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# APPLIED PERSPECTIVE

## THE THEORY AND APPLICATION OF
## PERSPECTIVE FOR ARCHITECTS, PAINTERS
## AND DRAUGHTSMEN

BY

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OF ARCHITECTURE, LONDON

AND EXAMINER IN PERSPECTIVE FOR THE BOARD OF EDUCATION,

AUTHOR OF

"COLOUR IN INTERIOR DECORATION," "ARCHITECTURAL SHADOW PROJECTION"

TO

M.A.H.

# FOREWORD

WHEREAS the form of the retina of the eye is concave, the surface of a perspective drawing is flat. A perspective drawing, too, is projected through one "eye point," whereas human vision is the result of two. For these reasons at least a perspective drawing can never truthfully represent what the human eyes see. The theory of perspective remains a conventional means to an end.

Perspective may be taught as an end in itself; as a means of developing general observation for instance, but its practical uses are in most cases limited to the application of simple principles which may be readily understood.

The tendency to regard perspective less as an examination subject and more as a direct aid to representation is thus explained. The acquisition of knowledge of theory is a step towards successful application in different circumstances.

For these reasons the writer has sought to condense the more practical part of theory into a form which is easily accessible with a view to meeting the needs of the draughtsman, the student studying for examinations, and the architect who wishes to confirm some point of theory at a moment's notice.

There is, of course, no intended suggestion that the book is comprehensive in any other sense, and no desire to imply that the further study of more abstruse theory is not of the greatest interest where time allows.

This book differs from previous publications on the subject in the following respects—

1. The complete theory is deduced by means of a photograph in one diagram, which demonstrates perspective laws by showing their origin.

2. A section is devoted to perspective composition and the application of theory in architectural perspectives, painting, and sketching.

3. The information is restricted to essentials. Application of theory is given on the use of perspective in freehand sketching.

4. Shadows and reflections in perspective are included.

# NOTE ON THE REPRINTING OF THE
## SECOND EDITION

In presenting this reprint the author wishes to express appreciation of the way in which the first two editions have been received. The number of plates has not been increased, as experience has shown that the elements of the subject are not more clearly exposed by multiplication of diagrams. Although the principles of perspective are sometimes not easy to identify in any given work, they play their part in any form of graphic representation.

Concentration on pattern, texture, and colour values have in recent years provided valuable and exciting results in Painting, Design, and Architecture. Perspective remains, however, a basic means, not to be neglected or superseded, of exploring and recording the visual world.

It is hoped that the book may continue to help the draughtsman to draw, design, and paint more expressively because of appreciation and understanding of its principles.

# CONTENTS

# LIST OF PLATES

J

HEIGHT LINE

H

E          EYE LEVEL          E'

T

G          GROUND LINE          G'

N

NO

O

M

P  VP1          V   TP  NP          BP          PLAN LINE OF PICTURE PLANE          VP2  P

VANISHING PARALLEL

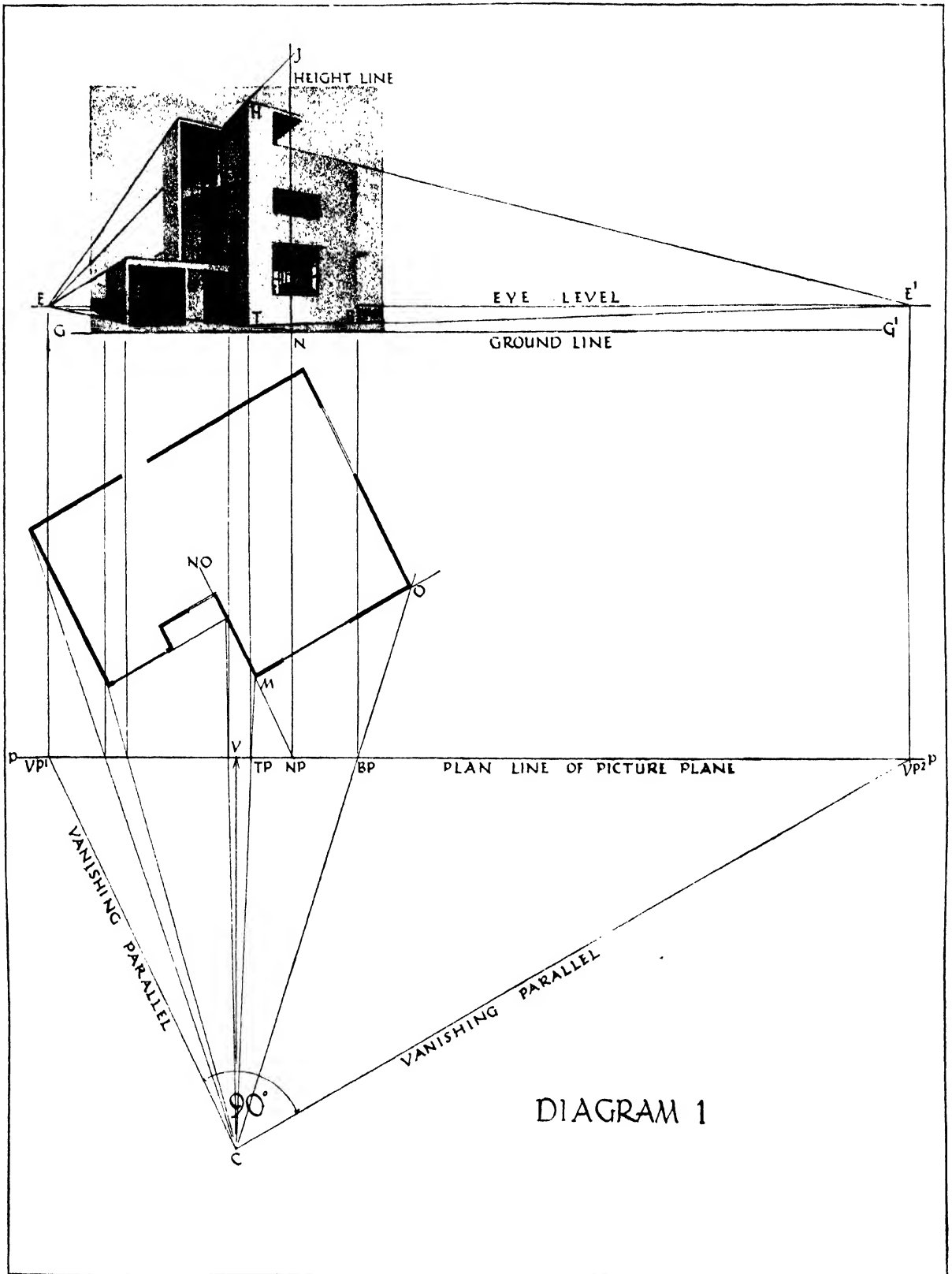VANISHING PARALLEL

90°

C

DIAGRAM 1

8

# APPLIED PERSPECTIVE

## PART I

## THE RELATIONSHIP OF PERSPECTIVE DRAWING TO MEASURED DRAWING

**Diagram 1.** It is possible to confirm the laws governing perspective by drawing lines on a photograph of a building as in Diagram 1. All horizontal edges of the buildings shown, if continued, are found to meet in one or other of the points E. or E¹. to left and right of the photograph. These points are called VANISHING POINTS.

If the points E. and E¹. are now joined by a straight line it will be found to be horizontal. This line is the horizontal level of the lens of the camera. In perspective drawing such a line represents the horizontal plane of the eye and is known as the EYE LEVEL. A horizontal line drawn through the lower edge of the photograph or picture area forms the line G.–G¹. This line is called the GROUND LINE. The rectangular area of the photograph may, for purposes of explanation, be regarded as a piece of glass through which the building is seen. The GROUND LINE is then the line of intersection of this vertical sheet of glass with the horizontal surface of the ground. In the case of a perspective drawing the picture area on the sheet of drawing paper takes the place of this imaginary sheet of glass. It is called the PICTURE PLANE, the vertical plane or surface upon which the "picture" is drawn.

The actual form of the building as distinct from its distorted perspective appearance and the relationship of one to the other may now be shown as follows—

Below the photograph at any convenient distance, a straight line P.–P. is drawn which represents the PICTURE PLANE in plan. It is a view from above of the plane or surface through which the building is seen and through which the salient points of the building are projected.

The position of the two VANISHING POINTS E. and E¹. are now transferred from above to this line at V.P¹. and V.P². The plan position of the camera or, in the case of a perspective drawing, the Eye of the observer is given at C. If lines are now drawn from this point C. to V.P¹. and V.P². it will be found that a right angle is formed at C. These lines C.–V.P¹. and C.–V.P². are, in fact, parallel with the near vertical surfaces of the building in plan and are called the VANISHING PARALLELS.

We are now able to discover the plan of the visible part of the building behind the plan line of the PICTURE PLANE. For instance the near lower corner of the building T. in the photograph is evidently situated on a line N.T.E. drawn from a point N. on the Ground Line to point E. on the Eye Level. The line N.T.E. may be represented in plan as follows: The point N. is transferred vertically down to N.P. on the Picture Plane. A line N.P.–N.O. representing the plan of line N.T.E. in the photograph is then drawn parallel with its VANISHING PARALLEL C.–V.P$^1$. The position of point T. on the Picture Plane is now found by projecting T. downwards from the photograph to T.P. on the PICTURE PLANE. The actual plan position of point T., the near corner of the building, is now found at M., where a line drawn from the Eye position C. through T.P. intersects the line N.P.–N.O.

The plan may now be completed, for any point in the perspective of the building may be found in plan by first transferring its position vertically downwards on to the plan line of the PICTURE PLANE and then drawing a line through this position from the Eye Point C. to cut the relevant receding line in plan. Thus the corner B. in the photograph is found on the Picture Plane at B.P., and in perspective space at O. on the line M.–O., which is drawn parallel with the Vanishing Parallel C.–V.P$^2$.

We have now found the true dimensions of the plan and their relationship to the distorted dimensions of the perspective as seen from one point of view.

We may also find the true vertical heights of the building in similar fashion, for the perspective height T.H. of the near corner of the building in the photograph is seen to be N.–J. on the Picture Plane when the line E.–H. is continued to meet a vertical line set up at N.

The line N.–J. is called a HEIGHT LINE and it is possible to measure the height of any other point on the building by projecting a point on the ground vertically beneath it and setting up a Height Line on the PICTURE PLANE.

Thus it is seen that all lateral measurements in perspective are governed by lines drawn from the EYE through the PICTURE PLANE to the Object in plan and that all height measurements in the perspective are governed by measurement on Height Lines which mark the intersection on the Picture Plane of vertical planes containing the points.

# DEFINITIONS

The technical terms used in connexion with all diagrams are defined as follows—

**Plan.** The representation of the shape of a building or other form showing the general disposition of its parts on the ground.

**Elevation.** A representation in which each part of a building, or other form, is projected at right angles to a vertical plane.

**Picture Plane.** In theory, the transparent plane through which lines are projected from Eye to Object. In practice, the surface on which the perspective representation is made.

**Eye Level.** A straight line representing in elevation the horizontal plane in which the position of the Eye is situated.

**Central Visual Ray.** A line drawn from the Eye position to the centre of the Picture at right angles to the Picture Plane, as C.V. in Diagram 1.

**The Centre of Vision.** A point on the Eye Level immediately opposite the position of the Eye. It is found in plan by drawing a straight line from the Eye Point to the Picture Plane at right angles to the Picture Plane. Point V. is the Centre of Vision in Diagram 1.

**Ground Line.** A straight horizontal line drawn in elevation below the Eye Level. It represents the line of Intersection of the vertical Picture Plane with the horizontal plane of the ground.

**Vanishing Parallel.** A line drawn from the Eye to the Picture Plane parallel with surfaces of the form to be represented.

**Vanishing Line.** A line, such as the Eye Level in Diagram 1, on which converging perspective lines meet.

**Vanishing Point.** A point on the Eye Level or other Vanishing Line, at which parallel lines will meet in perspective.

**Height Line.** A vertical line set up from the Ground Line on the Picture Plane to represent the near edge of a vertical plane containing a required point within the Picture Plane.

**Measuring Point.** A point on a Vanishing Line from which lines are projected to the Picture Plane in order to measure perspective heights and widths.
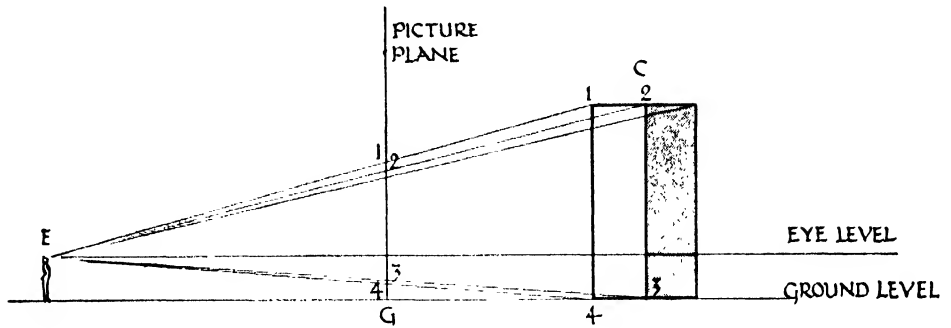
PICTURE
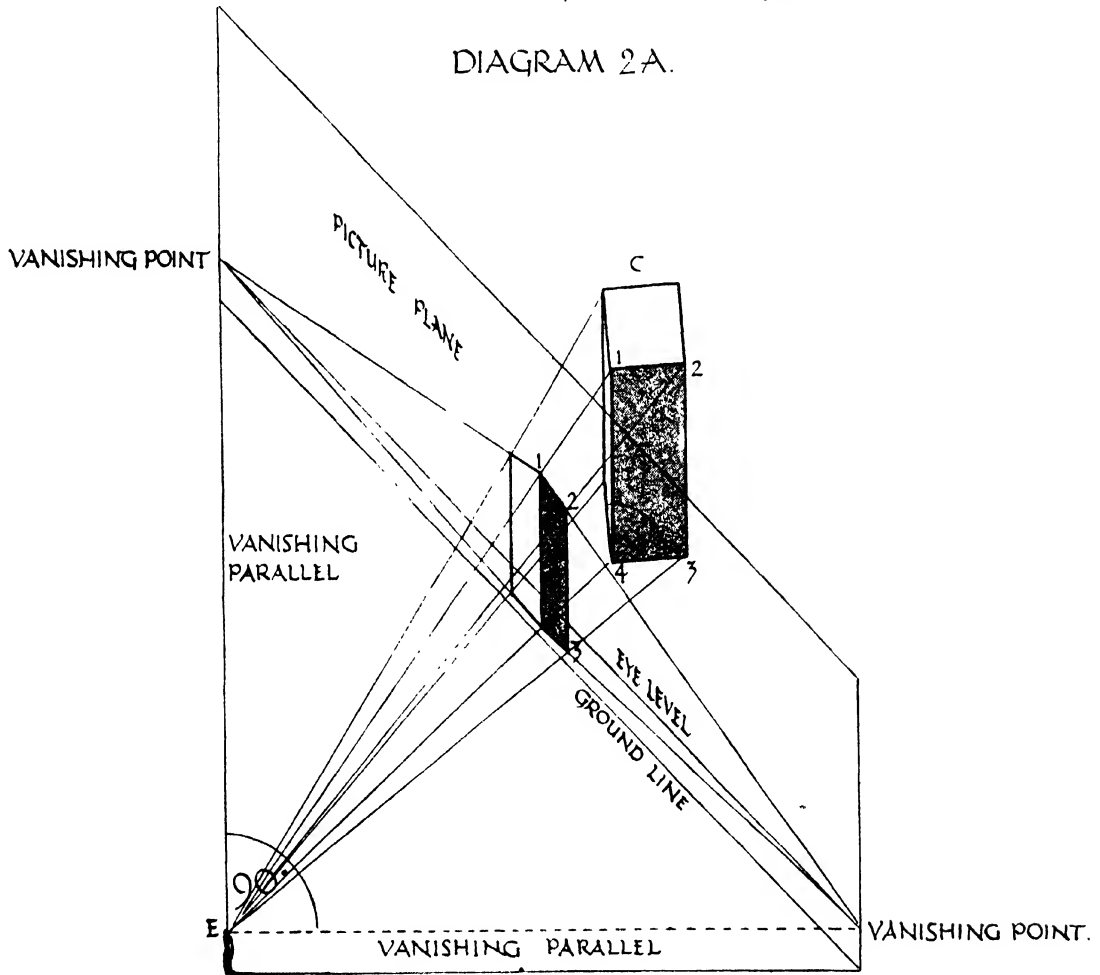PLANE

C

EYE LEVEL

GROUND LEVEL

DIAGRAM 2A.

VANISHING POINT

PICTURE PLANE

C

VANISHING
PARALLEL

EYE LEVEL

GROUND LINE

90°

E

VANISHING PARALLEL

VANISHING POINT.

DIAGRAM 2B.

12

# THE POSITION OF EYE, PICTURE PLANE, AND OBJECT

**Diagrams 2A and 2B.** Diagram 1 demonstrates the essential facts of perspective drawing theory and the relationship of perspective appearance to actual form recorded in terms of plan and elevation.

