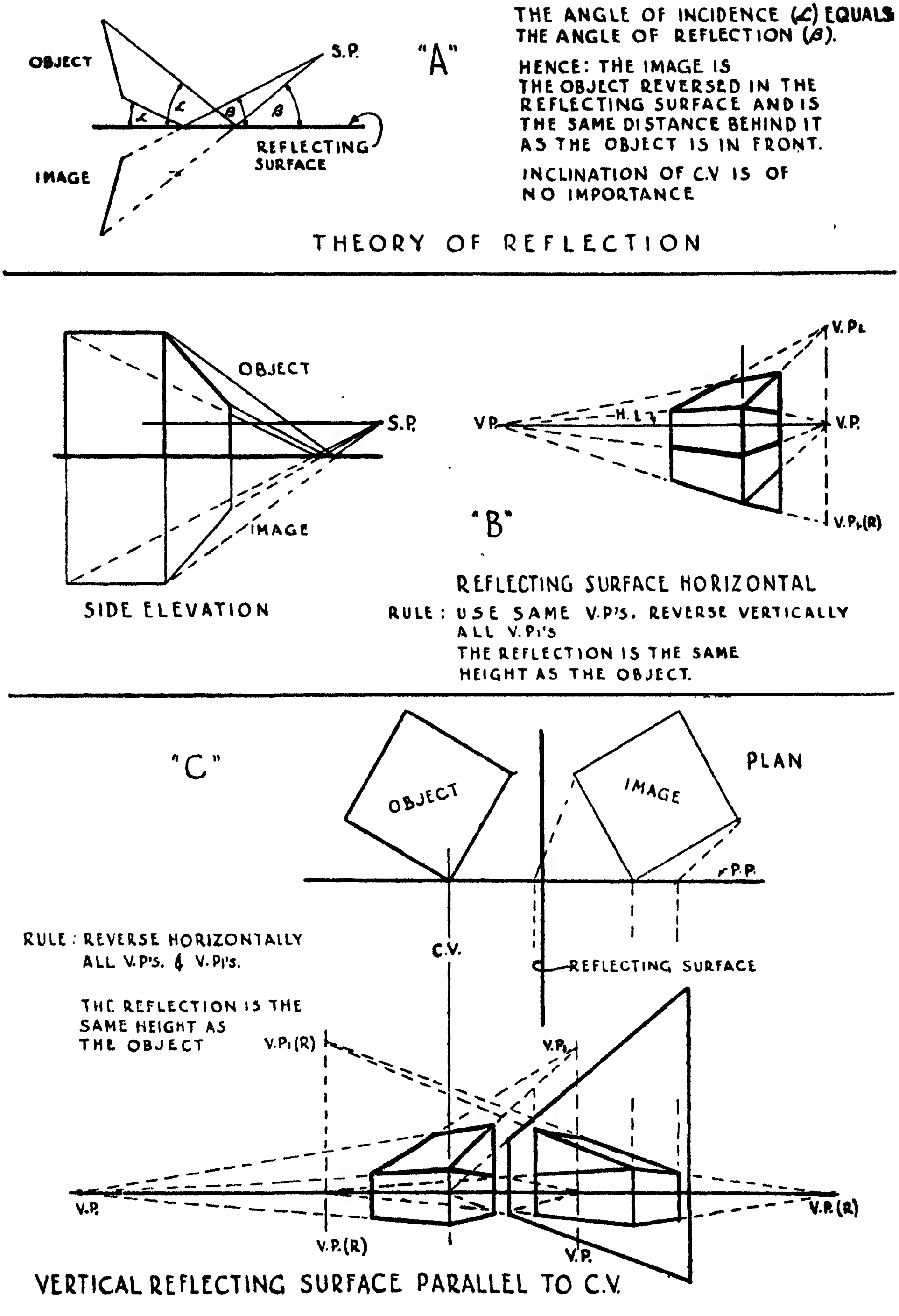


FIG. 16

REFLECTIONS

(*c*) ***Vertical reflecting surface parallel to P.P.***

Refer to Fig. 17.

For reflections:

Reverse horizontally all V.P's.

Reverse diagonally all V.P.1's.

(*d*) ***Vertical reflecting surface parallel to object.***

Refer to Fig. 18.

For reflections:

Use same V.P's. as for object.

Reverse vertically V.P.1's only for those sloping lines which are at right angles to the reflecting surface in plan.

(*e*) ***Vertical reflecting surface at an angle to the object, the P.P., and the C.V.***

Refer to Fig. 19.

In this case it is necessary to find special V.P's. and V.P.1's. for the image.

All the laws of perspective apply.

The Perspective Plan Method may be used.

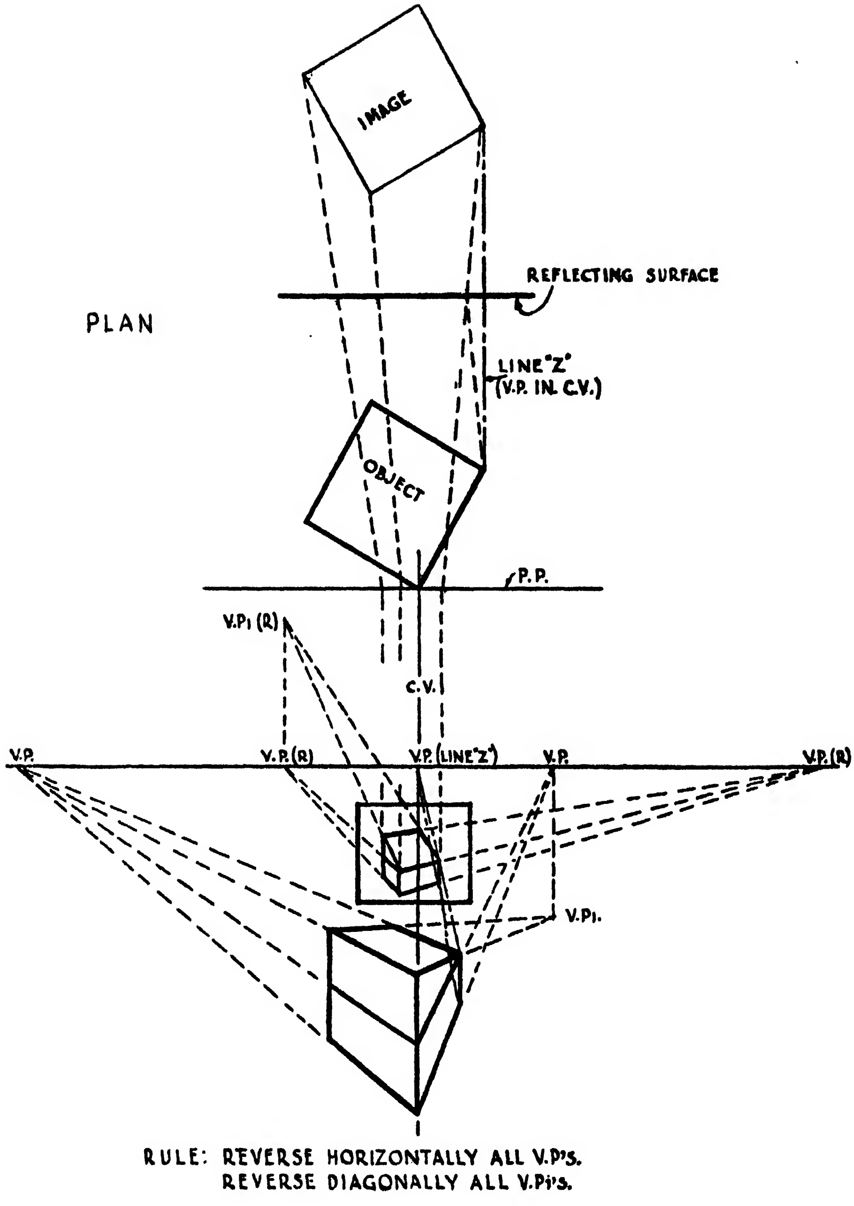


FIG. 17

REFLECTIONS

Vertical reflecting surface parallel to P.P.

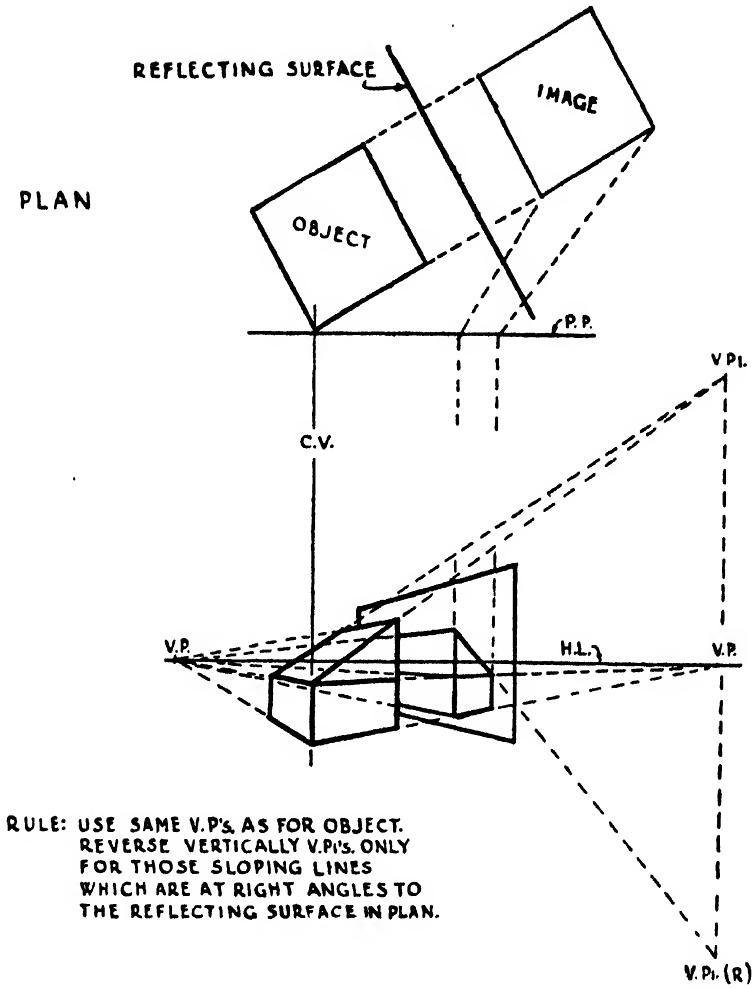


FIG. 18

REFLECTIONS

Vertical reflecting surface parallel to object

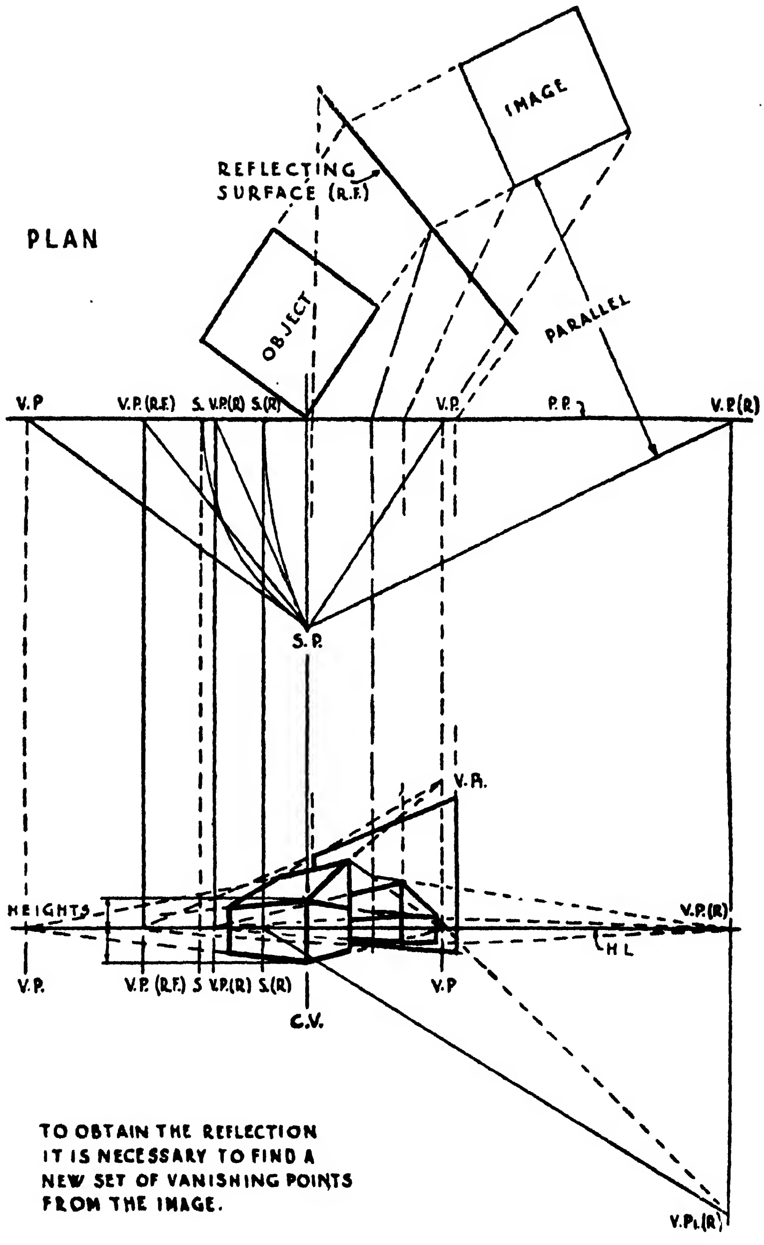


FIG. 19

REFLECTIONS

Vertical reflecting surface inclined to object

Section Two

SHADOWS

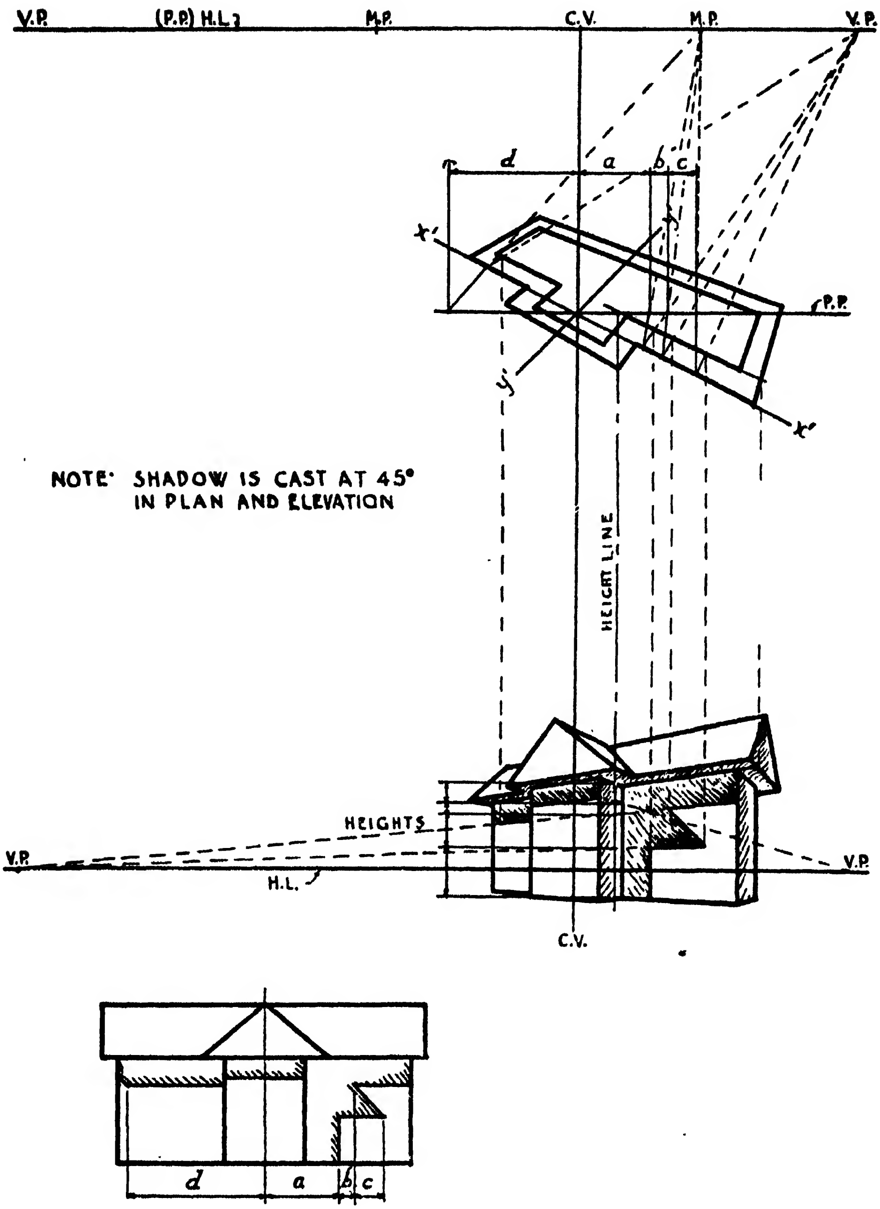
There are three methods of obtaining shadows in perspective:

(i) *Small shadows*, such as on column bases, capitals, and small irregular shapes, may be drawn by eye.

(ii) *Copying from the elevations and plans*.

Refer to Fig. 20.

The shadows are copied from the elevation by the 'Height and Plan Method'. (*See* Fig. 2.) The positions of the vertical lines are set out in the Perspective Plan (or marked on the plan if the perspective is being done without M.P's.) and the heights found in elevation.



FRONT ELEVATION

FIG. 20

SHADOWS

Method of copying from elevations

(iii) *Casting in perspective.*

Refer to FIG. 21.

All the rules of sciagraphy apply.

(*a*) Determine angle β as shown at '*A*'.
(*b*) Determine the true angle of the light θ as shown at '*B*'.
(*c*) Draw the Perspective Plan. (*See* Figs. 4 and 5.)
(*d*) Find the V.P. for the light by setting out the angle β at the S.P.
(*e*) With this V.P. cast the shadows in plan.
(*f*) Draw the Perspective Elevation. (*See* Fig. 7.)
(*g*) Bring down the vertical edges of the shadow from the plan to the elevation.
(*h*) Find S and S1. and with angle θ find V.P.1. for the light. (*See* Figs. 6 and 7.)
(*i*) With this V.P.1. cast the shadows in elevation.
(*j*) Complete the shadows with the aid of the V.P's. for the object.