The relationship of Eye Point, Picture Plane, and Object, and the position of the various lines drawn in the last diagram may be more clearly realized in Diagrams 2A and 2B where the Object, the Picture Plane, and the Observer are shown, first in elevation, Diagram 2A, and secondly in axonometric, Diagram 2B.

In Diagram 2A we have a side elevation of a man at E looking through a Picture Plane on which the Perspective is to be drawn, at a building C. The position of the Ground Line is seen at the point G. where the Picture Plane cuts the ground level.

The various corners, 1, 2, 3, and 4 of the building, will appear at points 1, 2, 3, and 4 on the Picture Plane.

In Diagram 2B the resulting perspective representation is seen on the Picture Plane.

The perspective position of points 1, 2, 3, and 4 on the Building is found where lines drawn from them to the Eye pass through the Picture Plane. The horizontal edges of the building in the perspective are seen to converge to two Vanishing Points. The Vanishing Points are found where two Vanishing Parallels, making 90 degrees at the Eye Point, cut the Eye Level. The Vanishing Parallels are lines drawn from the Eye parallel with the two receding surfaces of the building.
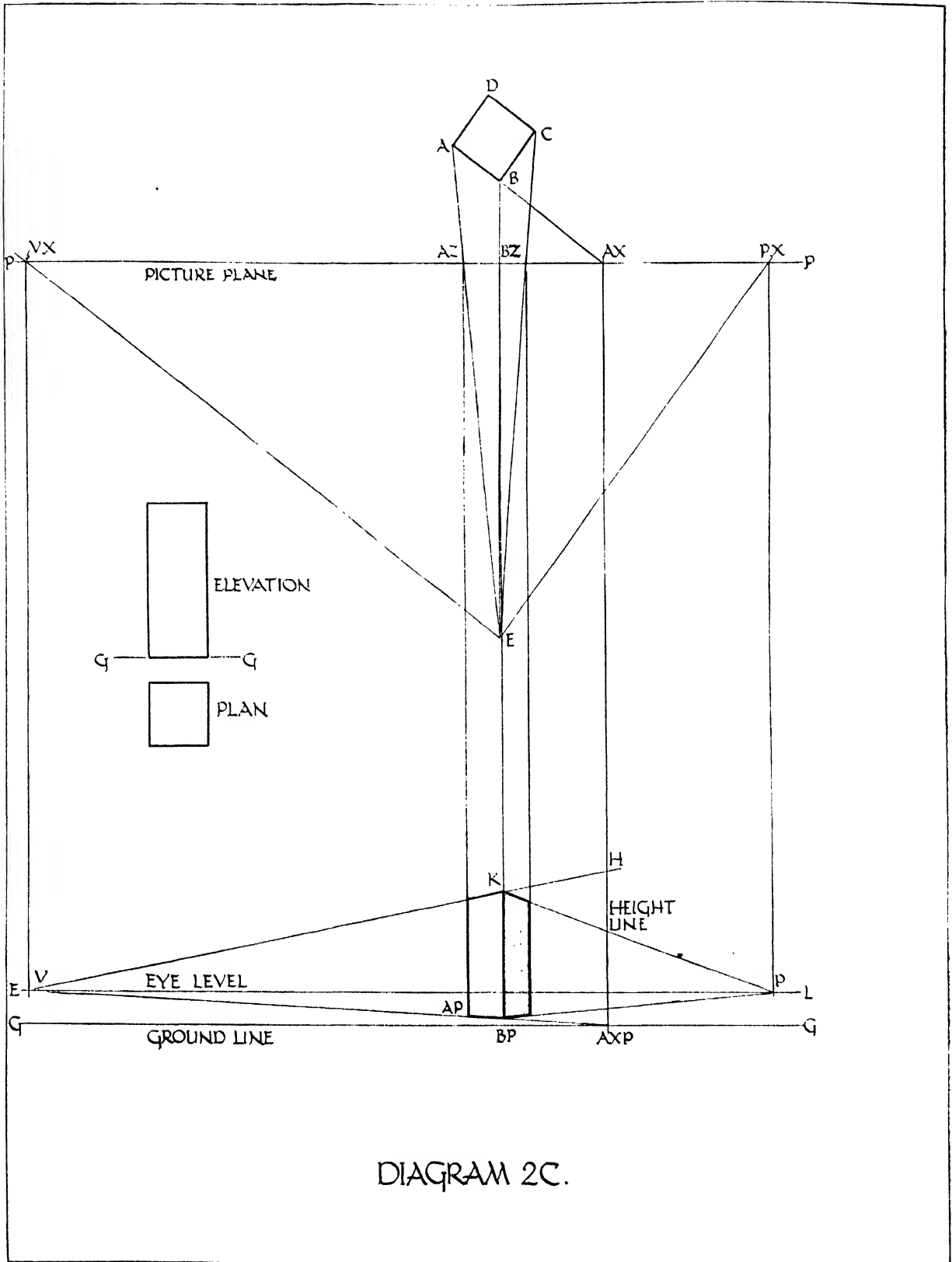
D

A C

B

P VX AZ BZ AX PX P

PICTURE PLANE

ELEVATION

G ——————— G

E

PLAN

H

K HEIGHT LINE

E V EYE LEVEL P L

AP

G —— G
GROUND LINE BP AXP

DIAGRAM 2C.

# THE PRACTICAL APPLICATION OF THEORY

**Diagram 2C.** Whereas in Diagram 1, plan and elevation were projected from a perspective, in ordinary circumstances the plan and elevation or dimensions of a building or object are given and a perspective is projected from them as in Diagram 2c.

In the upper part of the diagram a plan is shown of the eye of the Observer at E., the Picture Plane at P.P. and the building at A.B.C.D. The perspective is commenced, below, by drawing the elevation of the Eye Level and of the Ground Line at E.L. and G.G. The Distance E.G. is the chosen height of the Observer's eye from the ground. The Vanishing Parallels, E.–V.X. and E.–P.X. are drawn in the plan from the Eye to the Picture Plane parallel with the sides of the building B.A. and B.C. They meet the line P.P. at V.X. and P.X. These points are the Vanishing Points for the sides of the form. When transferred vertically down to the Eye Level they appear as points V. and P. The position of the corners of the building A. and B. are found in plan by continuing line A.B. to A.X. and transferring this point downwards to A.X.P. in Elevation. The line A.X.P.–V. is then the perspective representation of the plan line A.X.–A. The required corners of the building A. and B. are found on the line A.X.P.–V. by drawing lines from A. and B. to the Eye, in plan, and lines downwards from A.Z. and B.Z. to cut the line A.X.P.–V. at A.P. and B.P.

Other points in plan may be projected in similar fashion to find their perspective positions. The height of the prism, given in the elevation to the left, is then set up on line A.X.P.–H. Point H. is joined to V. The line H.V. cuts at K. a vertical line set up at B.P., thus giving the perspective height of the near vertical edge of the building. The perspective is then completed by drawing converging lines and vertical lines.
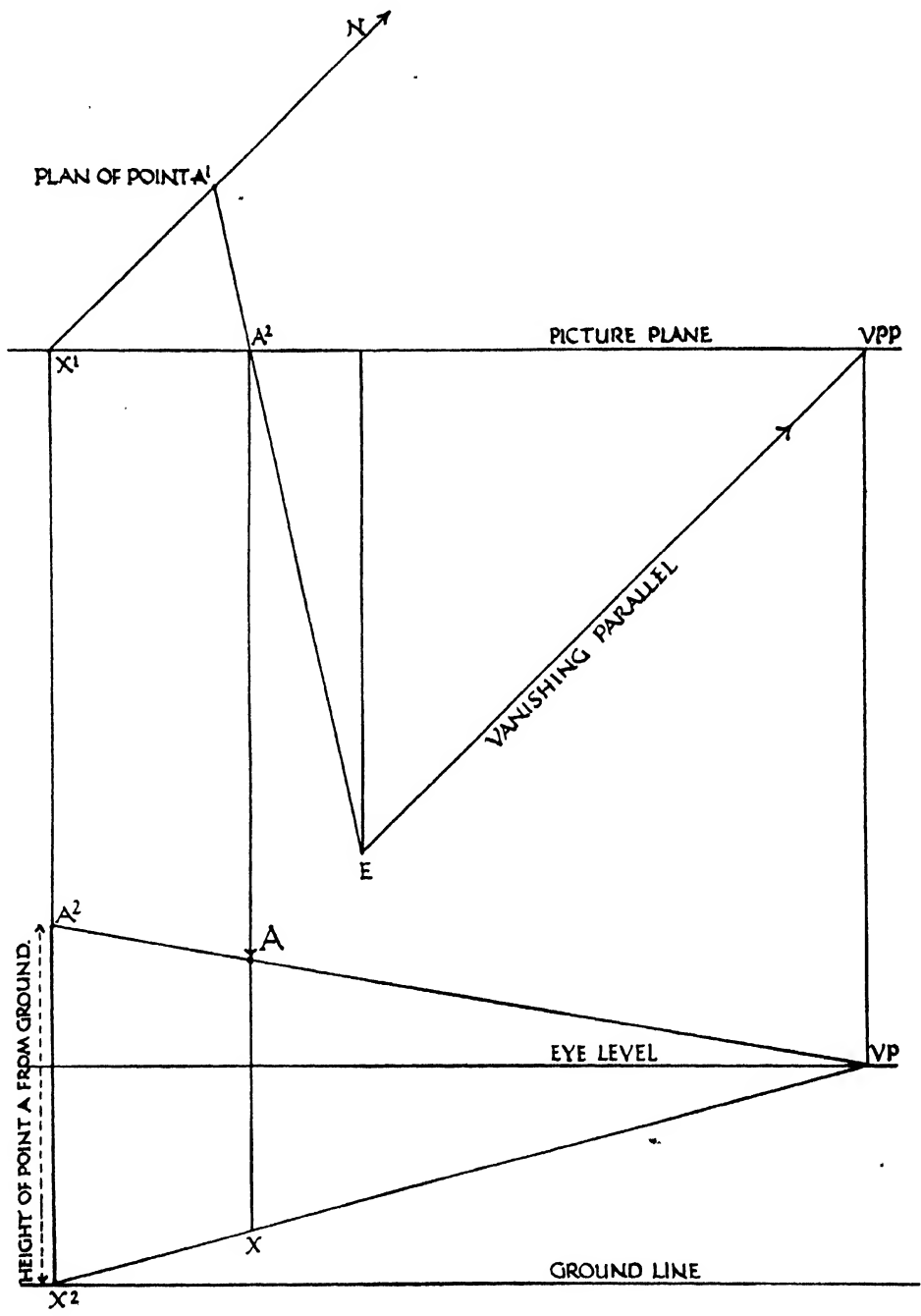
N

PLAN OF POINT A¹

A²

X¹

PICTURE PLANE

VPP

VANISHING PARALLEL

E

A²

A

HEIGHT OF POINT A FROM GROUND.

EYE LEVEL

VP

X

X²

GROUND LINE

DIAGRAM 2D.

# FINDING THE PERSPECTIVE POSITION
# OF A POINT

**Diagram 2D.** The practical application of perspective theory may now be shown in all its simplicity in Diagram 2D. A. is a point. The actual position of A. in space with reference to the Picture Plane and Eye Point is shown in the plan at A.1. The actual height of A. from the ground is shown in elevation at $X^2.-A^2$. The perspective position of point A. is found by drawing the lines shown. The lateral perspective position of point A. is found by drawing a line from $A^1$. to the position of the Eye E. in the upper part of the diagram and thence by a vertical line downwards from $A^2$. Its height position in the perspective is fixed by drawing Vanishing Lines $X^2.-V.P.$ and $A^2.-V.P.$ The perspective triangle $A^2.-X^2.-V.P.$ represents a vertical plane of the required height vanishing to the Eye Level at V.P. The plan of this plane is the line $X^1.-A^1.-N.$ above. Any vertical line in the triangle $A^2.-X^2.-V.P.$ is equal in actual height to $A^2.X^2$. The fixing of point V.P.P. in plan is in this case quite arbitrary. The vertical plane through the required point may be drawn at any convenient angle in the plan.

It is possible to summarize the practice of perspective drawing as follows—

*Identify a chosen point in both Plan and Elevation of the form. Find the lateral position of the point on the plan line of the Picture Plane.*

*Find the vertical position of the point by means of a Height Line which is the intersection with the Picture Plane of a vertical plane receding at any convenient angle.*

*Repeat the process for all salient points in Plan and Elevation and join the perspective points so found by lines.*

*In many cases it is not necessary to draw the Ground Line. The position of points A. and X. in this case could have been found by measuring above and below the Eye Level without indicating where the Picture Plane intersects the Ground.*

# CHOOSING THE POSITION OF EYE
# AND PICTURE PLANE

If the reader has appreciated in the preceding diagrams the relationship of the position of a point in perspective with its position in plan and elevation, and the method whereby one is obtained from the other, there is little more to learn of theory, but there are practical considerations which affect the resulting size and composition in particular cases.

The plan and elevation of a building are usually given and the perspective is projected from these. The first step is to select the most interesting and most significant point of view. The appearance of the building will vary according to the direction of vision and the height of the Eye Point. In addition the chosen position of the Picture Plane will govern the size of the perspective drawing in relation to the size of the given plan. The perspectivist is thus in the position of a painter composing a picture but with the added responsibility in the case of the architectural perspective of displaying the building in the most comprehensive manner. The resulting composition will be affected by three conditions; the placing of the Picture Plane, the distance of the Eye from the Picture Plane, and the height of the Eye from the ground. These three conditions are here considered separately.

PP4

PP3

B

A    PLANE    C

PP2    90°    D

PP1

E

DIAGRAM 3A.

20
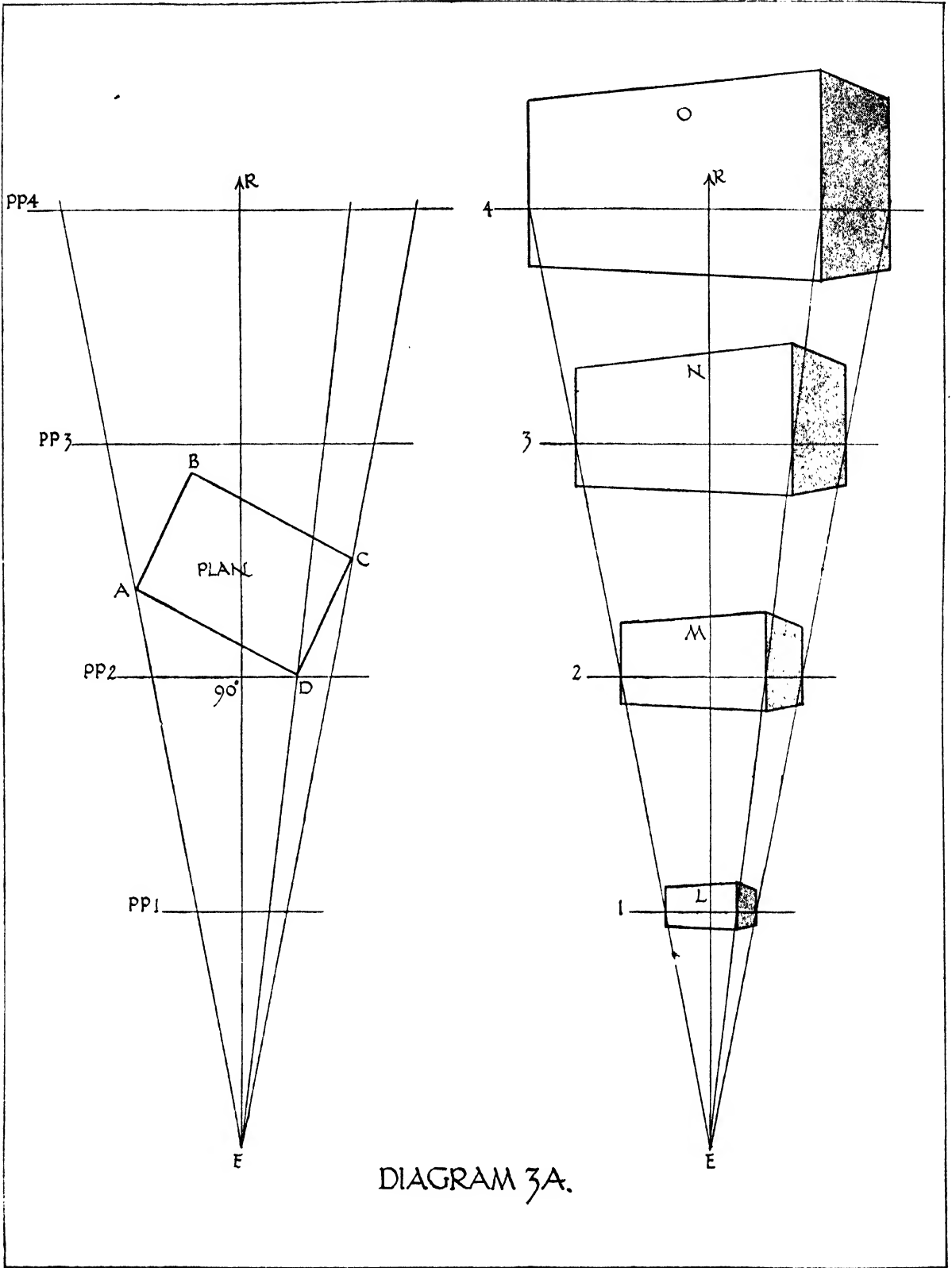
# ON PLACING THE PICTURE PLANE WITH REFERENCE TO A GIVEN PLAN

The plan of the Picture Plane may be placed at any convenient distance from the plan of the building to be drawn. The Picture Plane may be placed behind or even through the plan of the building. The choice of the Picture Plane's position depends upon several conditions. The given plan of a building or object from which a perspective is to be projected may be small or large. If a large perspective is desired it may be convenient to draw an enlarged plan, but it is more usual to adjust the size of the perspective drawing by the placing of the Picture Plane. This variation of size may be demonstrated by noting the different sizes of any object on a sheet of transparent glass (*a*) when the glass is held near to the eye and (*b*) when the glass is held farther away.