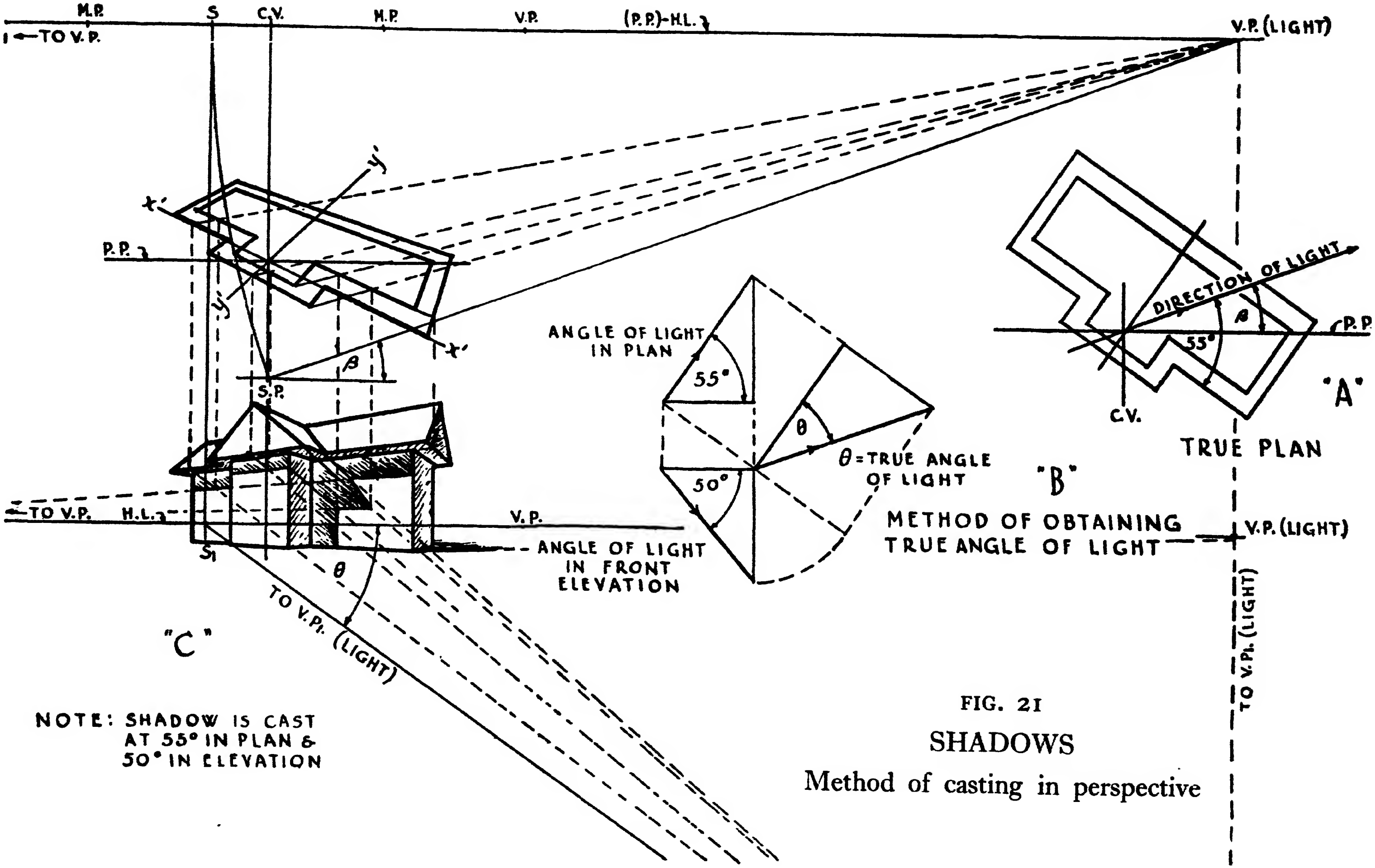


FIG. 21
SHADOWS
Method of casting in perspective

Section Three

PLANE CURVES, CURVED SURFACES, THE SPHERE

Plane Curves. Refer to FIG. 22A.

The simplest method of drawing any plane curve in perspective is given by the following rule, and illustrated in the figure.

(i) At a convenient number of points on the actual curve form intersections of straight lines.

(ii) Form these points on the curve, in perspective, by drawing the straight line intersections in perspective.

(iii) Draw the curve through these points.

Curved Surfaces.

Since the image of every object is formed by rays of light reflected from every visible point on the surface to the eye of the spectator, *the outline of the image of a curved surface is formed by those points whose rays reflected to the eye are tangental to the surface.* Hence, to obtain the image in perspective it is first necessary to define this outline and then to bring it into perspective. The actual determination of the outline is a matter of solid geometry rather than of perspective.

The sphere is a special case.

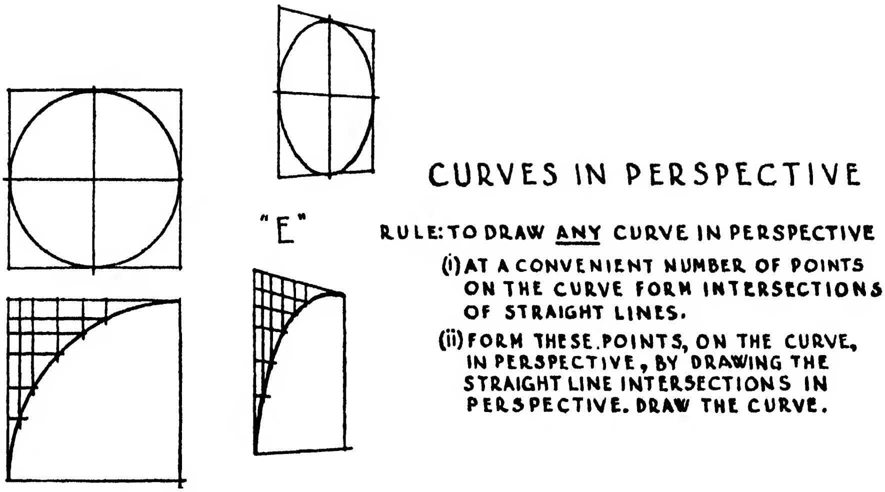


FIG. 22A

PLANE CURVES

The Sphere

The visible portion of the surface of the sphere is outlined by a circle—always smaller than the circumference of the sphere—containing the points of tangency between the surface of the sphere and the ' surface' of the *cone* of rays converging to the S.P. This circle will be referred to below as the 'circle of tangency'.

The P.P. cuts the cone of rays at angles varying according to the position of the sphere. When the C.V. coincides with the axis of the cone the perspective elevation is a circle; when it does not the perspective elevation is an ellipse.

To obtain the image it is necessary to define the ' circle of tangency ' and then to bring it into perspective.

Refer to FIG. 22B.

(*a*) Set up the P.P., C.V., S.P. and the plan of the sphere.

(*b*) From A, at the centre of the sphere, draw A–S.P.

(*c*) From A draw A–B at right angles to A–S.P., making A–B equal to the height of the centre of the sphere above or below the H.L.

(*d*) With centre B describe a circle of the same radius as the sphere.

(*e*) Join B–S.P. and bisect at C.

(*f*) With radius C–B describe an arc cutting the circle at D and E. Join D–E, cutting B–S.P. at F. Observe that B–S.P. is the true distance from the centre of the sphere to the S.P. and that D–E is the true diameter of the circle of tangency. In plan this circle will become an ellipse.

(*g*) Find the true diameter of the circle of tangency in plan by projecting F parallel to A–B to cut A–S.P. at I and produce F–I to cut the sphere at J and K. J–I–K is the required diameter and is the major axis of the elliptical plan of the circle of tangency.

(*h*) Obtain the minor axis of the ellipse by projecting D to G and E to H, both in A–S.P. produced. G–I–H is the minor axis.

(*i*) Obtain additional points in the ellipse by any of the usual constructions employed for drawing ellipses, one of which is shown, giving points 1, 2, 3, 4.

The ellipse of J–H–K–G represents the circle of tangency in plan. This must now be brought into perspective and the figure shows this carried out by parallel perspective.

Notice that the axes of the plan of the circle of tangency bear no relationship to those of the perspective elevation.

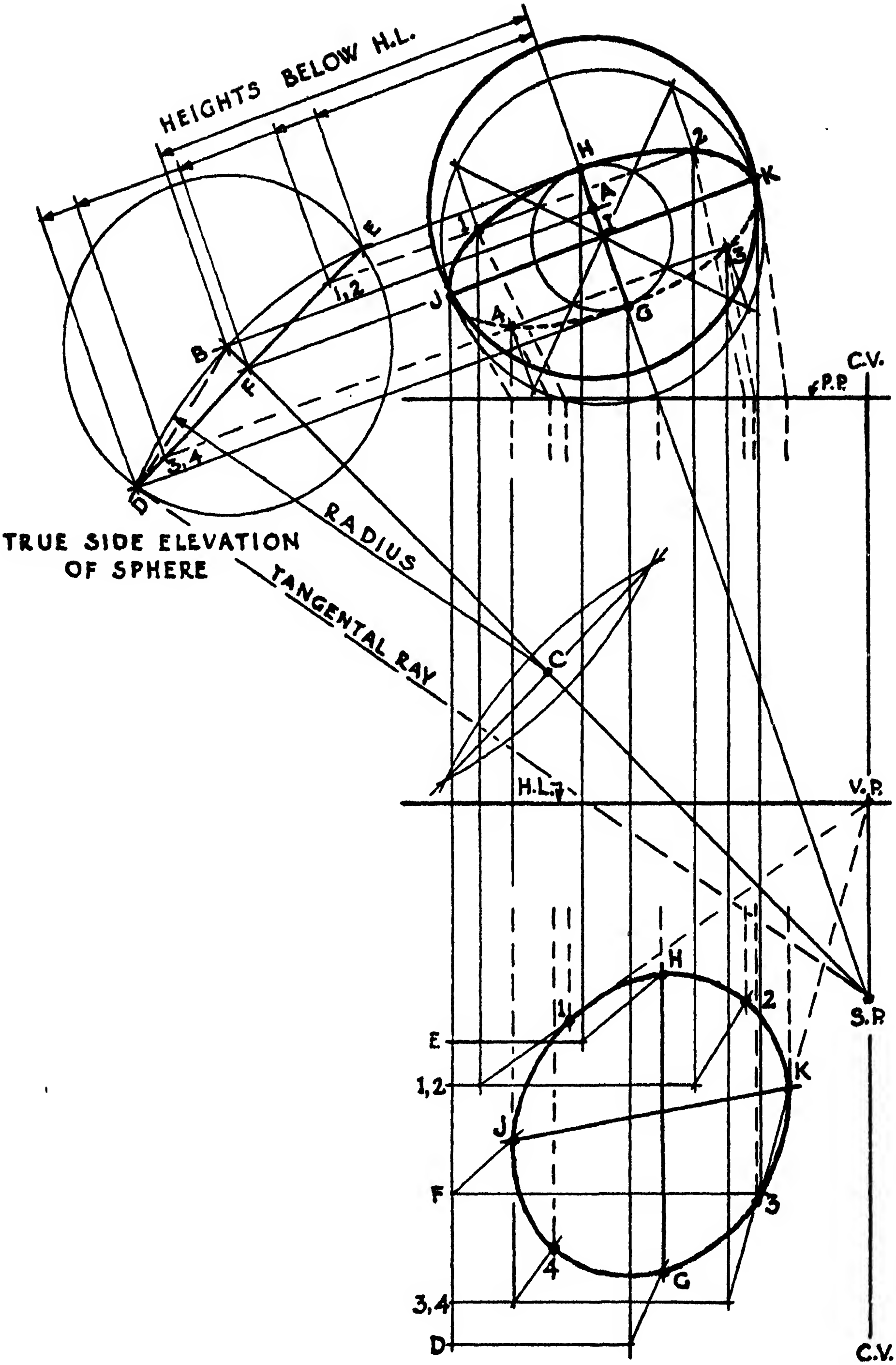


FIG. 22B

THE SPHERE

Section Four

THE CENTRELINEADS

THE centrelinead is an instrument designed to draw lines to vanish to any given point. It is essential when such points are off the drawing-board, as they usually are, if one is to fit one's perspective drawing to the view desired and not to the size of the drawing-board.