**Diagram 3A.** Diagram 3A shows the variation in size of the perspective of a building with plan A.B.C.D. when projected through four different Picture Planes. The perspective results vary as at L.M.N., and O. on the right. In the cases of N. and O. the Picture Plane is placed behind the building, an apparent anomaly, but this arrangement is often convenient and always adequate, the result being merely to produce a larger perspective drawing. Heights are in this case brought forward to the building from the Ground Line instead of being set back from the Ground Line.

In the case of M. the Picture Plane passes through the near corner of the building D. This is the most convenient and therefore the most customary position except where the resulting perspective size would be inadequate. It is convenient because heights may be set up directly on the near edge of the form without projection through a Height Line and without reference to a Ground Line.

The possibility of placing the Picture Plane anywhere in relationship to the plan enables the draughtsman to make a large perspective from a small plan or a small perspective from a large plan.

It is of the utmost importance that, wherever the Picture Plane be placed, its plan line should be at right angles to the Central Visual Ray shown here as the line E.–R.
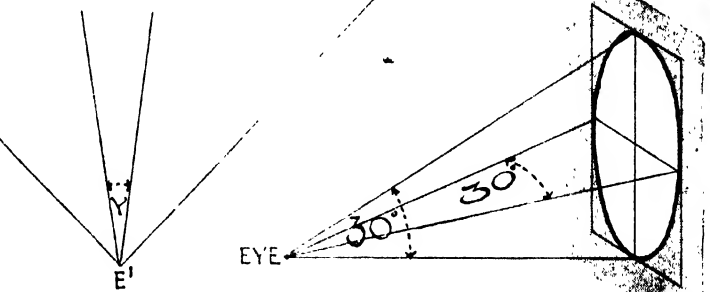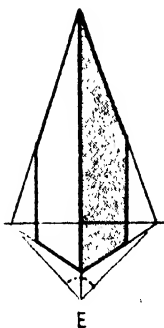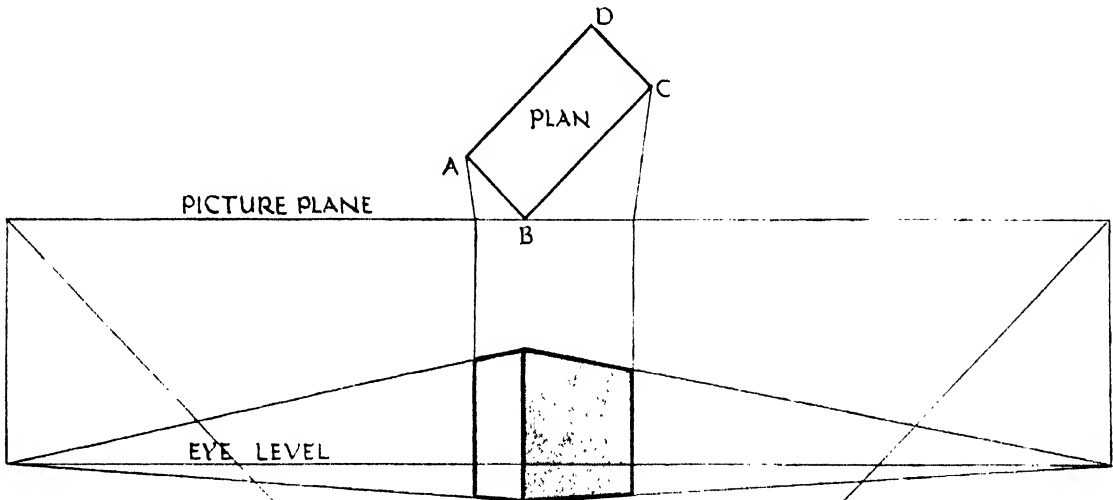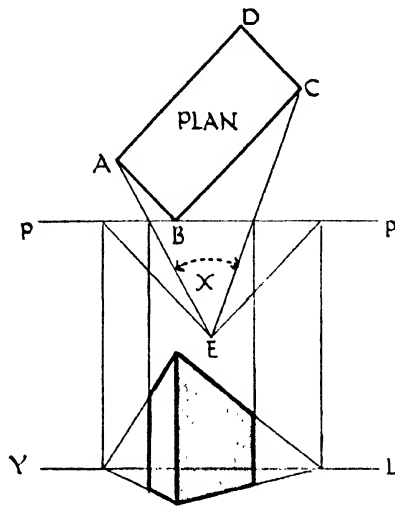
D

C

PLAN

A

P — B — P

X

E

Y — L

D

C

PLAN

A

B

PICTURE PLANE

EYE LEVEL

E'

DIAGRAM 3B.

EYE

30° 30°

E

# ON SELECTING THE DISTANCE OF THE EYE
# POINT FROM THE PICTURE PLANE

**Diagram 3B.** Comparison in Diagram 3B of two perspectives drawn from the same sized plan, A.B.C.D., shows that the distance of the Eye from the Picture Plane affects not only the size but also the perspective appearance of the form to a very great extent. In the upper diagram, where the Eye E. is placed close to the building, the upper and lower edges of the sides of the building converge very rapidly. In the lower diagram, where the Eye E$^1$. is more distant from the building, the sides converge less rapidly. There is a loss of scale in the first case. The building is small and distorted as compared with that in the second, although both have the same plan and the same height, while the position of the Picture Plane and the height of the Eye are also the same.

The reason for distortion in the upper perspective is that a perspective drawing is projected from one Eye Point only. If the reader will close one eye it will be found that the effective field of vision is limited and that objects in the outer edge of the field are out of focus. The field of vision is approximately circular. In perspective drawing, owing to the inevitable projection through a flat Picture Plane instead of on to a concave surface like that of the retina of the eye, the field of vision is best limited to a vertical angle of approximately 30 degrees and a horizontal angle of 30 degrees. It is, in any case, always advisable to place the eye as far as conveniently possible from the object.

In the upper diagram the horizontal angle of vision X. is much more than 30 degrees, with the result that the perspective representation is distorted and unreal. This is because a large building could not be seen in its entirety from such a short distance. It would be necessary to move the eye farther away as in the lower diagram, where the angle of Vision is Y.

If, on the other hand, the form A.B.C.D. were a small object, it would be possible to see it in perspective as shown above because the eye could take in the complete form while quite near to the object. Its lack of scale is therefore understandable.

For the same reason the tower shown in the small diagram on the left is distorted because it is drawn with an Eye Point E. placed so near to the Picture Plane that the vertical angle of vision could not include the entire form.

From this it should be noted that when the Picture Plane is in a normal position the farther the Eye position is placed from the object the larger the perspective representation and the less the distortion.

The circular field of vision or cone of visual rays on the Picture Plane is indicated in the small diagram on the right. Although it is of course possible to include a larger area, the perspectivist is advised to limit the horizontal angle to 30 degrees and the vertical angle to 30 degrees, especially in the case of buildings or large forms, so as to avoid loss of scale and distortion. In the human eye absolute distinctness of vision resides alone in the Central Visual Ray. In examining even a small object the Central Visual Ray moves rapidly in different directions. It is best therefore to limit the fixed Visual angle in perspective drawing.
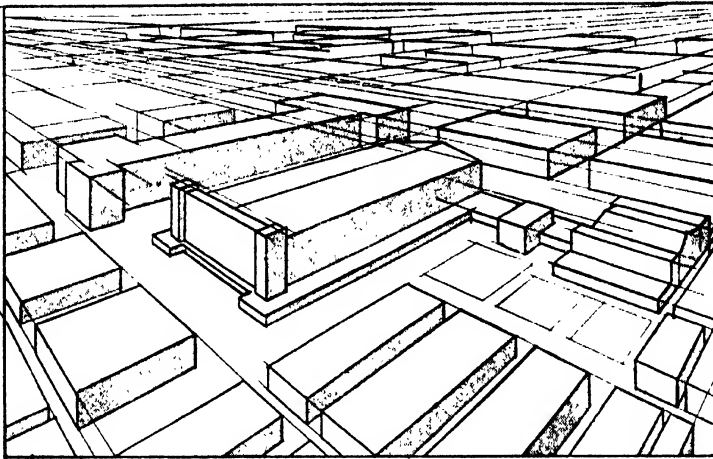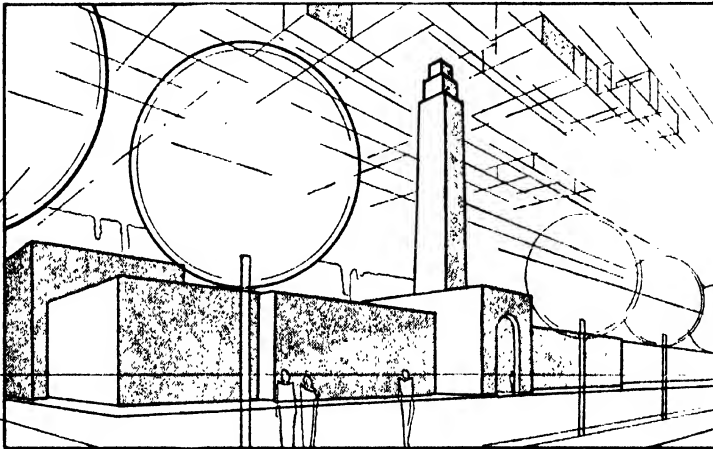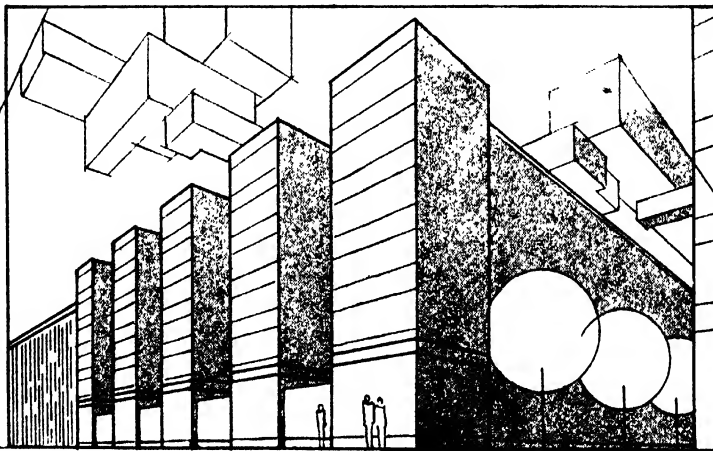
EYE LEVEL

DIAGRAM 3C

EYE LEVEL

H

GROUND LEVEL



EYE LEVEL &
GROUND LEVEL.

24

# ON SELECTING THE HEIGHT OF THE EYE POINT FROM THE GROUND IN RELATION TO A GIVEN BUILDING

**Diagram 3C.** We have seen in previous diagrams that the first line to be considered in any perspective is the Eye Level with reference to the object and the ground. The choice of the Eye Level is most important because it will affect the resulting perspective appearance of the building even more than the plan position of the Eye or the position of the Picture Plane, already mentioned.

It is a matter of composition which calls for careful consideration of the particular subject and of the best way of expressing it.

Typical effects on composition are shown in the three examples in Diagram 3c.

In the upper example buildings are seen from above. The Eye Level is here placed high because the plan arrangement and grouping of buildings are considered more important than their façades. The high position of the Eye enables the perspectivist to show the general lay-out.

In the central example the height of the Eye from the ground is H. This distance between Ground Line and Eye Level is 6 ft. measured to the same scale as the plan from which the perspective has been set up. In this case the building will appear in the perspective as it would be seen by a person approximately 6 ft. high.

This arrangement of Eye Level and Ground Line is therefore normal for most perspectives.

The lower example shows a perspective of a building as seen if the spectator's eye were on the level of the ground. The Eye Level and the Ground Line are therefore both represented by one line. The effect is imposing, but suggests false height owing to the unnatural point of view.

Two vanishing lines only are shown in the case of each diagram.

*It will be seen that in addition to an understanding of theory, the arrangement and composition of a perspective drawing involves preliminary consideration of—*

1. *The placing of the Picture Plane in relation to the form to be drawn.*
2. *The distance of the Eye Point from the Picture Plane.*
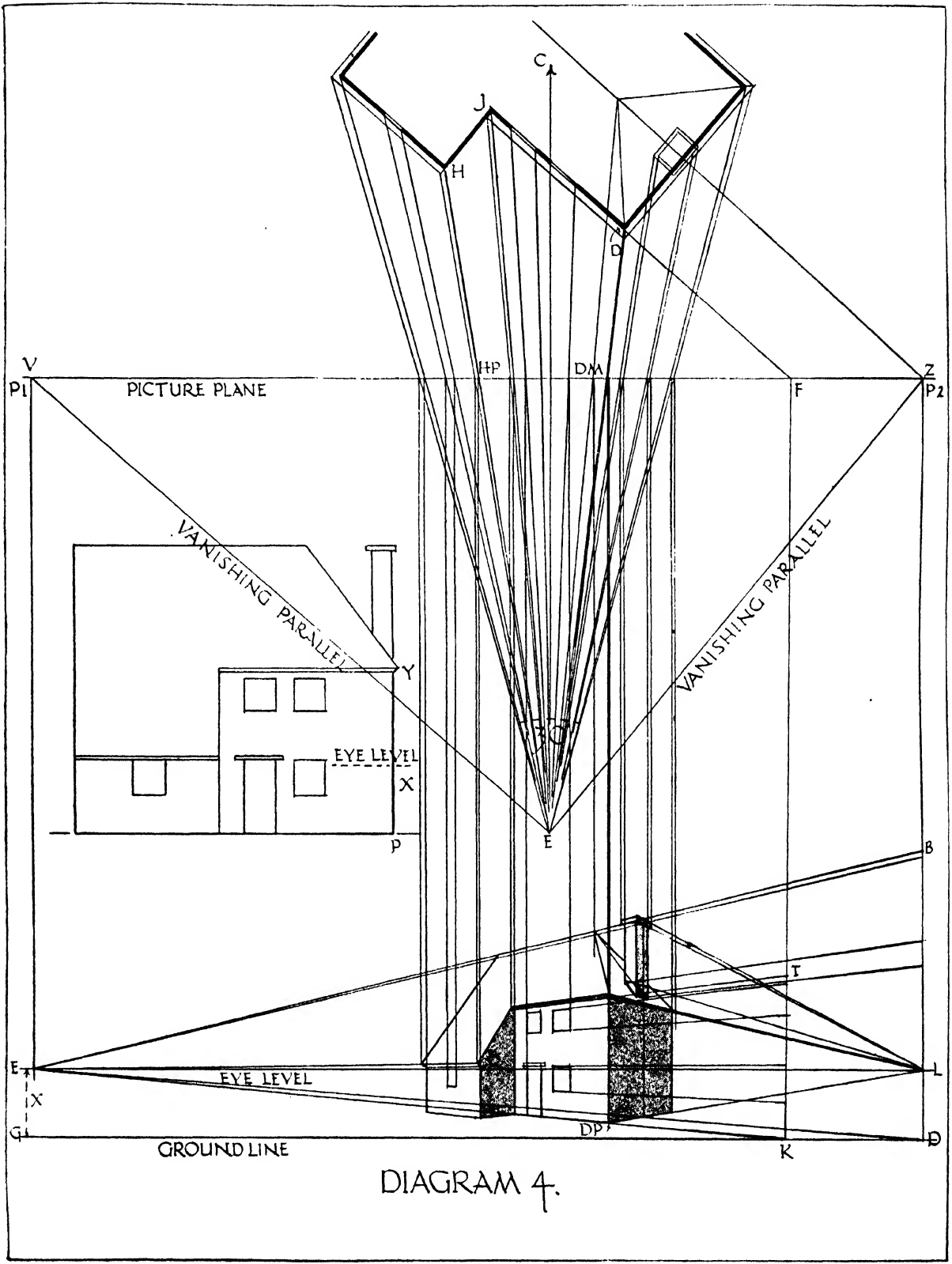3. *The height of the Eye Point in relation to the form.*

DIAGRAM 4.

# EXEMPLARY FORMS IN PERSPECTIVE

**A House—Diagram 4.** It is now possible to summarize in connexion with typical examples the orderly steps taken in producing a perspective drawing. Having considered the given plan and elevation of a house, we decide to take up the view point illustrated by the Eye position E. in relation to the near plan lines of the house (see Diagram 4).

Point E. is placed sufficiently far from the house for the latter to be included in an angle of 30 degrees made at E. The next step is to draw a line E.C. from the Eye E. to the approximate centre of the house.

The Picture Plane is then drawn at right angles to E.C. This is most important in all cases as any variation from the right angle will cause distortion. For purposes of demonstration the Picture Plane is, in this case, placed at P¹.–P². in order to reduce the size of the perspective and so to ensure that the Vanishing Points are within the area of the diagram below. It is often convenient to draw the Picture Plane through the near corner of the plan, e.g. point D., as explained in Diagram 3A. Heights are then measured on this corner, thus avoiding the necessity for a Height Line at this point.

The Vanishing Points for the sides of the house, points V. and Z., are found by drawing lines E.V. and E.Z. parallel with its sides, to left and right. The lateral positions of the salient points of the house are found on the Picture Plane P¹.–P². by drawing lines from them to the Eye. Thus point H. will appear on the Picture Plane at H.P.

The next step is to draw in any convenient position below the plan two horizontal lines representing the Eye Level and the Ground Line. Such lines are shown at E.L. and G.D. In this case a normal Eye Level is chosen and the distance X. between the lines is 6 ft., the approximate height of a man to the same scale, as the elevation shows.

The perspective position of D., the near corner of the house in plan, is now found by prolonging the line J.D. to F., which point is in turn transferred to K. on the Ground Line. The required position D.P. is found where a vertical line D.M.–D.P. cuts a Vanishing Line drawn from K. to E.

The perspective ground plan of the house is then completed by projecting other points in similar fashion and joining them to Vanishing Points on either side.

The position for Height Lines is now selected. A most convenient vertical section will be one passing through the central axis of the right end of the house, for heights marked on it will include those for the chimney. The centre line is therefore projected to Z. in the plan, and the heights of wall, roof and chimney are marked on Height Line D.–B., while those of the windows and door are set off on another Height Line K.–T., in the plane of the front wall.

The lateral position of any point in the perspective is found by projection from plan, and the height of any point is found by setting up a Height Line in the plane of the point. Thus the height of point Q. is found by means of a Height Line in that plane, or it may be marked on Height Line K.T. and drawn round the different faces of the house as a horizontal section.

The position of the perspective drawing in relation to the plan is optional. The draughtsman may place the plan below the perspective drawing instead of above or in fact wherever most convenient. The projection of points on the Picture Plane in plan may be carried out on a separate sheet from that on which the perspective is drawn; the position of all points between P¹. and P². being transferred with dividers to the Eye Level E.L. instead of by direct vertical projection. Vertical measurements are transferred from the elevation to Height Lines in the perspective in similar fashion.

Also in this and preceding diagrams the Vanishing Points are shown in each case, with the result that the perspective is necessarily small in relation to the area of the paper. In practice it is not usually possible to show both Vanishing Points on the sheet, for the perspective itself fills the available area. Methods of

PICTURE PLANE

VANISHING PARALLEL

VANISHING PARALLEL

EYE LEVEL

EYE

DIAGRAM 5.

28
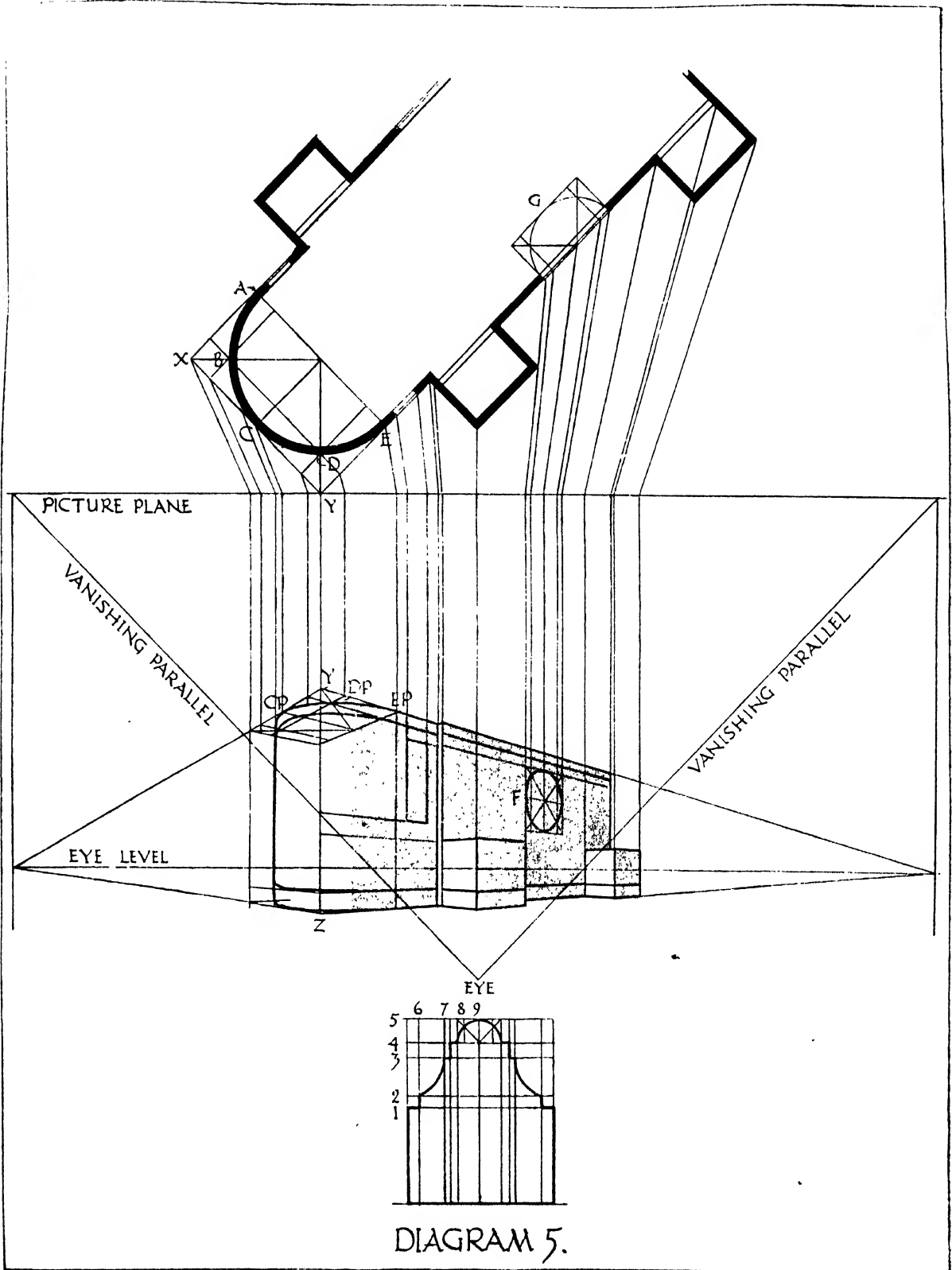
# CURVED FORMS IN PERSPECTIVE

**Diagram 5.** A straight line is projected in perspective by finding the perspective position of two points only, one at either end. In the case of curved lines it is necessary to select for projection a sufficient number of points in the line, in plan and elevation, to indicate the position of the line in perspective. The perspective points are then joined by a freehand line.
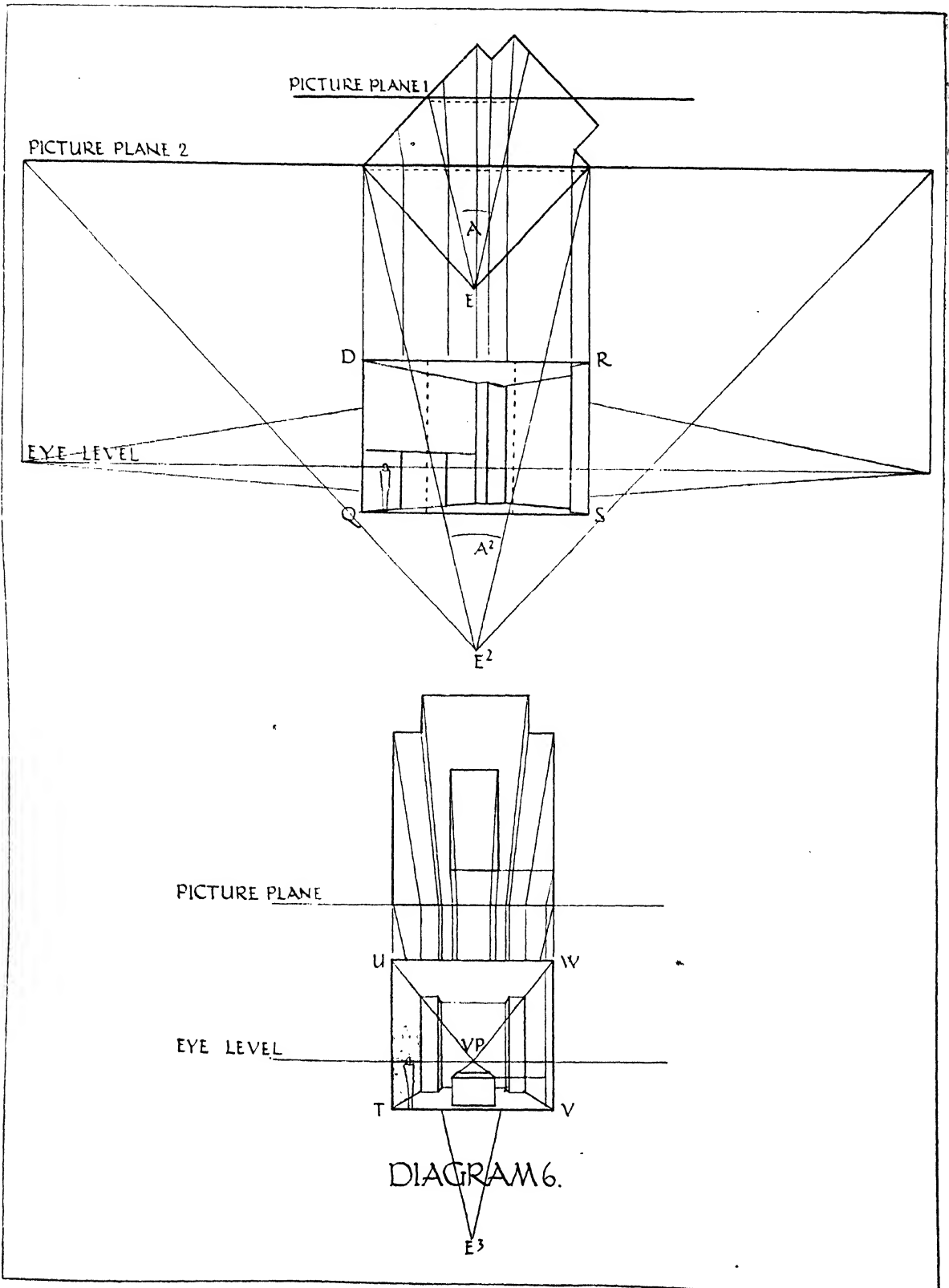
In most cases it is convenient to draw a framework of straight lines round the curve, and in the particular case of the circle it is usual to select for projection the 8 points where the circle is tangent to a square and where the diagonals of the square cut the circle.

This method is shown in the upper diagram where the position of the points B.C.D. and E. in the plan of the semicircular apse are found on the sides of the half square A.X.Y.E. and projected downwards to give the perspective positions C.P., D.P., and E.P., etc., on a similar half square drawn in perspective.

Similarly perspective points for the circular window at F. in the perspective are found by projecting five points from the square construction in the plan at G.

In this example, as the Picture Plane touches the near corner Y. in plan there is no need to draw a ground line, and all heights are measured on the line Y.Z. above and below the Eye Level. Heights are measured round the building horizontally from this corner.
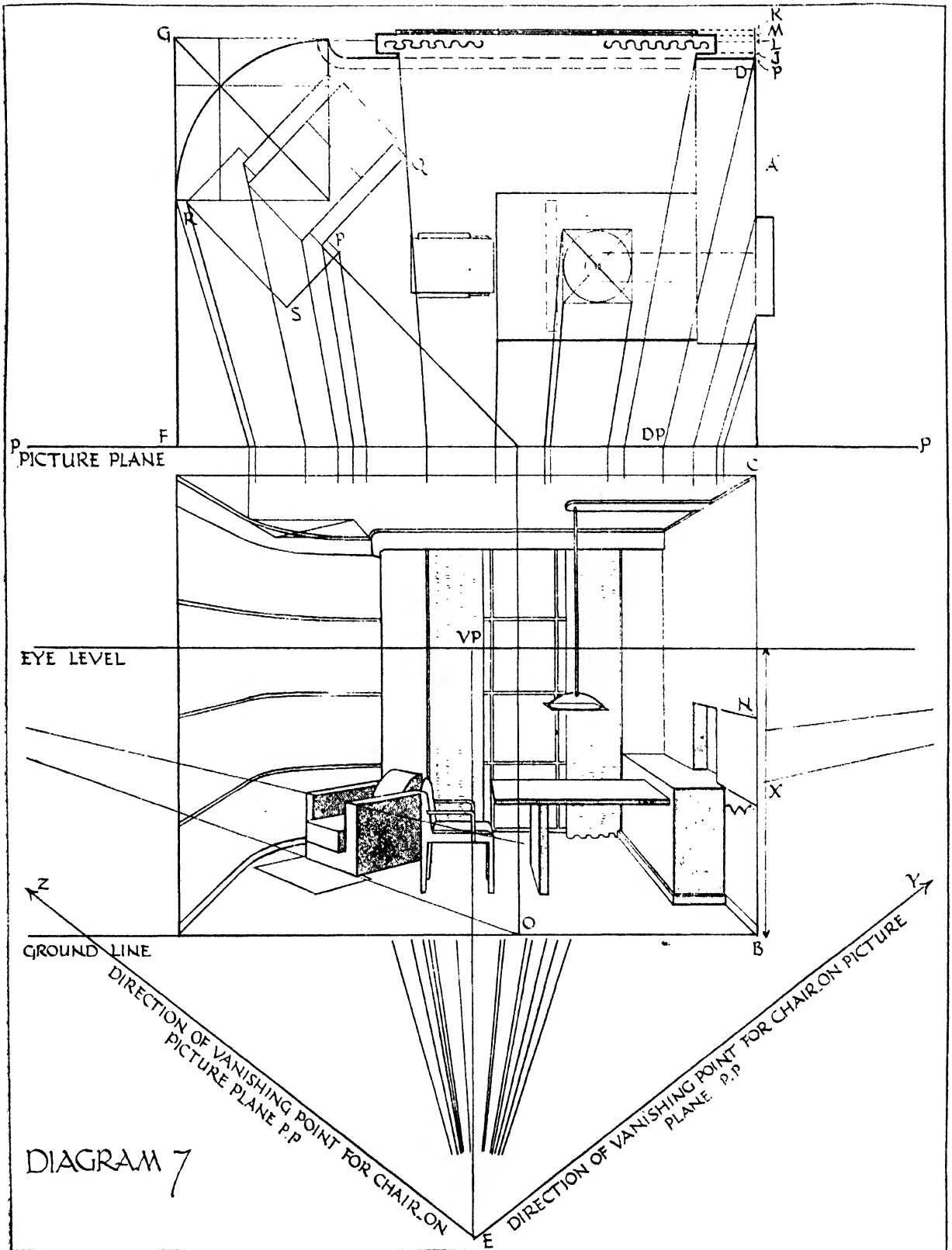
The lower diagram shows typical construction lines for a curved gable. It is not necessary, in practice, to draw all the lines shown, but only to indicate the various points 1, 2, 3, 4, 5, etc., on the outer frame.

PICTURE PLANE 1

PICTURE PLANE 2

A¹

E

D          R

EYE LEVEL

Q          S

A²

E²

PICTURE PLANE

U          W

EYE LEVEL          VP

T          V

DIAGRAM 6.

E³

# INTERIOR PERSPECTIVES ╱

**Diagram 6.** When drawing perspectives of rooms a difficulty occurs which is not present in the case of exterior perspectives. It is usually desirable to show as much of a room as possible, but owing to the necessity of limiting the Angle of Vision so as to avoid distortion—as shown in Diagram 3B (page 22)—it is, in most cases, necessary to imagine one or even two of the walls to be removed. This difficulty is illustrated in the upper diagram, where consideration of the plan of the room will show that, if the spectator stands in corner E., his angle of perspective vision will include only the portions of each wall on Picture Plane 1, which occur within the angle of approximately 30 degrees. The area so included is indicated by a horizontal dotted line. This "picture" will only include the part of the room shown between the vertical dotted lines in the perspective. The spectator must therefore choose either a distorted view from this point with a greater Angle of Vision, or a view from point $E^2$. outside the room with the Angle of Vision $A^2$. In the latter case it is possible to move the Picture Plane forward so as to include two complete walls, as at Picture Plane 2. For this position of the Picture Plane, it is assumed that the two near walls are removed. This produces a view which could never in fact be possible. On the other hand, such practice is often justified in order to show the relationship of walls, floor and ceiling. The heights are measured on line D.–Q. or R.–S. where the walls cut the Picture Plane, or upon separate Height Lines in other vertical sections. The lateral positions of the various points are projected downwards from the plan as before.