Centrelineads are in two forms:

(i) The head is adjustable.

(ii) The head is fixed.

To Set Up.

Find position of all V.P's., &c., to a small scale. From this, set up the H.L., C.V., and the V.P's. and M.P's. that fall *on* the drawing-board to the final scale.

For the purpose of the following illustrations, suppose:

(i) It is desired to set up the centrelinead for the left-hand V.P., which falls *off* the drawing-board.

(ii) The V.P. is 95 inches from the C.V.

(iii) It is desired to set up the centrelinead at 15 inches to the left of the C.V.

(*a*) Adjustable Head Type. Refer to FIG. 23 at '*A*'.

(i) 15 inches from the C.V. mark the point '*b*'.

(ii) Assume *x*, draw the line *a–a* and calculate *c* *or* assume *c*, calculate *x* and draw the line *a–a*.

(iii) Beyond the point '*b*' repeat *x* to locate the point '*d*'.* Draw the lines *a–d* and adjust the arms to lie along them, and the blade along the H.L.

(iv) Insert pins at the points *a*.

* This method of locating the point *d* is convenient, but it is an approximation since the lines *a–d* should be tangents to the circle at the points *a*. For practical purposes the error is negligible provided that *x* is small in relation to *r*.

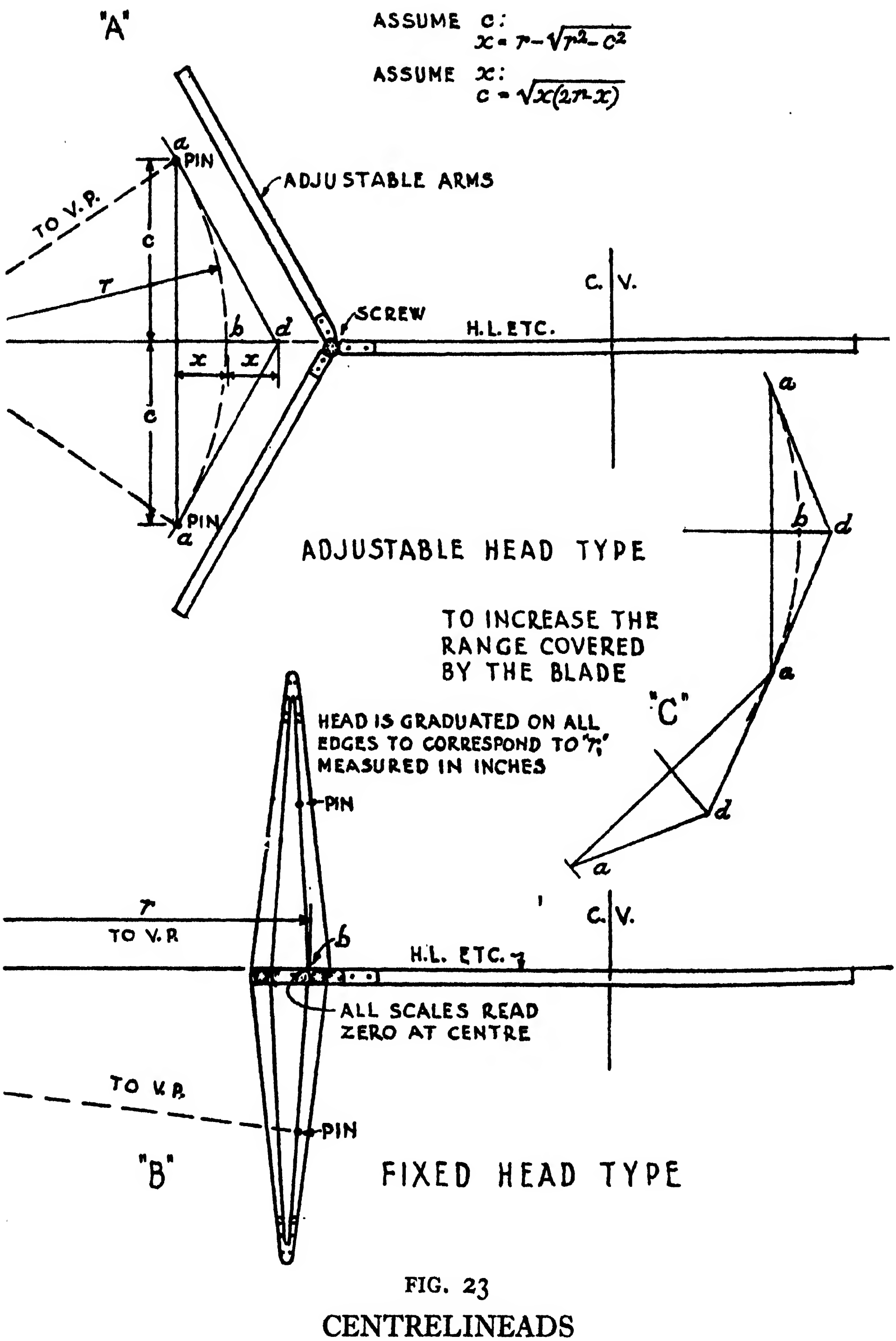


FIG. 23

CENTRELINEADS

CALCULATIONS

$$r = 95 - 15 = 80 \text{ in.}$$

Assume $x = 1$ in.

Then $c = \sqrt{\{x(2r-x)\}} = \sqrt{\{1(160-1)\}} = 12{\cdot}6$ in.

Or, Assume $c = 12{\cdot}6$ in.

Then $x = r - \sqrt{(r^2 - c^2)} = 80 - \sqrt{(80^2 - 12{\cdot}6^2)} = 1$ in.

The table gives values of c and x for values of r from 15 in. to 880 in. The values given for c are accurate to the nearest twentieth of an inch.

To increase the range covered by the blade. Refer to FIG. 23 at '*C*'.

Construct identical triangles as shown. The points so found are the positions of the pins.

Note. The centrelinead may be used on the other side of the C.V. for the same V.P. by setting the arms at an acute angle to the blade instead of an obtuse. The formulae and tables still apply, ***but*** then as $r = 95 + 15 = 110$ in., x and c would require to be obtained for 110 in. instead of 80 in.

(*b*) **Fixed Head Type.** Refer to FIG. 23 at '*B*'.

(i) 15 inches from the C.V. mark the point *b*.

(ii) $r = 95 - 15 = 80$ in.

(iii) Lay the blade along the H.L. with the zero on the desired scale at the point *b*.

(iv) At the points marked 80 on this scale insert pins.

To increase the range of the blade.

Move the zero to one of the pins. As set up for the above condition the reading at the other pin will then be $80 \times 2 = 160$.

Insert a fresh pin at the new point marked 160 and remove the first pin.

Note. The centrelinead may be used on the other side of the C.V. for the same V.P. by using the outer or left-hand scales, ***but*** as r would then equal $95 + 15 = 110$ in. the pins would be inserted at the points marked 110 on the scale.

CENTRELINEAD—ADJUSTABLE HEAD. TABLE FOR c''. FORMULA: $c = \sqrt{\{x(2r-x)\}}$

r''	$x =$ 1"	$x =$ ½"	$x =$ ¼"	r''	$x =$ ½"	$x =$ ¼"	$x =$ ⅛"	r''	$x =$ ¼"	$x =$ ⅛"	r''	$x =$ ¼"	$x =$ ⅛"	r''	$x =$ ⅛"
15	5·4	...	...	145	12·0	8·5	...	275	11·7	8·3	405	14·2	10·05	630	12·5
20	6·25	...	...	150	12·2	8·65	...	280	11·8	8·35	410	14·3	10·1	640	12·6
25	7·0	...	...	155	12·4	8·8	...	285	11·9	8·4	415	14·4	10·2	650	12·7
30	7·7	...	...	160	12·6	8·95	6·3	290	12·0	8·5	420	14·5	10·25	660	12·8
35	8·3	...	...	165	12·8	9·1	6·4	295	12·1	8·6	425	14·6	10·3	670	12·9
40	8·9	6·3	...	170	13·0	9·25	6·5	300	12·2	8·65	430	14·65	10·35	680	13·0
45	9·45	6·7	...	175	13·2	9·35	6·6	305	12·3	8·7	435	14·75	10·4	690	13·1
50	9·95	7·05	...	180	13·4	9·5	6·7	310	12·4	8·8	440	14·8	10·5	700	13·2
55	10·45	7·4	...	185	13·6	9·6	6·8	315	12·5	8·9	450	...	10·6	710	13·3
60	10·9	7·75	...	190	13·75	9·75	6·85	320	12·6	8·95	460	...	10·75	720	13·4
65	11·35	8·05	...	195	13·95	9·85	6·95	325	12·7	9·0	470	...	10·85	730	13·5
70	11·8	8·35	...	200	14·1	10·0	7·05	330	12·8	9·1	480	...	10·95	740	13·6
75	12·2	8·65	...	205	14·3	10·1	7·15	335	12·9	9·2	490	...	11·05	750	13·7
80	12·6	8·95	6·3	210	14·45	10·25	7·25	340	13·0	9·25	500	...	11·15	760	13·8
85	13·0	9·25	6·5	215	14·65	10·35	7·3	345	13·1	9·3	510	...	11·25	770	13·9
90	13·4	9·5	6·7	220	14·8	10·5	7·4	350	13·2	9·35	520	...	11·4	780	13·95
95	13·75	9·75	6·85	225	...	10·6	7·5	355	13·3	9·4	530	...	11·5	790	14·05
100	14·1	10·0	7·05	230	...	10·75	7·6	360	13·4	9·5	540	...	11·6	800	14·1
105	14·45	10·25	7·25	235	...	10·85	7·7	365	13·5	9·55	550	...	11·7	810	14·2
110	14·8	10·5	7·4	240	...	10·95	7·75	370	13·6	9·6	560	...	11·8	820	14·3
115	...	10·75	7·6	245	...	11·05	7·8	375	13·7	9·7	570	...	11·9	830	14·4
120	...	10·95	7·75	250	...	11·15	7·9	380	13·8	9·75	580	...	12·0	840	14·5
125	...	11·15	7·9	255	...	11·25	8·0	385	13·9	9·8	590	...	12·1	850	14·6
130	...	11·4	8·05	260	...	11·4	8·05	390	13·95	9·85	600	...	12·2	860	14·65
135	...	11·6	8·2	265	...	11·5	8·1	395	14·05	9·9	610	...	12·3	870	14·75
140	...	11·8	8·35	270	...	11·6	8·2	400	14·1	10·0	620	...	12·4	880	14·8