In the lower diagram a "parallel" perspective viewed from $E^3$., outside the room, has one Vanishing Point at V.P. The advantages of a parallel perspective are that it may show three complete walls with complete ceiling and floor. It is therefore usually adopted. Heights are measured on the lines where the walls intersect the Picture Plane at T.U. and V.W. Separate Height Lines will be necessary for objects in the room.

PICTURE PLANE

EYE LEVEL

GROUND LINE

DIRECTION OF VANISHING POINT FOR CHAIR-ON PICTURE PLANE P.P

DIRECTION OF VANISHING POINT FOR CHAIR-ON PICTURE PLANE P.P

DIAGRAM 7

32

# A SMALL ROOM WITH FURNITURE

**Diagram 7.** In the case of the room of the given plan, a parallel perspective is decided upon and the Picture Plane is drawn through the near side. By removing this wall we may include three complete walls, floor and ceiling in the perspective. The Eye Point is placed at E. on a Central Visual Ray drawn at right angles from the Picture Plane and is sufficiently far away to include the width of the room in approximately 30 degrees as the Angle of Vision.

The salient points of walls and furniture are next projected through the Picture Plane to the Eye Point. This gives their lateral position on the Picture Plane. The Eye Level is next drawn; a horizontal line at any suitable distance below the plan. The Ground Line or lower edge of the picture is drawn below the Eye Level. The distance between Eye Level and Ground Line, shown as X, on the right of the Diagram, represents the height of the Eye. In this case it is approximately 6 ft. to the scale of the plan.
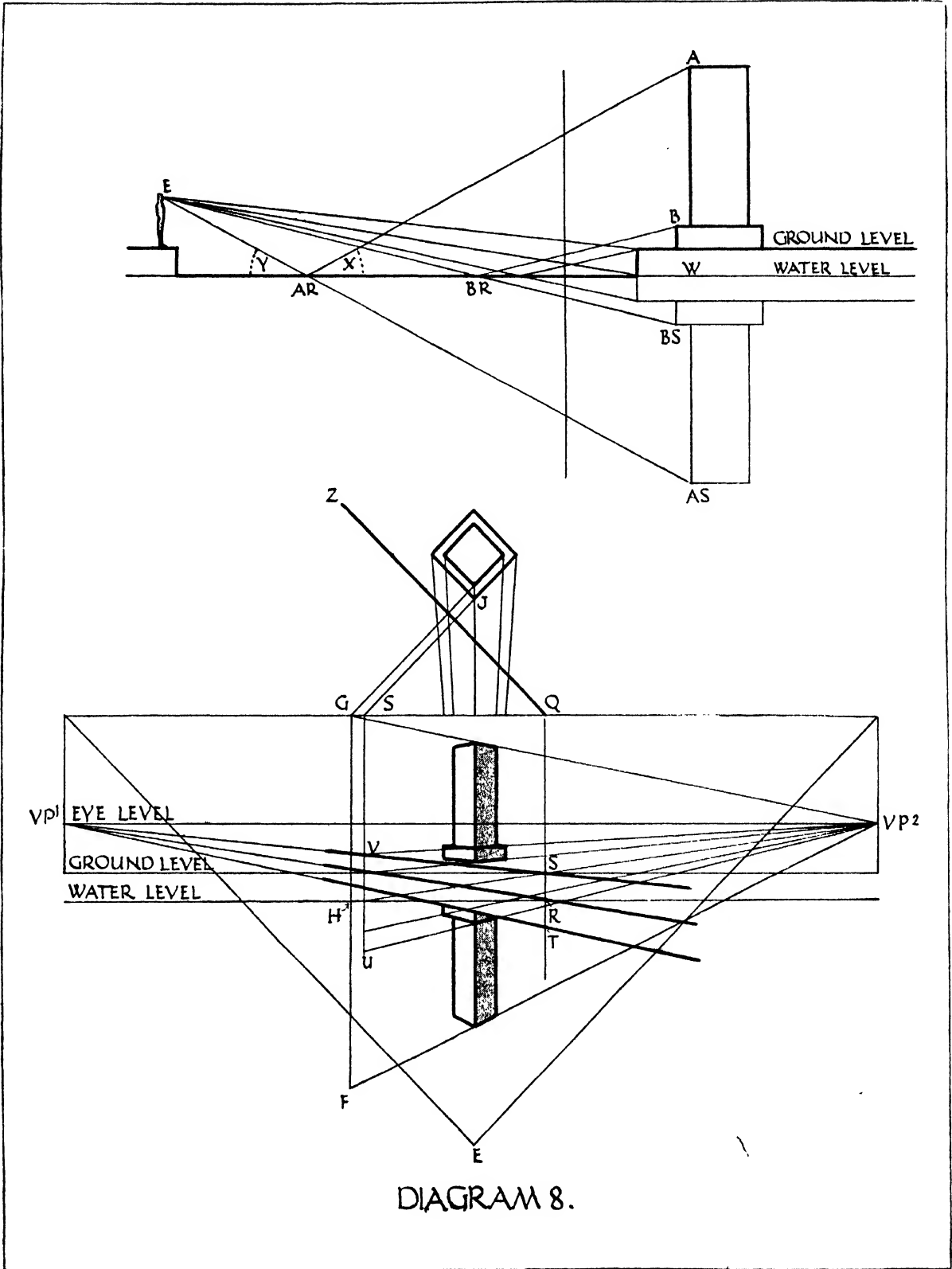
The Vanishing Point for the right side of the room, in the plan, is found as in all other cases by drawing a line from the Eye, parallel with the wall, to cut the Picture Plane at V.P. The height of the room is then set up at B.C. on the right of the perspective and Vanishing Lines are drawn from B. and C. until they cut a vertical line projected from D. through D.P. in plan. The left side of the room, F.G. in plan, is drawn by similar means and the back wall indicated in the perspective as the plane G.L. The construction of the frame for the arc on the left is shown in plan. This framework is projected down to the floor and ceiling and also to the horizontal divisions of the wall as in Diagram 5, page 28, so that the quarter circles may be drawn in perspective as freehand lines. The construction lines for one only of these quarter circles is indicated in the diagram at ceiling level.

Points K.M., J., and P., in the top right corner of the plan, are now projected downwards on to the upper and lower edges of the right-hand wall in the perspective and give the various planes of the window frame, pelmet, curtain frame and window, which are shown by horizontal or vertical lines through perspective points thus obtained.

The height of the sideboard and serving hatch to the right are found at W. and N. on the right wall. The height of the table and of the chair are found on other subsidiary Height Lines giving a vertical plane through the required points. The lateral position of any point is found by projection from plan and its height is found on a vertical section set up from the Picture Plane to vanish to the point V.P.

The easy chair and the rug on the left will require two different Vanishing Points which occur outside the area of the diagram. These points are found firstly on the Picture Plane by drawing lines E.–Z. and E.–Y. parallel with plan lines P.–Q. and S.–R. to cut the Picture Plane. From the Picture Plane these points are transferred downwards to give the Vanishing Points on the Eye Level. One Height Line is shown at O. on which the heights of the front of the chair were measured.

The lighting fitting above the table is projected from the plan in the same way and the familiar frame drawn in plan to produce an ellipse in the perspective.

Labels in upper diagram: A, E, B, GROUND LEVEL, Y, X, W, WATER LEVEL, AR, BR, BS, AS

Labels in lower diagram: Z, J, G, S, Q, VP¹, EYE LEVEL, VP², GROUND LEVEL, V, S, WATER LEVEL, H, R, T, U, F, E

DIAGRAM 8.

# PERSPECTIVE REFLECTIONS

**Diagram 8.** In the upper diagram the section of a square tower standing on a river bank is shown. A spectator is standing at E. and looking across the river at the tower. What would be the appearance of the tower and its reflection?

The Angle of Incidence of a ray of light equals the Angle of Reflection. Thus the point A. is reflected at A.R., a point where the angle X. equals the angle Y. By drawing a line from E. through A.R., we may discover the position of point A.S. in the section, immediately below A. The distance A.S. to the water level W. equals the distance W.–A. In similar fashion we may find the position of the reflection of any other point on the tower by drawing lines representing the Angles of Incidence and Reflection in each case. Thus the reflection point of B. is found at B.R. on the water surface and at B.S. immediately below B. in the section.

In the perspective below, the tower and the near edge of the bank are placed at 45° to the Picture Plane and are projected from the plan in the usual way. The ground level is drawn below the Eye Level, a distance equal to the height of the spectator, and the water level is drawn as a horizontal line below the ground level, a distance equal to any given height of the bank.

The perspective line where the plane of the water intersects the vertical plane of the bank is found by projecting point Q. in plan downwards to cut the water level at R. The line R.–V.P$^1$. drawn to the Vanishing Point is the required line. The height of the bank R.S. is then measured above the water level R. and the reflection of the bank R.T. (an equal distance) is measured below point R.

The total height of the tower and bank is obtained by measuring the true height on Height Line H.G. above point H. on the water level and the depth of the reflection of the tower, an equal distance, is measured on H.F. below point H.

A further Height Line U.V. in the plane of the base of the tower is necessary and is projected downwards from J. in the plan. The height of the bank and the base, and the depth of the reflection are measured equally above and below the water level as before.

Reflection points are thus obtained by means of a Vanishing Vertical Plane containing the required points. Reflection points always occur vertically beneath the points reflected at a perspective distance from the plane of the reflecting surface equal to the perspective distance of the point reflected above the reflecting surface.
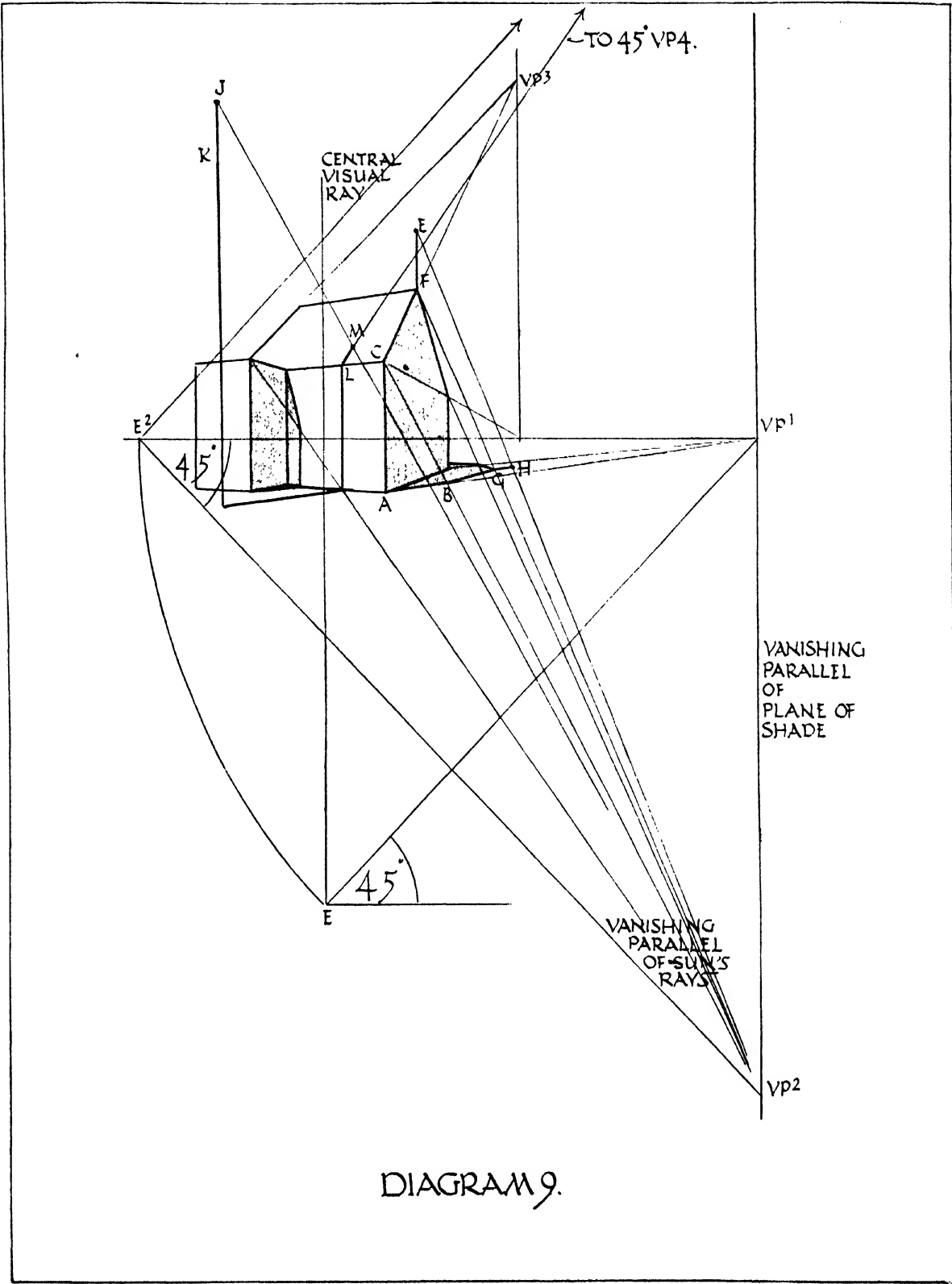
TO 45° VP4.

VP3

CENTRAL
VISUAL
RAY

J

K

E

F

M

C

L

E²

45°

A

B

Q H

VP¹

VANISHING
PARALLEL
OF
PLANE OF
SHADE

45°

E

VANISHING
PARALLEL
OF SUN'S
RAYS

VP2

DIAGRAM 9.

# PERSPECTIVE SHADOWS OF A HOUSE IN SUNLIGHT

**Diagram 9.** In the diagram the perspective lines of the house have been projected from the plan in the usual way. The conventional architectural lighting is assumed. The rays of light are parallel and the direction of light is 45 degrees in plan and 45 degrees in elevation.*

When the sun is behind the spectator, as in this case, its rays will descend downwards to the right. The first step therefore is to find the Vanishing Line for the vertical plane of the rays at 45 degrees. The angle of 45 degrees is set off to the right at Eye Point E. and a vertical line is drawn through V.P¹. The Vanishing Point of all rays descending at 45 degrees will occur on this line. The actual position of this Vanishing Point is found by transferring the position of the Eye Point E. to E². on the Eye Level and making a Vanishing Parallel at 45 degrees downwards from the Eye Level to meet the vertical Vanishing Line at V.P². The shadow edges of any vertical edges of the house will vanish to V.P¹. The shadow edge A.B. is an example. The position of B. is found by drawing a line C.B.–V.P². The line C.–B. is a perspective line in a vertical plane making 45 degrees with the Picture Plane and making a vertical angle of 45 degrees with the horizontal Ground Plane.

The shadows of points E. and F. are found in similar fashion at H. and G.

As the upper part of shadow of the pole J. falls on the sloping roof surface whose Vanishing Point is V.P³., it is necessary to find a further Vanishing Point for this shadow. A line is drawn above the Eye Level at E². at 45 degrees (the angle of the sun-rays of light) to cut the Vanishing Parallel of the Plane of Shade on the right at V.P⁴. (not in the area of the diagram). Point L. is then joined to V.P⁴. and the shadow of J. is found at M. by joining J. to V.P².

In the case of sunlight, the shadow of any Point is found where a line which is the trace of the plane containing the Point and drawn to the 45-degree Vanishing Point cuts a line drawn from the Point to the Vanishing Point of the vertical angle (45 degrees) of the rays of light.

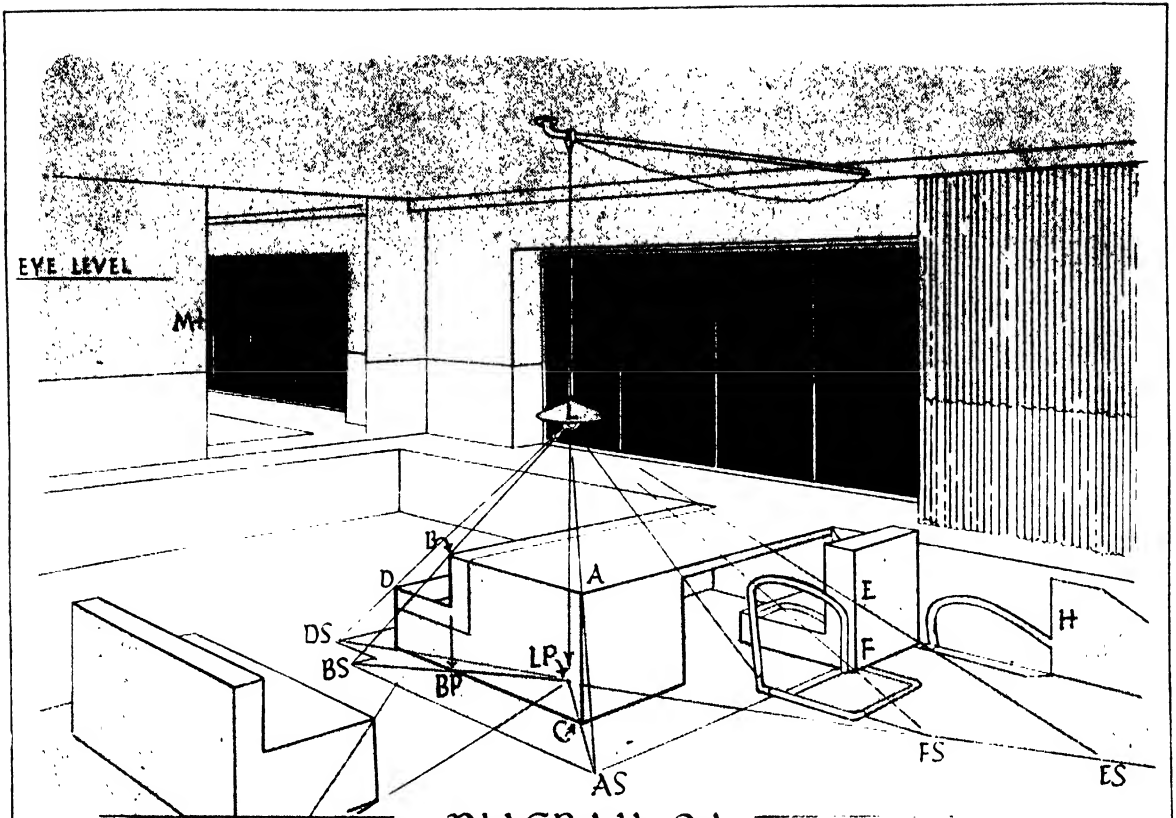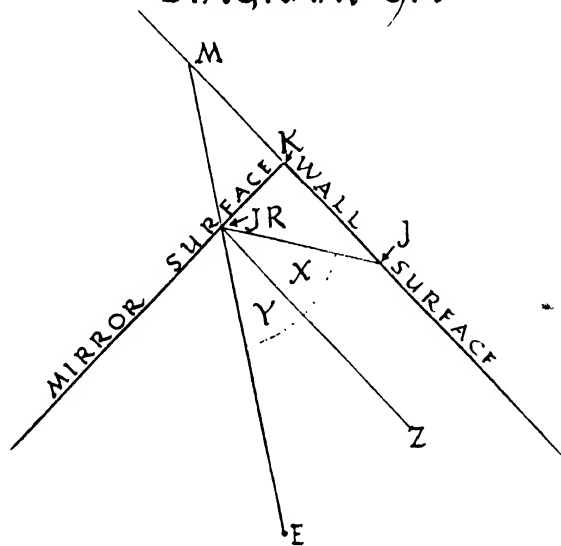* See *Architectural Shadow Projection*, by John M. Holmes.

EYE LEVEL

M

B
D
A
DS
BS
BP
LP
Y
C
AS
E
F
H
FS
ES

DIAGRAM 9A



M
K
WALL
JR
J
SURFACE
MIRROR SURFACE
X
Y
Z
E

DIAGRAM 9B.

# SHADOWS FROM ARTIFICIAL LIGHT AND REFLECTIONS IN A MIRROR

**Diagram 9A** shows a perspective of a portion of a room projected from a plan in the usual way as shown in Diagrams 6 and 7 (pages 30 and 32). The plan is not shown in the diagram. The room is partly illuminated by an electric light at point L. which casts the shadow of the horizontal edge of the opaque conical shade on to the walls, and the shadows of the edges of furniture on to the floor. The outline of such shadows is found by projecting from the source of light L. a number of salient points round the surfaces illuminated, on to the surfaces receiving the shadow. Thus the shadow of A., the nearest corner of the desk, is found at A.S. on the ground by the following means—

Find L.P., a point on the ground immediately beneath point L. by projection from plan. From L.P. draw the line L.P.–A.S. through the corner C. From point L. draw the line L.–A.S. through the corner A. The point A.S. where these two lines meet is the shadow of point A. on the ground.

The triangle L.–L.P.–A.S. represents a plane in perspective containing the point of light L., the point L.P. immediately beneath it on the ground, the corner A., and a point C. immediately beneath A. on the ground. In order to find the shadows of other points it is necessary to set up similar triangles fulfilling these same conditions. Thus the shadow of point B. at B.S. is found by drawing the triangle L.–L.P.–B.S. containing B. and its plan point B.P. As the edge A.–B. is straight, it is now only necessary to join A.S.–B.S. to represent its shadow.

If the shadow line A.S.–B.S. be continued in perspective, it will be found to meet the vanishing line of the edge of the desk A.B. in the same point on the Eye Level. Further experiment will show that the shadow of any horizontal straight edge on the ground is in all cases parallel to the edge casting the shadow.

The shadows of points E. and F. on the vertical edge of the back of the chair are found at E.S. and F.S. The shadow of any vertical straight edge is in all cases a line radiating from a point situated immediately beneath the source of light on the plane on which the shadow falls, and passing through the point representing the plan of the vertical edge.

As shown at H. the shadow of any vertical edge on a vertical surface is a vertical line.

The shadows falling on the horizontal part of the chair are found by fixing a point above L.P. equal to the height of the horizontal surface receiving the shadow.

The height of the horizontal shadow of the edge of the conical reflector above the light L. is obtained by means of a height line through point L. in the usual way.

MIRROR REFLECTIONS

**Diagram 9B** shows a point J. on a wall surface on the right reflected in a mirror at right angles to the wall. Because the angle of incidence X. equals the angle of reflection Y. (see Diagram 8, page 34) the reflection of J. as seen from the Eye position E. will appear at J.R., where the rays are symmetrical about J.R.–Z. drawn at right angles to the mirror surface at J.R.

If the line E.–J.R. is now continued it meets a line continuing the wall surface at M. M.–K. is found to equal K.–J.

To draw the reflection of the window in the mirror M., shown in the diagram above, the widths of the shapes within the room were therefore duplicated on a continuation of the wall surface behind the mirror in plan and projected from the plan in the usual way.
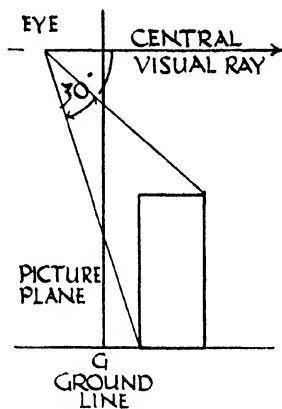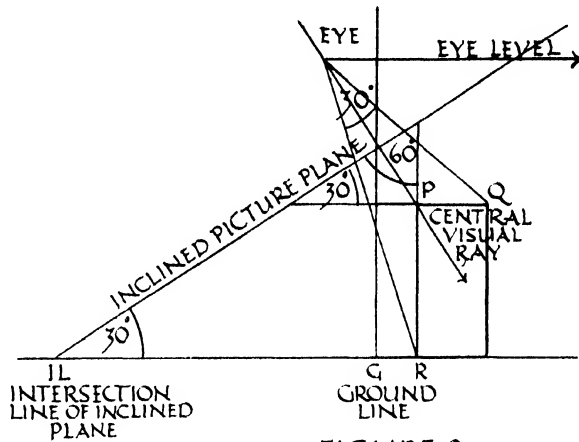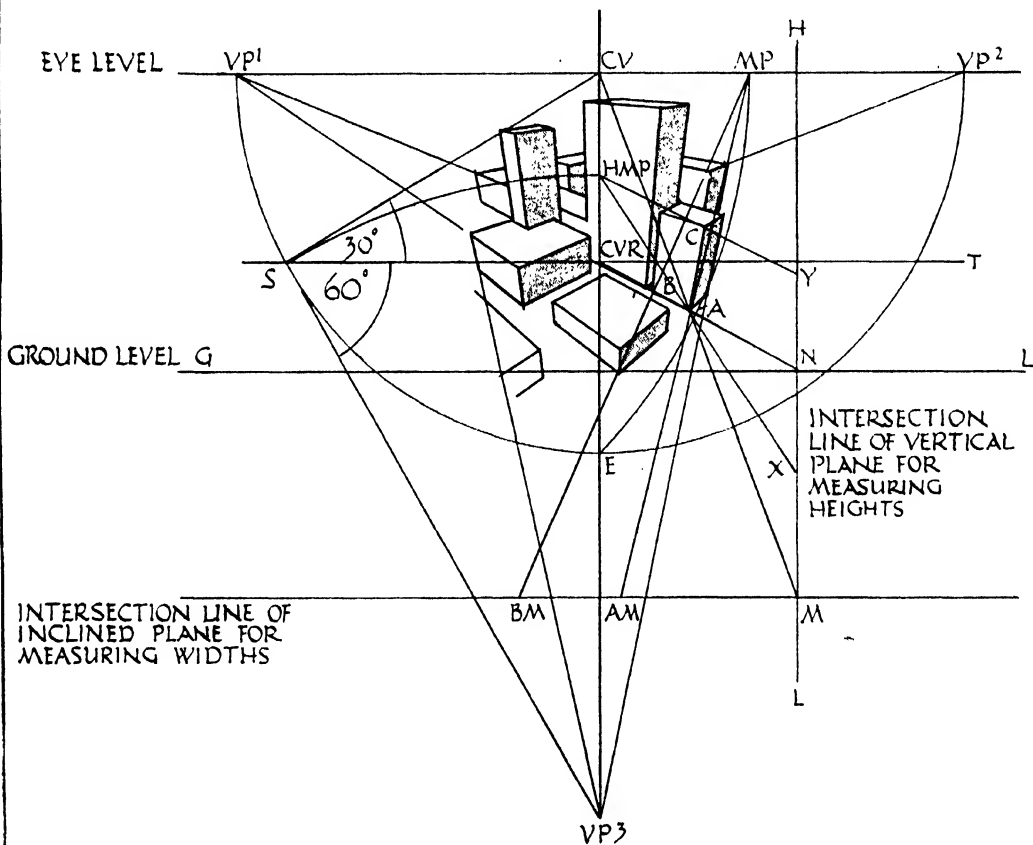
**FIGURE 1**

EYE

CENTRAL
VISUAL RAY

30°

PICTURE
PLANE

G
GROUND
LINE

**FIGURE 2**

EYE

EYE LEVEL

30°

60°

P   Q

INCLINED PICTURE PLANE

30°

CENTRAL
VISUAL
RAY

30°

IL
INTERSECTION
LINE OF INCLINED
PLANE

G   R
GROUND
LINE

**FIGURE 3**

**DIAGRAM 10**

EYE LEVEL   VP¹   CV   MP   VP²

H

HMP

30°

CVR

C

60°

S   B   Y   T

A

GROUND LEVEL  G   N   L

INTERSECTION
LINE OF VERTICAL
PLANE FOR
MEASURING
HEIGHTS

E   X

INTERSECTION LINE OF
INCLINED PLANE FOR
MEASURING WIDTHS

BM   AM   M

L

VP3

# PERSPECTIVE OF BUILDINGS WITH AN INCLINED PICTURE PLANE

**Diagram 10.** As explained in Diagram 3c the Eye Level may be placed above the forms to be drawn, but if the Eye Level is very high the forms become distorted and unreal. The reason for this is that the vertical angle of vision is limited, and, as shown in Figure 1, the angle may become much greater than the 30 degrees limit when it includes the Horizontal Central Visual Ray. Reference to Figure 2 will show that in looking down on to objects from above, the Central Visual Ray is not really horizontal, and that as the Picture Plane is always at right angles to the direction of vision, the Picture Plane is inclined.

For this reason, where the Eye is placed too high to include all the picture area in 30 degrees it is necessary to find a Vanishing Point below for lines which would otherwise be drawn vertically.

The principles governing the perspective of forms with such an inclined Picture Plane are illustrated in Figure 3 where the distance of the Eye Level V.P¹.–V.P². from the Ground Line G.L. is equal to the Vertical Height of the Eye above the Ground. It is assumed here that the Picture Plane is inclined at 30 degrees to the ground as in Figure 2. The angle is arbitrarily chosen. The edge of all horizontal planes in the buildings will vanish to V.P¹. or V.P²., found in the usual way, because the upper edge of the form P.Q. in Figure 2 is seen to be parallel with the horizontal plane of the Eye Level, although vanishing at an angle of 30 degrees with the inclined Picture Plane. On the other hand, the edge P.R. in Figure 2 is seen to form an angle of 60 degrees with the inclined Picture Plane. It is therefore necessary to find in Figure 3 the position of the point representing the Central Visual ray and further to fix a Vanishing Point below for lines vanishing downwards at 60 degrees. The Central Visual Ray is found as follows—

Reference to Figure 2 shows that the Eye Level line V.P¹.–V.P². in the perspective is the Vanishing Line for planes at 30 degrees to the Inclined Picture Plane.

Point S. on the left in the perspective is found by drawing a line downwards to the left from point C.V. at 30 degrees to the horizontal to cut the semicircle representing the distance of the Eye Point E. from the Picture Plane. A horizontal line S.T. is drawn to give the position for the Central Visual Ray at C.V.R. As angle Q.P.R. in Figure 2 is a right angle the Vanishing Point for lines at the remaining 60 degrees downwards is next found at V.P³., where a line at 60 degrees with S.T. cuts the line C.V.–V.P³. All vertical edges will therefore vanish to V.P³.

Point A or some other convenient point in plan is found as usual. It is now necessary to find a Measuring Point for horizontal edges vanishing to V.P¹. or V.P². Such edges are measured on the horizontal line where the Inclined Picture Plane intersects the ground shown in Figure 2, as point I.L. The position of this line in Figure 3 is found as follows—

A vertical plane is set up through A. and C.V.R. by erecting a vertical line at N. where a line drawn from C.V.R. through A. cuts the Ground Line G.L. A line is then drawn from C.V. through A. to cut the vertical line at M. The intersection line of the Inclined Picture Plane with the Ground Plane is a horizontal line drawn through point M.

Distances such as A.B. at the base of a building are measured on this line from a measuring point M.P. The point M.P. is found by drawing an arc with V.P¹. as centre and V.P¹.–E. as radius to cut line V.P¹.–V.P². at M.P. Distances such as B.M.–A.M. are measured on the intersection line of the Inclined Plane by converging lines to M.P. The distance B.M.–A.M. on the intersection line represents the true length of A.B. in the perspective. A similar Measuring Point is set up on the left to measure horizontal lines vanishing to the right.

The heights of the building are measured on vertical Height Lines set up in similar fashion to the line H.L. The Measuring Point for all heights is H.M.P. This point is found by drawing an arc with V.P³. as centre and V.P³.–S. as radius. The distance X.Y. for example on the intersection line of the Vertical Plane is the true height of the edge of the building A.C.
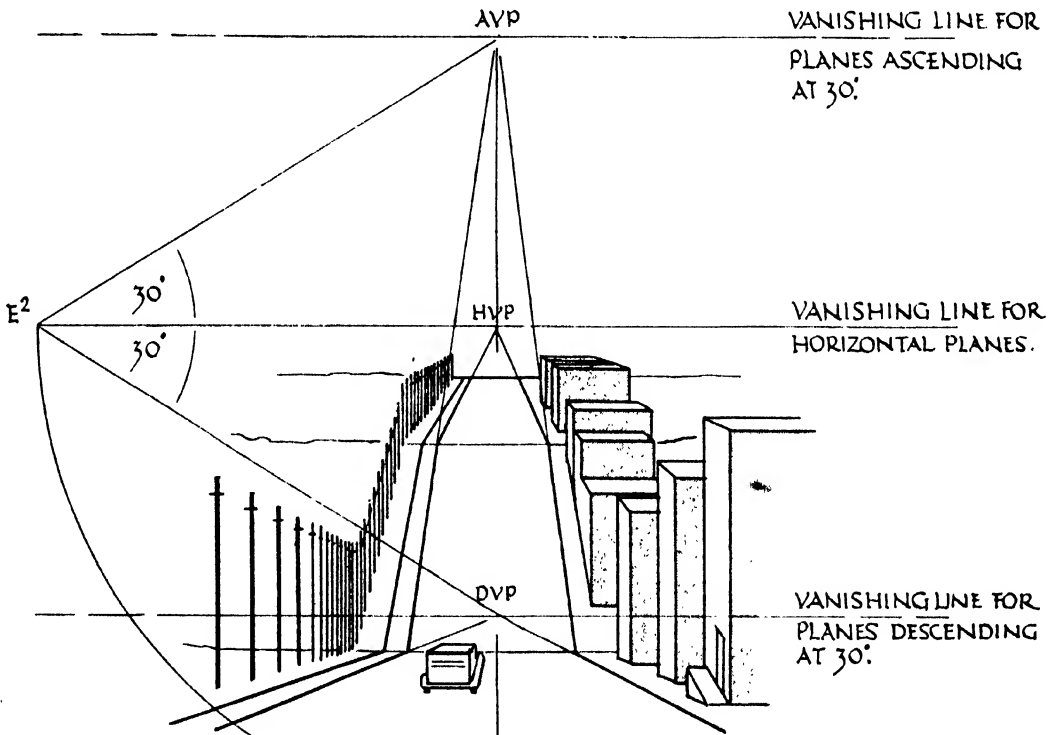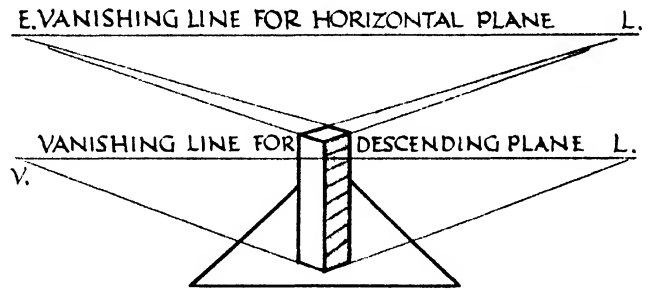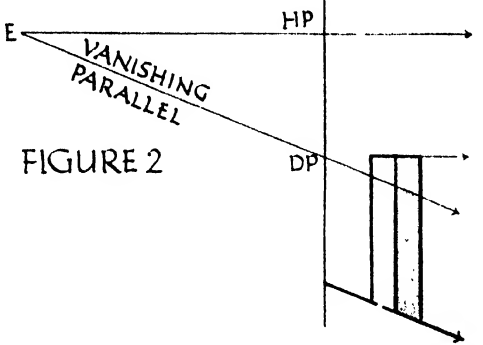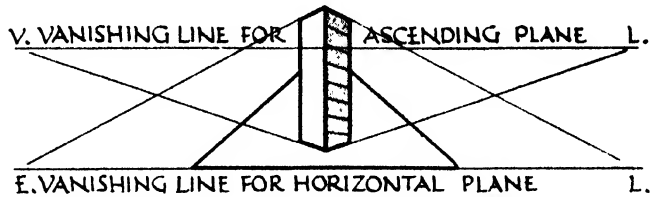
FIGURE 1

E VANISHING PARALLEL AP

HP

A

V. VANISHING LINE FOR        ASCENDING PLANE        L.

E. VANISHING LINE FOR HORIZONTAL PLANE        L.

E        HP

VANISHING PARALLEL

FIGURE 2        DP

E. VANISHING LINE FOR HORIZONTAL PLANE        L.

VANISHING LINE FOR        DESCENDING PLANE        L.