Section Five

ALTERNATIVE CONSTRUCTIONS

THE following methods are derived from the orthodox constructions. They are all subject to disadvantages and should not be employed if the usual methods can be conveniently applied. *They should not be attempted by the student until the theory and principles of the methods already given have been mastered.*

Fig 24 dispenses with projections from the S.P. to the P.P. but does not require M.P's.

Figs. 25-31 are all methods of avoiding distant V.P's. without the use of a centrelinead. If a centrelinead is available it will be found faster and, in practice, more accurate to use it unless the object is very simple in shape.

(*a*) *Without projection from the plan of the object to the S.P.*

Refer to FIG. 24.

(i) On the actual true plan, e.g., working drawing, draw the P.P. and C.V. and extend the sides of the object to the P.P.

(ii) Set out the H.L. and mark off the C.V. and V.P's., the latter being found as set out in Fig. 2 and text.

(iii) Set out along the H.L. distances from the C.V. equal to the distances from the C.V. to where the extended sides of the object intersect the P.P. on the true plan—as indicated in the figure by the dimensions '*a*', '*b*', '*c*' and '*d*'.

(iv) At the points so found set up the true heights.

(v) Project these to the V.P's.

(vi) The intersections of these projection lines locate the positions and lengths of the vertical lines of the object in the perspective elevation.

(vii) To complete the perspective join the ' ends ' of the vertical lines.

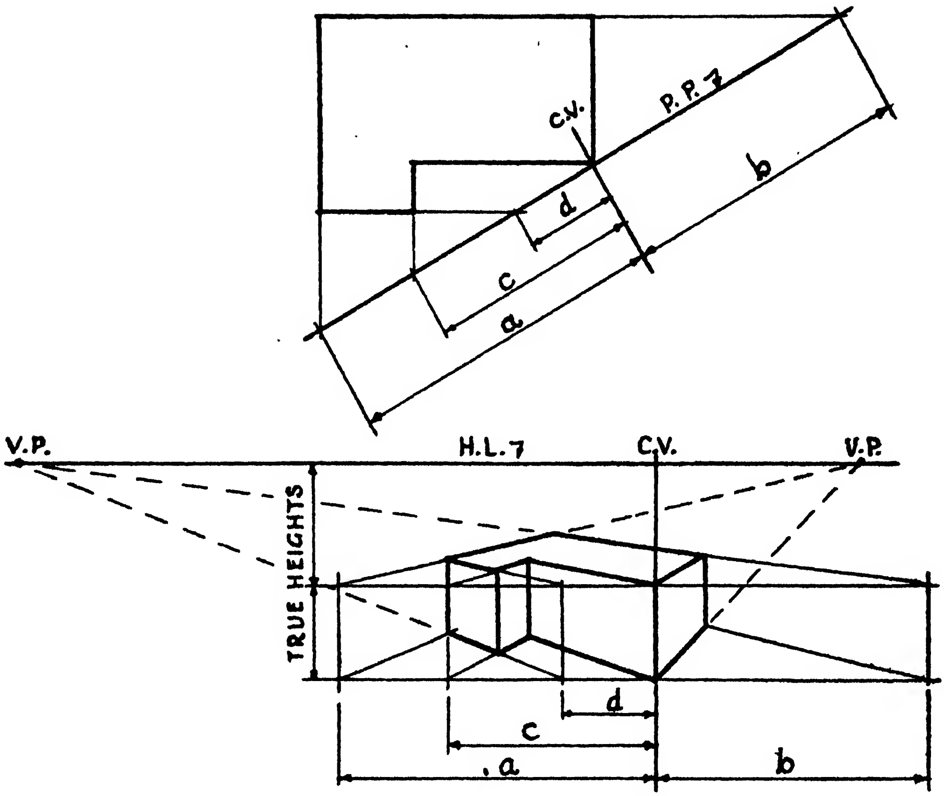


FIG. 24

WITHOUT PROJECTION FROM PLAN TO S.P.

(*b*) *Without V.P's. or M.P's.*

Refer to FIG. 25.

(i) Set up the P.P., C.V., S.P. and true plan and project the angles of the plan from the S.P. into the P.P. in the usual way—*see* Fig. 2.

(ii) Set up the H.L. and C.V.

(iii) At one side set up the P.P. the same distance from the C.V. as the S.P. is from the P.P. in plan.

(iv) At the true heights above and below the H.L. set up such part of the object as is necessary in side elevation, i.e., looking at right angles to the C.V. in plan.

(v) Project the angles of the object in elevation from the intersection of the C.V. and H.L. into the P.P.

(vi) For each end of each line in the perspective elevation project the pairs of points found under (i) and (v) until they intersect.

(vii) To complete the perspective join the intersections found under (vi).

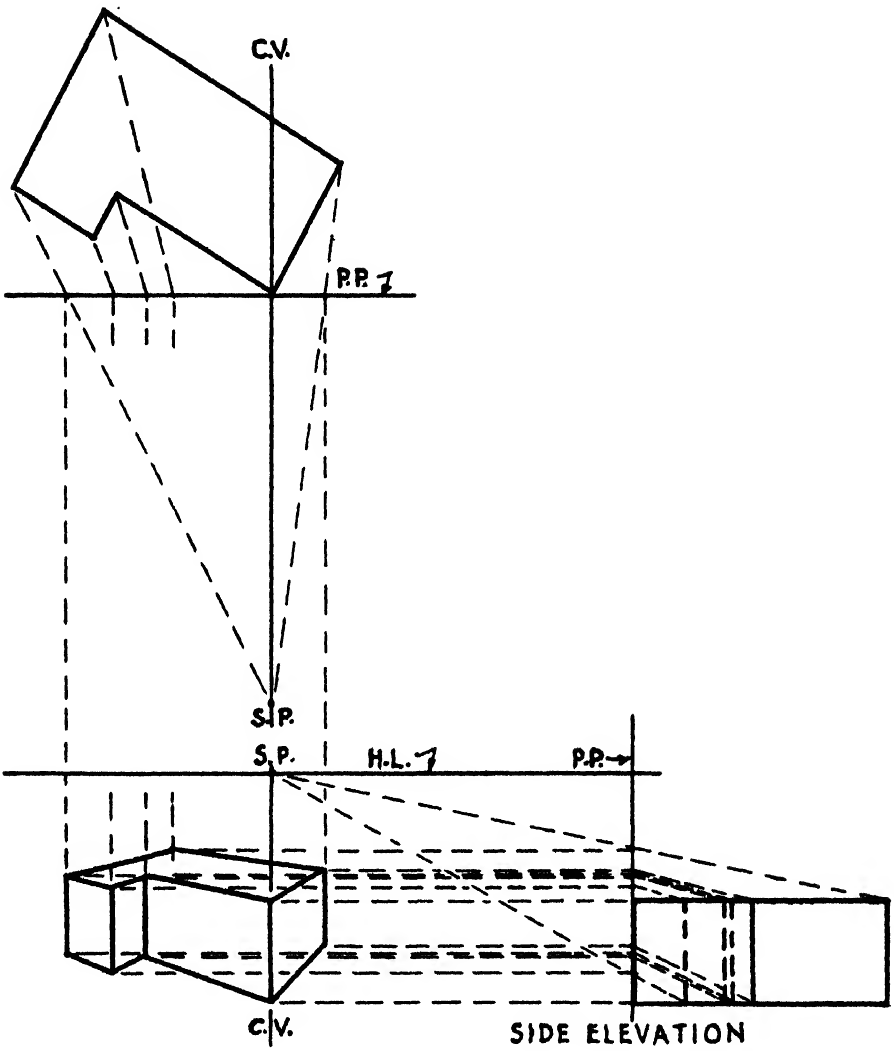


FIG. 25

WITHOUT V.P'S. OR M.P'S.

(*c*) *Using one V.P.*

Refer to FIG. 26.

(i) Set up the plan, P.P., C.V., S.P. and the nearer V.P., as in Fig. 2.

(ii) Extend to the P.P. only those sides of the object which will vanish to the V.P.

(iii) Project the angles, etc., in the plan from the S.P. into the P.P.

(iv) Set out the H.L., C.V. and V.P.

(v) Project down through the H.L. the points in the P.P. found under (ii) and set up the true heights.

(vi) Project these heights to the V.P.

(vii) Bring down the positions of the vertical lines in the perspective elevation, as found under (iii).

(viii) Obtain those lines for which the V.P. has been omitted by joining together the appropriate intersections of the lines found under (vi) and (vii), e.g., points 1 and 2 in the figure.

(ix) The sides of the object vanishing to the V.P. are drawn in the usual way.

(*d*) *Using one 'ordinary' V.P. and the parallel perspective V.P.*

Refer to FIG. 27.

(i) Set out the plan, P.P., C.V., S.P. and the nearer V.P. as in Fig. 2.

(ii) Project the angles, etc., in the plan from the S.P. into the P.P.

(iii) Set out the H.L., C.V. and V.P.

(iv) Locate the parallel perspective V.P. at the intersection of the C.V. and H.L.

(v) Project down through the H.L. the *actual* angles of the plan and set up the true heights.

(vi) Project these heights to the *parallel perspective V.P.*

(vii) Bring down the positions of the vertical lines in the perspective elevation as found under (ii).

(viii) Obtain those lines for which the V.P. has been omitted by joining together the appropriate intersections of the lines found under (vi) and (vii), e.g., points 1 and 2 in the figure.

(ix) The sides of the object vanishing to the 'ordinary' V.P. are drawn in the usual way.

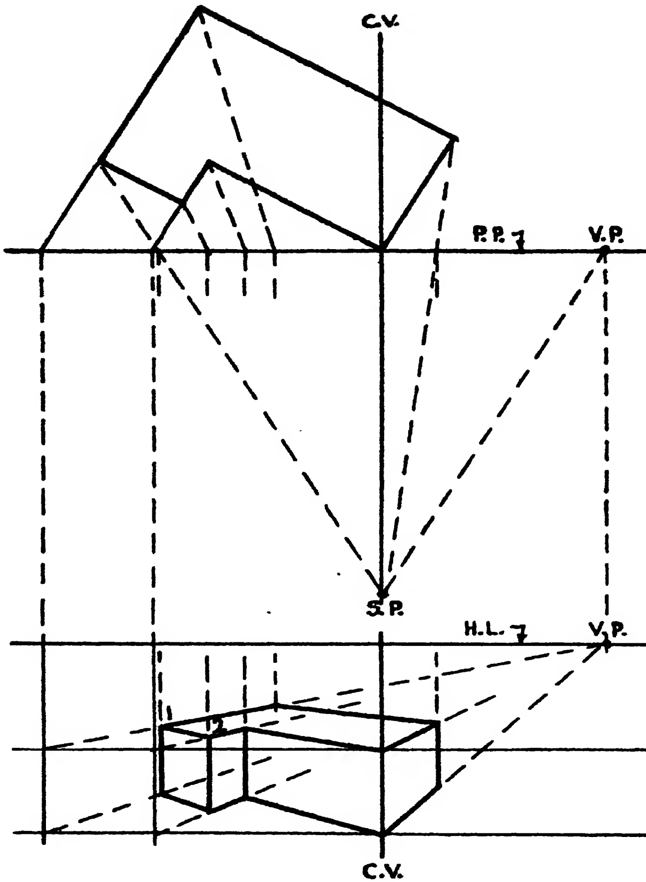


FIG. 26
USING ONE V.P.

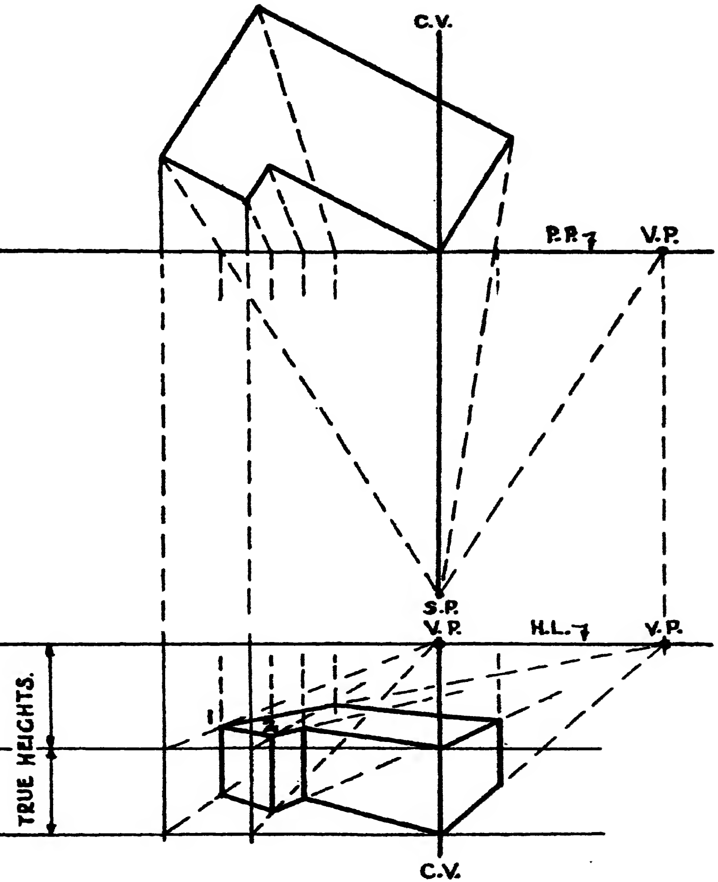


FIG. 27
USING ONE V.P. AND THE
PARALLEL PERSPECTIVE V.P.

(*e*) *Using the parallel perspective V.P. only.*

Refer to FIG. 28.

(i) Set out the plan, P.P., C.V. and S.P.

(ii) Project the angles, etc., in the plan from the S.P. into the P.P.

(iii) Set out the H.L. and C.V.

(iv) Locate the parallel perspective V.P. at the intersection of the H.L. and C.V.

(v) Project down through the H.L. the *actual* angles of the plan and set up the true heights.

(vi) Project these heights to the V.P.

(vii) Bring down the positions of the vertical lines in the perspective elevation as found under (ii).

(viii) Obtain the horizontal lines of the object in perspective by joining together the appropriate intersections of the lines found under (vi) and (vii), e.g., points 1, 2 and 3 in the figure.

(*f*) *Using two false V.P's.*

Refer to FIG. 29.

(i) Set out the plan, P.P., C.V. and S.P.

(ii) Mark off any two convenient V.P's.

(iii) From each angle in the plan project two lines to the P.P., these lines being parallel to lines drawn from the S.P. to the V.P's.

(iv) Set out the H.L., C.V. and V.P's.

(v) Project down through the H.L. the points in the P.P. found under (iii) and set up the true heights.

(vi) Project these heights back to the V.P's.

(vii) Obtain the horizontal lines of the object in perspective by joining together the appropriate intersections of the projection lines obtained under (vi).

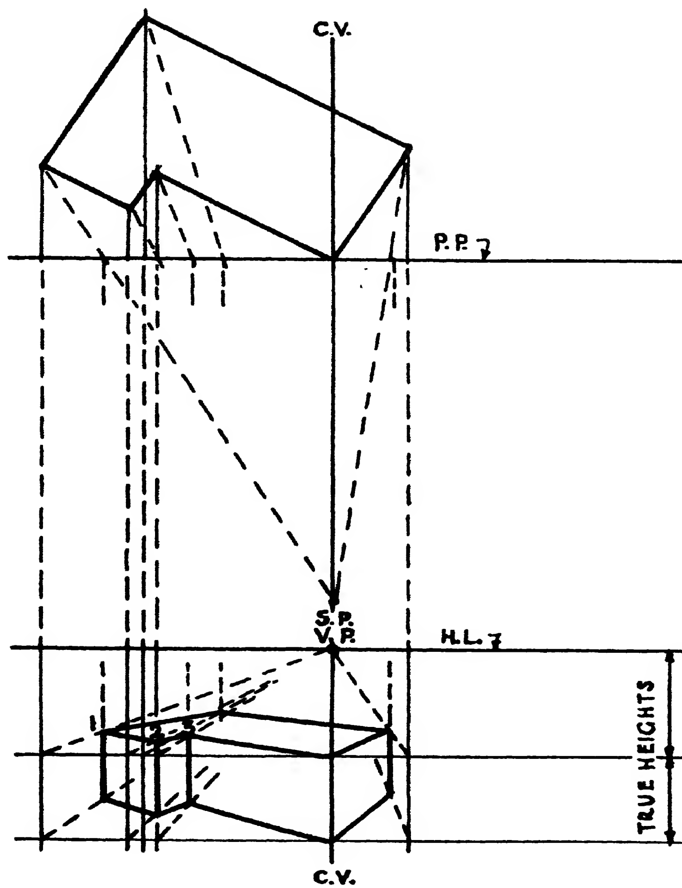


FIG. 28
USING PARALLEL PERSPECTIVE
V.P. ONLY

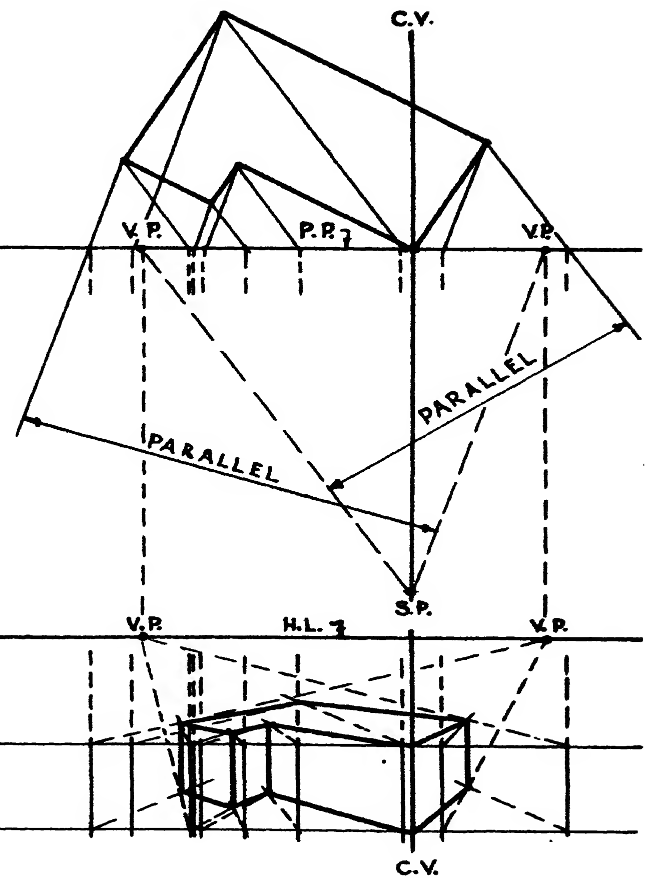


FIG. 29
USING TWO FALSE V.P'S.