V.

AVP        VANISHING LINE FOR
PLANES ASCENDING
AT 30°.

E²        30°        HVP        VANISHING LINE FOR
HORIZONTAL PLANES.

30°

DVP        VANISHING LINE FOR
PLANES DESCENDING
AT 30°.

FIGURE 3.

E

DIAGRAM 11.

# BUILDINGS ON INCLINED PLANES

**Diagram 11.** When a building is set upon a sloping surface such as a hill-side it is necessary to find a Vanishing Line for the slope in addition to the Vanishing Line for the horizontal lines of the building.

Diagram 11, Figure 1, shows in section a building A. standing on a hill-side. The Vanishing Parallel of the hill-side intersects the Picture Plane at A.P. The Vanishing Parallel of the horizontal lines of the building, a horizontal line from the Eye to the Picture Plane, intersects the Picture Plane at H.P.

The resulting perspective is shown to the right of Figure 1. All horizontal lines vanish to E.L. but the lines where the building intersects the hill-side are drawn to the Vanishing Line of the hillside V.L.

Similarly when a building stands upon a descending hill-side as in Figure 2 it is necessary to draw vanishing lines for both horizontal lines and for lines in the plane of the downward slope.

The position of the two vanishing Lines is shown in this section at H.P. and D.P. The resulting perspective is shown on the right of Figure 2 where the building intersects a descending slope.

The distance between the two Vanishing Lines in each case will depend upon the angle of the slope with the horizontal plane. The parallel lines which converge on either side of the building in the perspectives Figures 1 and 2, are identical. It is only by the relationship of other perspective lines that they may express ascending or descending planes.

The method of finding where these Vanishing Lines occur in relation to the Horizontal Eye Level is shown in Figure 3.

The distance of the Eye from the Picture Plane, H.V.P.–E. is marked along the Eye Level to the left at $E^2$. The position of the Vanishing Line for any ascending Plane is found by setting the angle of the required slope above the Eye Level at $E^2$. and the position of the Vanishing Line for any descending plane by setting the angle of the required slope below the Eye level at $E^2$. as shown in Figure 3. The points where these angles cut the central axis of the perspective give the levels for the required Vanishing Lines A.V.P. in the case of the ascending plane and D.V.P. in the case of the descending plane. In the example shown the angle is in each case 30 degrees.

The perspective lines in Figure 3 therefore show a road which descends at first at 30 degrees, ascends an upward slope of 30 degrees and then becomes horizontal. The buildings at the side of the road share one Vanishing Point H.V.P. for all their horizontal lines. The buildings on the inclined planes have Vanishing Points at A.V.P. and D.V.P. in addition, for lines where the lower parts of the buildings intersect the inclined planes.

The varying heights of the posts on the left are also governed by these Vanishing Points.

In order to show all construction lines in this diagram the position of the Eye Point E. has been placed near to the Picture Plane with the resulting distortion and lack of scale explained in Diagram 3B, page 22.

# PART III
# SKETCHING IN PERSPECTIVE

## SKETCHING PERSPECTIVE EXTERIORS

**Diagram 12.** There are two uses for perspective in connexion with design. The first in which a perspective is set up from completed plans and elevations to explain the final appearance of the form to someone other than the designer. The second, and perhaps the more useful of the two to the designer, is the free perspective which is prepared in the course of the design. Ability to make such sketches calls for facility in applying the more obvious rules of perspective without reference to a plan or elevation.

It has been shown in Part II that the appearance of any form in perspective is governed not only by the fact that parallel lines appear to get nearer together, but also by the chosen level of the Eye of the observer, the distance of the Eye from the form, and the position of the Picture Plane.

It will be found that preliminary consideration of these points will be of great assistance in the case of the freehand sketch, and notes on perspective facility and composition are given in connexion with Diagrams 12 and 13.

In Figure 1, Diagram 12, the composition is unsatisfactory. The placing of the Eye Level divides the picture into two equal parts and the building itself presents two equal faces. The Vanishing Points are too near together, because the position of the Eye is too near to the building.

In Figure 2 these disadvantages are overcome by placing the Eye Level lower, or in other cases higher; by showing a greater width of one side of the building; by moving the Eye position farther away and thus placing Vanishing Points farther apart. The building is also larger compared with the picture area and therefore becomes more important in effect. It is placed slightly to the right so that the centre of its long façade occupies approximately the centre of the picture area.
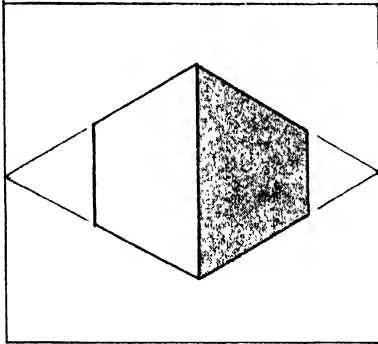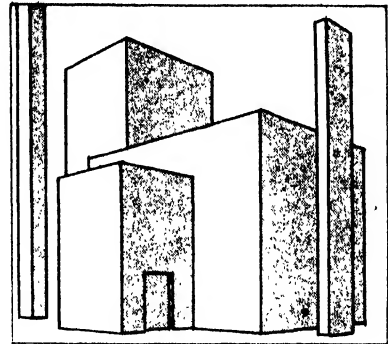
FIGURE 1

FIGURE 2

B

STRING

D

G

VP¹

EYE LEVEL

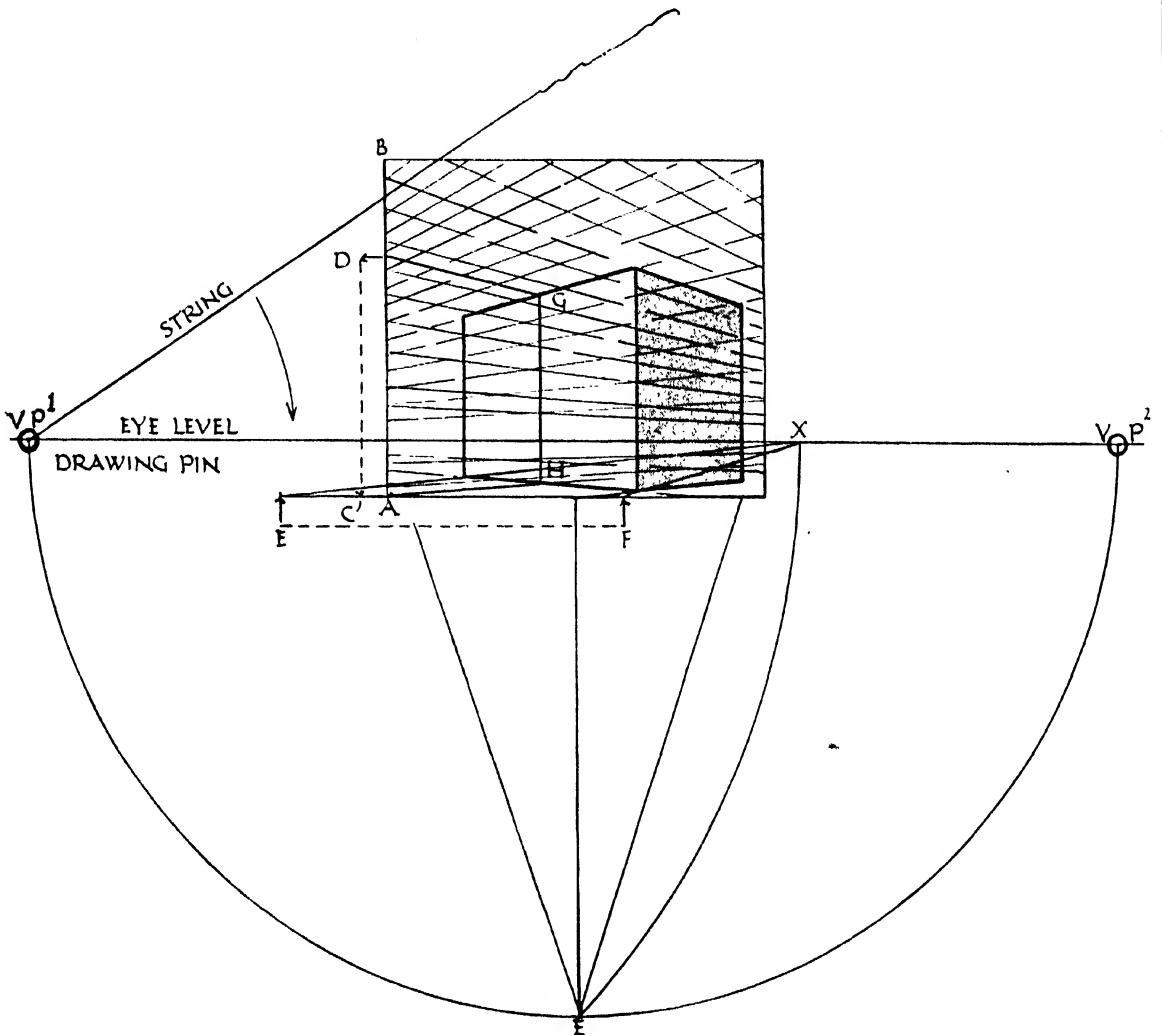DRAWING PIN

X

VP²

C' A

H

E

F

E

FIGURE 3.

DIAGRAM 12.

Figure 2, however, has the inevitable disadvantage of the "three-quarter" view; the eye is carried to the left or right, out of the picture and it is desirable to concentrate attention on the building. This may be accomplished in various ways. The effect of strong direction to the left may be checked by the introduction of vertical forms, while a mass on the right helps to neutralize the effect of the vanishing parallels on that side. It is advisable to make several preliminary sketches involving different compositions of both form and surroundings by varying the position of the Eye Level and the distance of the Eye and Picture Plane.

The nature of the accessory forms introduced will depend upon the character of the building and its surroundings. They should, however, remain accessory, their function being to emphasize and display the building rather than to compete in interest with it. For this reason natural forms such as trees and human figures are usually treated conventionally rather than realistically.

If we accept Figure 2 as the basis for our sketch the Eye Level is first drawn in Figure 3 and we discover that the Vanishing Points V.P$^1$. and V.P$^2$. will occur off the drawing board to right and left. It is important to fix the position of the two Vanishing Points because all horizontal lines on the building and in the background and foreground will meet at one or the other. How far should they be apart? As we have seen in Diagram 3B, page 22, the distance between Vanishing Points depends upon the distance of the Eye from the building, and if we have tentatively fixed V.P$^1$. and V.P$^2$. we may find the approximate distance of the Eye from the building by imagining a semicircle based upon these two points. If a vertical line be drawn from the centre of the Eye Level downwards to cut the semicircle, we shall have found point E. which is the approximate position of the Eye in plan with reference to the Picture Plane. In the present case, where the sides of the building vanish at 45 degrees to right and left, the distance of the Eye from the Picture Plane is accurately found by the above method. It is, however, sufficiently accurate for sketching any three-quarter view.

We may now judge whether the spectator is placed in a reasonable position with reference to the size of the building and its surroundings by confirming that the Angle of Vision made at point E. is not more than approximately 30 degrees. In so much as the Vanishing Points are inconveniently placed it will be best to draw a series of faint lines extending over most of the paper rather than to attempt to deal with each line in the building separately.

For this purpose the drawing board may be placed upon the floor. A piece of string is fixed with a drawing pin in each Vanishing Point position in turn and, being held tightly, is moved round as shown. A faint pencil line is made in each position; the taut string being used as a straight edge. A T-square or long rule may take the place of the string where the Vanishing Point is not too far distant.

The paper is now prepared and the draughtsman will superimpose the line of the building on selected faint lines and will add other lines, chiefly vertical. The faint lines may be removed in the latest stage of the drawing. Heights in the building may be compared with widths, as follows: The edge of the drawing A.B. may be used as a Height Line. Distance C.–D. is for instance the Height of the building at G.H. Widths may be judged by lines converging to a Measuring Point on either side. The accurate position for the Measuring Point is obtained by striking an arc with the Vanishing Point as centre, and the distance from the Vanishing Point to the Eye as radius, to cut the Eye Level. Thus X. is the Measuring Point for lines vanishing to V.P$^1$. The true relative width of the building shown is E.F.

The preparation suggested above is of short duration in practice and experience seems to show that even the most skilled draughtsman achieves a more convincing perspective by approaching his sketch in this pseudo-scientific manner. Knowledge of theory brings ability to judge the position of the Eye and Measuring Points with sufficient accuracy without actually fixing these points.
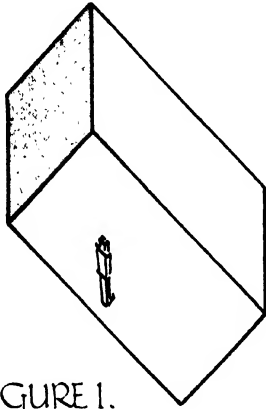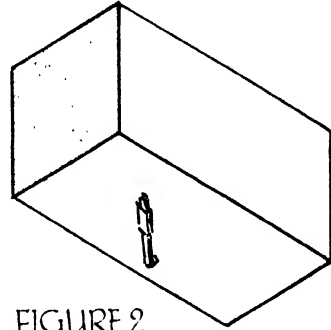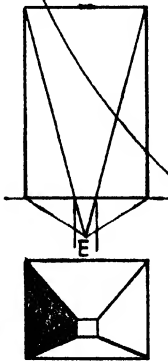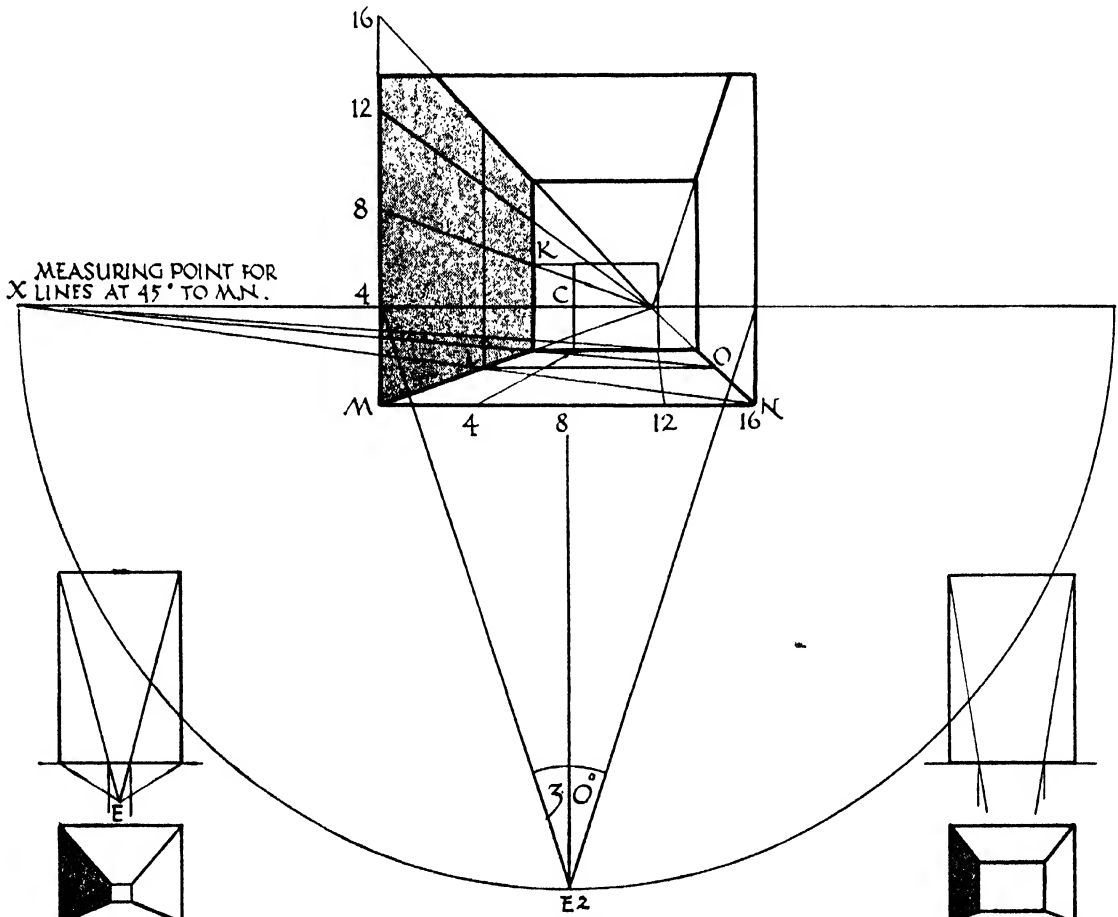
FIGURE 1.