(*g*) *Using one V.P. and both M.P's.*

Refer to FIG. 30. (The construction of the perspective plan is divided for clarity only.)

(i) On the actual true plan, e.g., working drawing, draw the P.P., C.V. and the axis for which the V.P. is to be omitted. (Use only the V.P. which will lie the nearer to the C.V.)

(ii) Extend to the P.P. at least one line parallel to the sides of the object which will vanish to the V.P.

(iii) Locate the V.P. and M.P's. as in Fig. 4 and text.

(iv) Set out the H.L., C.V., M.P's. and the V.P. and, below, the P.P., as in Fig. 5.

(v) Only the axis vanishing to the omitted V.P. is required. Obtain this as follows: Along the P.P. set out the distance from the C.V. to the point found under (ii) —dimension '*a*' in the figure—to obtain point 1. Draw line 2. From point 1 set off point 3 the true distance from the point found under (ii) to the axis, i.e., dimension '*b*'. From the point 3 draw line 4 to the M.P. derived from the V.P. in use, to intersect line 2 at point 5. Draw line 6 from point 5 to the intersection of the C.V. and P.P. Line 6 coincides with the required axis.

(vi) Obtain points along the axis in the usual way and, where required, project these by means of the V.P. (*See* Fig. 5.)

(vii) As for the method given under (v) for obtaining the axis *all principal distances along lines vanishing to the V.P.*, and not passing through the intersection of the C.V. and P.P., *must be located by measuring along the P.P. from the point or points found under* (ii) and projecting to the M.P. derived from the V.P. to intersect the lines vanishing to the V.P. See points 1, 3 and 11, dimensions '*b*' and '*c*' and points 5 and 13 in the figure.

Distances along the line vanishing to the V.P. through the intersection of the C.V. and P.P. are set off in the usual way as for the y'–y' axis in Fig. 5. See dimension 'c'' and points 8 and 10 in the figure.

(viii) Obtain minor distances along lines vanishing to the V.P. by reversing the method given under (vii), i.e., by projecting points found under (vi) to the P.P. by means of the M.P. derived from the V.P., measuring from these points along the P.P. and projecting to the same M.P. to intersect projections from the V.P. to the axis.

This is illustrated in the figure : Point 18 is obtained as under (vi) and is projected from the M.P. to the P.P. by line 19 to obtain point 20. Point 21 is measured along the P.P. from point 20 and projected to the same M.P. by line 22 to intersect line 23 at point 24. Line 23 is projected from point 18 by means of the V.P. Point 27 is similarly obtained.

(ix) Obtain the lines vanishing to the omitted V.P. by joining together the appropriate points found as above. In the figure the points and lines are numbered in sequence.

(x) Set out the H.L., C.V. and V.P.

(xi) Project the point or points found under (ii), (point 1 in the figure), down through the H.L. and mark off the true heights.

(xii) Project these heights to the V.P.

(xiii) Bring down the angles of the perspective plan.

(xiv) Obtain those lines for which the V.P. has been omitted by joining together the intersections of the lines found under (xii) and (xiii).

(xv) The sides of the object vanishing to the V.P. are drawn in the usual way.

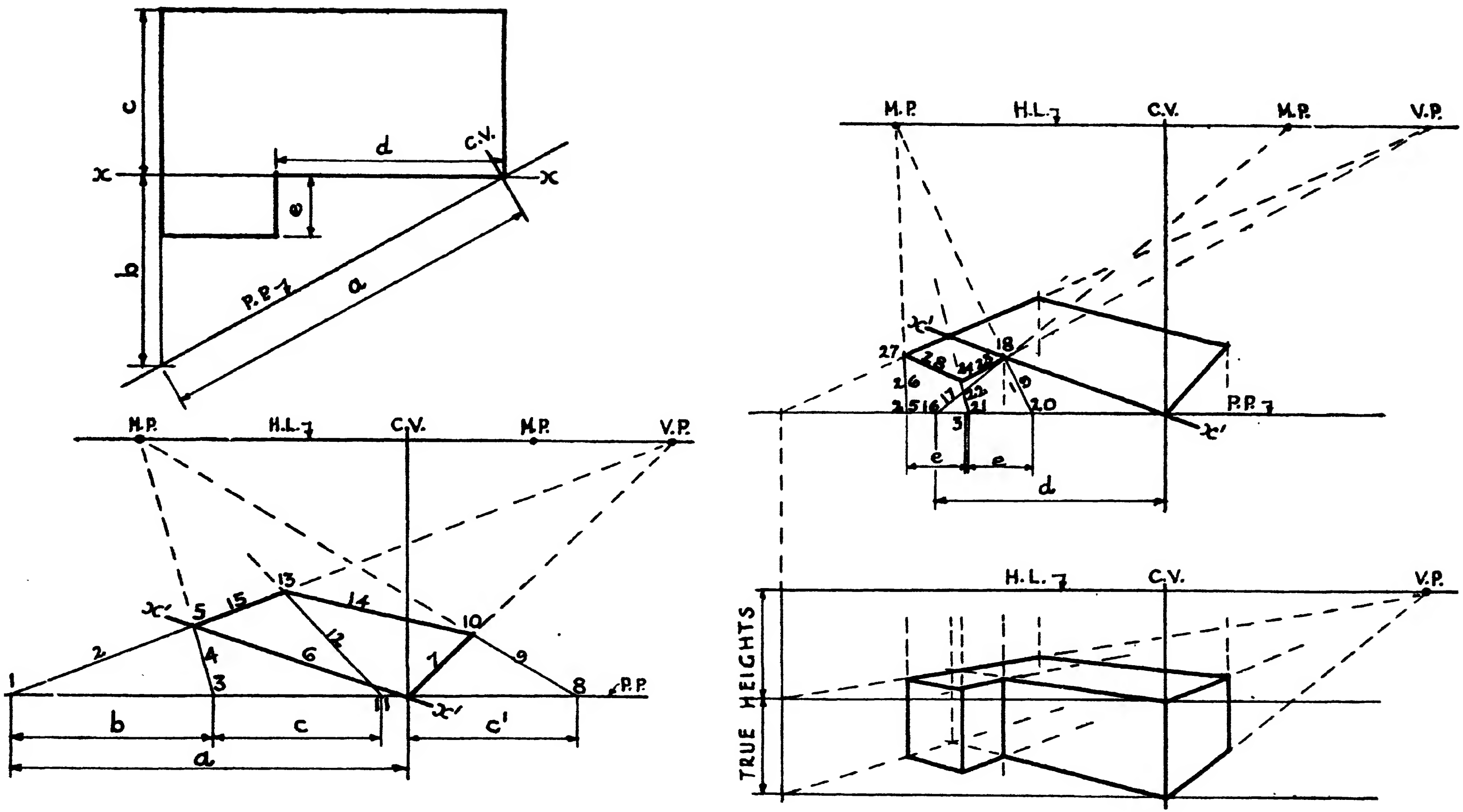


FIG 30

USING ONE V.P. AND BOTH M.P'S.

(*h*) *Using the M.P's only.*

Refer to FIG. 31. (The construction of the perspective plan is divided for clarity only.)

The *x–x* and *y–y* axes are not required since they cannot be projected from in the absence of the V.P's. Each vanishing line in the perspective plan and elevation must therefore be obtained by locating its end points and joining them. ***Each of these end points must be obtained by the intersection of two lines projected from the P.P. to the M.P's.***

The only points in the P.P. from which principal dimensions may be measured to locate the projections to the M.P's. are those where the P.P. cuts the object, or lines produced parallel to its sides.

(i) On the actual true plan, e.g., working drawing, draw the P.P. and C.V.

(ii) Extend to the P.P. at least one line parallel to each side of the object—giving points 1 and 8 in the figure. These lines need not be placed, as shown, coincident with the extreme outer planes of the object.

(iii) Locate the M.P's. as in Fig. 4 and text.

(iv) Set out the H.L., C.V. and M.P's. and, below, the P.P. as in Fig. 5.

(v) Along the P.P. set out the distances from the C.V. to the points found under (ii)—dimensions '*a*' and '*d*' to points 1 and 8 in the figure.

(vi) From the points found under (v) and from the C.V. measure off each pair of dimensions and project to the appropriate M.P's.; each intersection of the projection lines will locate the end points of a vanishing line.

In the figure point 6 is found by the intersection of the projection lines from points 2 and 4 to the M.P's. Points 2 and 4 are located by the dimensions '*b*' and '*c*' measured from point 1 and the C.V.

(vii) The end points of minor lines in the perspective plan may be found in three ways:

(*a*) Points along lines vanishing through the intersection of the C.V. and P.P., i.e., along lines coincident with the *positions* of the *x′–x′* and *y′–y′* axes, may be measured along the P.P. and projected to the M.P's. in the usual way—*see* Fig. 5. In the figure point 31 is so found from dimension '*i*'.

(*b*) Points already found in the vanishing lines may be used to project back from to locate points in the P.P. from which dimensions may be measured and projected to the same M.P's. In the figure point 31 is used to locate point 33 from which point 34 is measured and projected by line 35 to the same M.P.

(*c*) Measurements may be taken from points already found in the P.P. In the figure point 22 is measured from point 2.

(viii) Set out the H.L., C.V. and M.P's.

(ix) For each angle in the perspective plan project down through the H.L. one of the points in the P.P. used to find it.

(x) Mark off the true heights and project to the appropriate M.P's.

(xi) Bring down the angles in the perspective plan.

(xii) Obtain the horizontal lines in perspective by joining the intersections of the lines found under (x) and (xi).

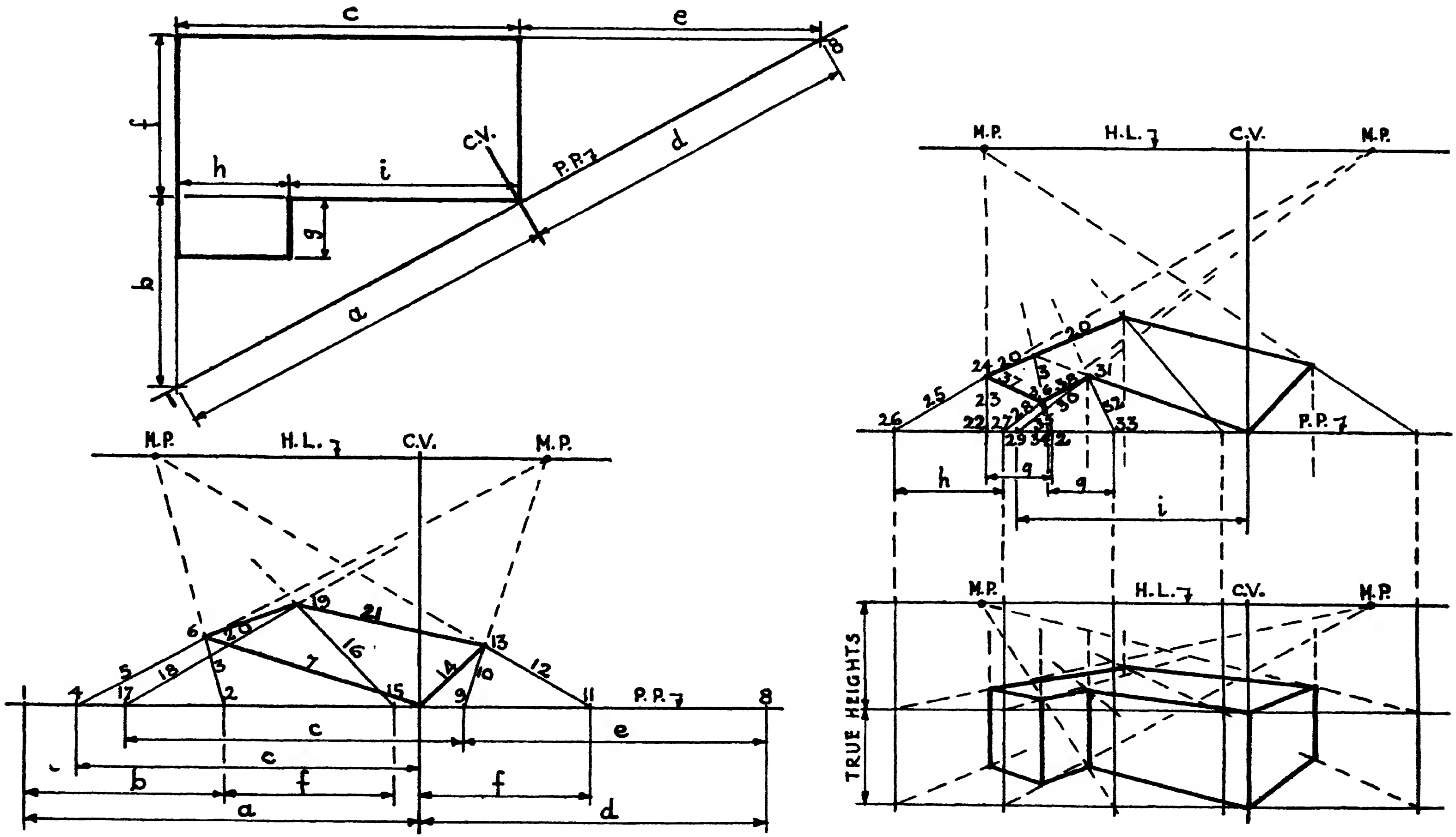


FIG. 31

USING THE M.P'S. ONLY

APPENDIX

SUPPLEMENTARY NOTES

(i) Cone of Vision

The angle of 60° at the apex of the Cone is a purely arbitrary value based on the supposed comfortable angle of vision of the human eye. If the object touches the sides of a Cone of Vision of 60° some distortion is liable to occur at the outer parts of the picture, the effect of which will depend upon the shape of the object, the type of perspective (the maximum angle may generally be slightly greater for Parallel Perspective), and upon the rendering of the drawing. It is important to remember that the C.V. forms the *axis* of the Cone and that therefore the sloping surface will lie at 30° on *each* side of it, not, say, 20° on one side and 40° on the other. This does not mean that the spectator must look directly at the centre of the object, but that however little of the Cone of Vision may be filled on one side of the C.V. the angle must not exceed 30° on the other. It should not be forgotten that *the Cone of Vision applies to heights* as well as to widths.

(ii) Station Point

The minimum distance from the S.P. to the object is determined by the Cone of Vision. Other than for practical considerations, there is no limit to the maximum distance.

The distance from the S.P. to the object has a marked effect on the perspective elevation. If the S.P. is close to the object the V.P's. are close to the C.V. and hence all lines not parallel to the P.P. vanish rapidly and there is a general effect of angularity, planes are widely separated and the foreground is relatively enlarged. But if the S.P. is far from the object the V.P's. are also far from the C.V. and the perspective elevation becomes quieter and more restful. Thus the *distance* from the S.P. to the object should be chosen for the effect or 'feeling' desired.

(iii) Picture Plane

The P.P. may be behind, through or in front of the object. Assuming a fixed distance from the S.P. to the object, if the P.P. is behind the object an enlarged picture will result, if it is in front a diminished view will result. But apart from size there is no change in the resulting picture since the V.P's. move proportionately with the P.P. A change of the steepness of the vanishing lines, separation of planes and relative sizes of different parts of the object occurs only when the distance from the S.P. to the object is changed.

(iv) Lateral Relation of the Object to the Intersection of the C.V. and P.P.

The intersection of the C.V. and P.P. should be placed in relation to the object so that the intersection will occur, laterally, reasonably near to the centre line of the finished picture, when it is framed round by the border or mount. The composition of the completed picture should be borne in mind. Thus the chief point of interest or 'balance' will usually be to one side of the intersection of the P.P. and C.V.

Avoid the common fault of placing an end corner of a building at the intersection of the C.V. and P.P. purely to simplify the setting out, regardless of the fact that nine tenths of the completed picture may lie to one side of the C.V. and one tenth to the other. Remember that a perspective drawing represents the view the eye would actually see, just as does a photograph, and one would not look at or photograph a corner when one wished to see the whole.

(v) Setting Out

The method without M.P's. is usually quicker for simple problems, but the method with M.P's. should be used for all complicated problems, especially where it is important to avoid more than the minimum of projection lines, etc., on the final paper or it is necessary to make as large a picture as possible on a given drawing board. Parallel perspective is usually confined to interior views and is rarely done by the M.P. method.

Large perspective problems, especially when a clean careful drawing is required, may be carried through advantageously by the following method.

(*a*) Prepare quick small scale trial perspectives to select the S.P., using small scale outline plans and no M.P's.

(*b*) Prepare an accurate small scale set out, including the M.P's. (and the dimensions *a*, *b* and *c* if the C.V. is inclined) from the view finally selected.

(*c*) Cover a board with white detail paper.

(*d*) If the C.V. is inclined, prepare, to the scale of the final drawing, a scale of diminished heights, not forgetting to mark the level *e–e*, and transfer to a strip of stiff paper.

(*e*) Near the top set up to the final scale the H.L., C.V., V.P's. and M.P's. and below these the P.P. and the lines x'–x' and y'–y'. (See Fig. 5.)

(*f*) Ink in these lines and points so that they will not be lost by subsequent erasures.

(*g*) Draw the perspective plan and ink it in. If the object has many changes of shape at different levels it will be found helpful to use a different coloured ink for each level and each time to erase the pencil marks and lines incidental to the preparation of the preceding plan. These erasures will avoid confusion and inadvertent errors which a mass of pencil dots and marks no longer required would be likely to cause.

(*h*) Unpin the paper, fold until only the perspective plan is showing, and pin along the top or bottom of the final sheet. Do not cut the detail paper because it may be necessary to use the V.P's. and M.P's. to locate further points on the plan such as shadows or additional height lines.

(*i*) Use a finely pointed hard pencil to faintly but firmly draw the H.L. and C.V. on the final sheet and insert thin broken off sewing needles at the V.P's. Use the same kind of needles for the centrelinead.

(vi) **Bird's-eye Perspective**

Correct results may only be obtained by using a V.P.2. But in addition to the approximate method given in the text, similar, though still more limited, results may be obtained by using a distant S.P. elevated above the object and keeping the C.V. horizontal, thus not foreshortening the heights. The S.P. must be distant since the Cone of Vision must not be exceeded in depth below the H.L. This method, though it has the advantage of being somewhat simpler than either of the others, has the distinct disadvantage of producing a rather unnatural result since, if the observer were in an elevated position, he would naturally look down towards the scene before him, not straight over it.

(vii) **Reflections**

The commonest case is that in which the reflecting surface is horizontal, e.g., water in the immediate foreground. The reflection is simply the object reversed vertically. Where the object comes to the water's edge there is no difficulty but care is required when there is a solid foreground between the object and the reflecting surface. As the height of the reflection is measured from the *intersection* of the reflecting surface and the object, it is necessary to project the object down through the foreground to the surface of the water and then to repeat below it the 'thickness' of the foreground and then the height of the object.

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