FIGURE 2.

16

12

8

MEASURING POINT FOR
X LINES AT 45° TO M.N.

4

K

C

M    4    8    12    16 N

O

30°

E

E2

FIGURE 3.

V E¹

FIGURE 4.

DIAGRAM 13.

FIGURE 5.

48
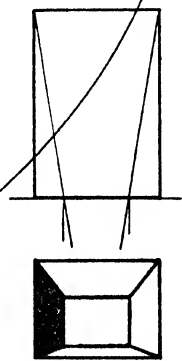
**Diagram 13.** The parallel perspective of an interior with one wall removed, as shown in Figure 3, Diagram 13, has advantages over the three-quarter view in Diagram 6, page 30; the axonometric (Figure 1) and the isometric (Figure 2), in that it is able to show three complete walls, floor, and ceiling.

In sketching a parallel perspective of this kind the widths and heights may be judged without difficulty but it is not easy to decide on the depth. An elementary knowledge of Measuring Points will overcome this difficulty, and provide an approximate means of measuring perspective depth. In Figure 3 the lower edge of the Picture is divided into units according to the required width of the room. On the left vertical edge divisions are marked of the same size. These divisions may represent units of 1, 2 or 3 feet at will. The proposed height of the room is marked on this vertical edge. The height may be greater than the height of the picture area as in this case. Lines are drawn to a chosen Centre of Vision, usually placed somewhat to the left or right of the centre for reasons shown in Diagram 12, Figure 1, page 46.

Experiment will show that with any given plan the depth of the room will vary according to the Eye position, irrespective of the room's actual size. The same room when projected from plan may appear as in Figure 4 when the Eye position is at E., or as in Figure 5 when the Eye position is at $E^1$. In the case of Figure 4 the appearance is of a very long room with no relationship to the room's actual dimensions because the Eye position is too near to the Picture Plane. In Figure 5 the Eye position is placed far enough away to limit the Visual Angle to approximately 30 degrees and the resultant perspective is more accurate.

It is therefore necessary to visualize an approximate position for the Eye before making any decision as to the depth of the room. The Eye Point is placed at a distance from the Picture Plane, on a line drawn at right angles to the Eye Level, sufficient to include the width of the Picture in 30 degrees. If this distance C.–$E^2$. be transferred to the Eye Level at X., the point X. is the Vanishing Point for all lines on the floor of the room at 45 degrees. A line drawn from the corner N. to this point will mark off the corner of a square on the floor of the perspective. Thus in the diagram, L.–M.–N.–O. is a square in perspective and L.–M. equals M.–N. It is now possible to divide the distance M.L. into the same equal number of parts as the ground line by further diagonal lines. A further line to X., the 45 degree Vanishing Point from point O., will mark another square on the floor and a scale of feet may thus be made into the third dimension of the room. As in the last example, the method is complicated by the need for Eye and Vanishing Points situated off the board, but knowledge of this principle and approximate accuracy will be found to justify the method. The setting up of a large number of vanishing lines by means of string or a long straight edge at the outset of the drawing as in Diagram 12, page 46, is recommended.

The position and height of the door, furniture, and fittings may be approximately judged. For instance the height of the opening on the back wall is 8 units, its width also 8 units.
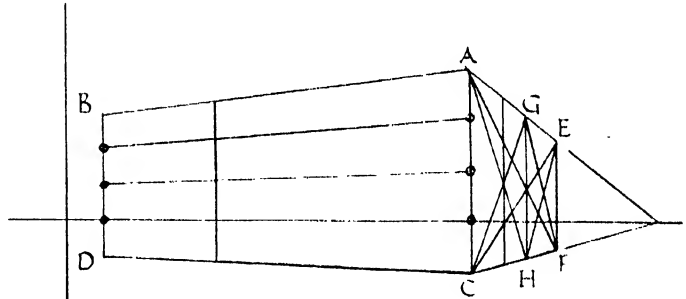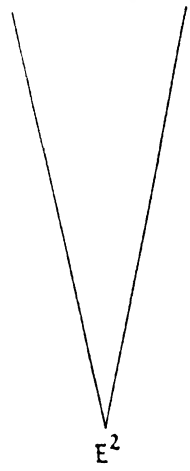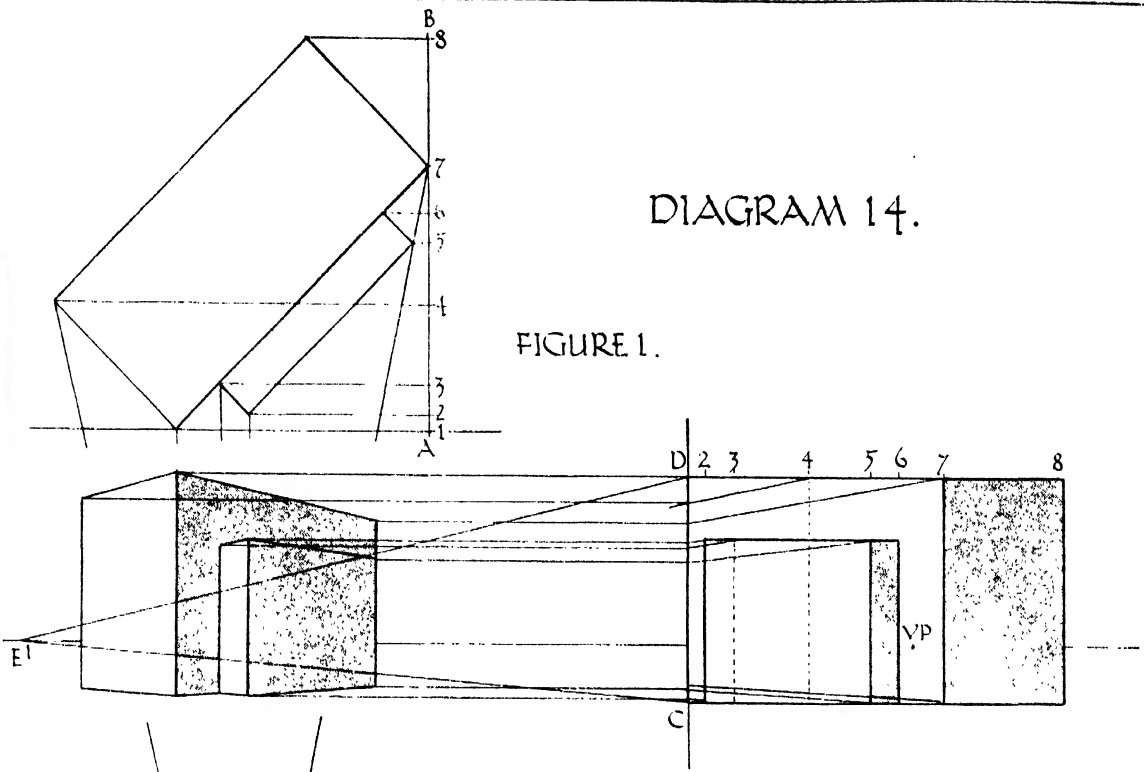
# DIAGRAM 14.

FIGURE 1.

FIGURE 2

EDGE OF
DRAWING
BOARD.

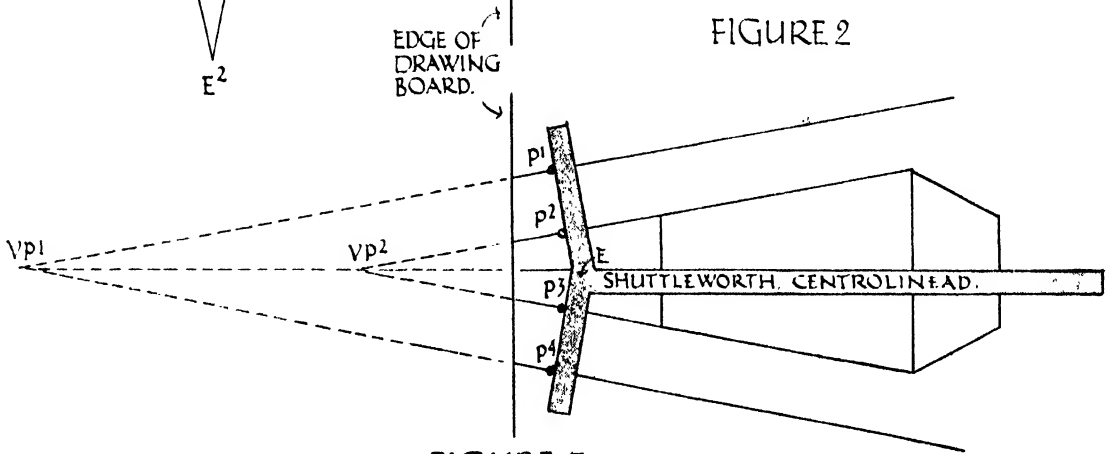SHUTTLEWORTH. CENTROLINEAD.

FIGURE 3.

# METHODS OF DEALING WITH VANISHING POINTS WHICH OCCUR OUTSIDE THE DRAWING AREA AVAILABLE

Much ingenuity has been shown in attempts to overcome the difficulty of the occasionally inaccessible Vanishing Point in perspective drawing. The following notes review such methods—

**Diagram 14**

**Method 1.—Figure 1.** No Vanishing Points are necessary if a special ($\frac{3}{4}$) side elevation of the Eye Point and the form is prepared. Figure 1 shows such an elevation on the right. The various widths 1, 2, 3, 4, etc., are found on the line A.B. in the plan and transferred to the elevation. These points are then projected on to the Picture Plane C.D. through the elevation of the Eye Point E¹. The level of each point on the Picture Plane is then transferred horizontally to the relevant vertical lines projected from plan to E². in the usual manner.

This method is good, for it solves all troubles in connexion with Vanishing Points. The necessity for a three-quarter side elevation, a drawing which must in nearly all cases be specially prepared, prevents its more frequent use.

**Method 2.—Figure 2.** Two vanishing parallels are first obtained by means of a long straight edge as A.B. and C.D. A vertical line, B.D., is then drawn at a convenient distance from the edge of the paper parallel with A.C., the vertical edge nearest to the Picture Plane.

B.D. and A.C. are divided respectively into an equal number of equal parts.

By joining pairs of corresponding points a series of Vanishing Parallels is produced. The result is a diminished scale on the left which may be further subdivided. Any number of further Vanishing Lines may then be drawn.

For the equal division of spaces on a vertical plane in perspective, diagonal lines may be drawn as A.F. and C.E. on the right of Figure 2. The point where such lines intersect is always the perspective centre of the space. C.H. and A.G. may be further divided by diagonals C.G. and A.H.

**Method 3.** A perspective projection small enough to include Vanishing Points on the same sheet is enlarged to the required size by squaring, or by taking off measurements with Proportional Compasses or set squares or by means of a Pantagraph.

*The Pantagraph* is based upon a parallelogram and consists of a frame jointed at the four corners. One point of the frame is fixed, while the rest of the frame may be freely extended and contracted so that when a tracer, which is fixed at one part of the frame, is guided along the lines of a drawing these lines are reproduced at a larger or smaller scale by means of a pencil fixed at another part of the frame.

The Pantagraph is, however, more successfully used to produce a smaller drawing from a larger one than vice versa.
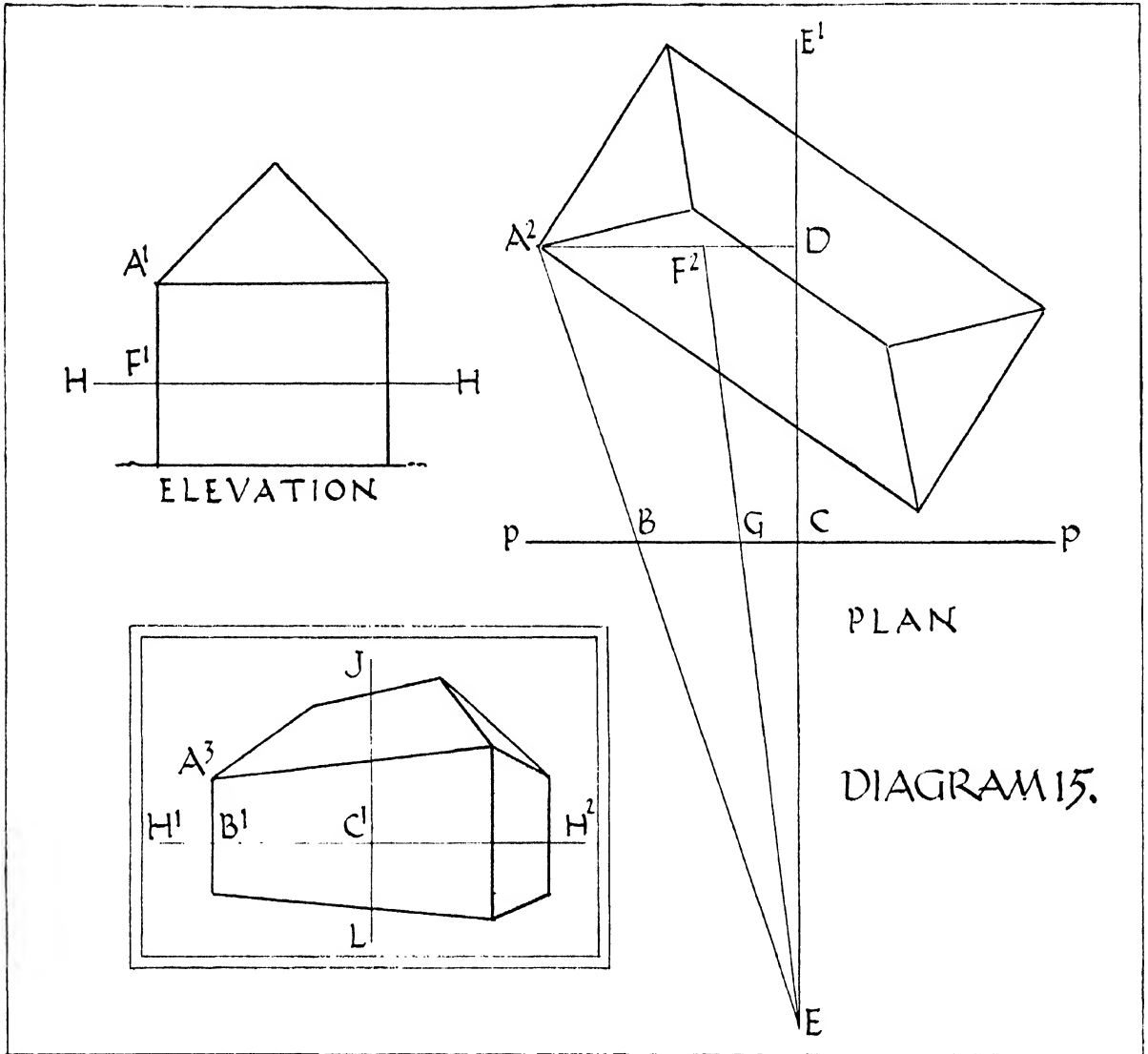
ELEVATION

PLAN

DIAGRAM 15.

**Method 4.** Yet another ingenious method whereby a perspective may be set up without Vanishing Points is that demonstrated by Mr. C. L. T. Griffith. It is shown in Diagram 15 by his kind permission.

The Central Visual Ray $E^1$.–C.–E. is drawn in the plan, and the vertical line J.–$C^1$.–L. and the Eye Level $H^1$.–$H^2$. are drawn in the perspective. The Eye Level H.–H. is drawn in the elevation.

To find the perspective position of plan point $A^2$. Join $A^2$. to E. in the plan. The line cuts P.–P. in B.

In the perspective, on the line $H^1$.–$C^1$.–$H^2$., make $B^1$.–$C^1$. equal to B.–C. in the plan.

Draw the line $A^2$.–D. in the plan at right angles to the line $E^1$.–E., and mark off along D.–$A^2$. from D. the distance D.–$F^2$., equal to the distance $F^1$.–$A^1$. taken from the elevation.

Draw the line F².–E. in plan, cutting the Picture Plane in G.

The distance G.–C. is the perspective height of point A¹. above the Eye Level, and it is now set up vertically above point B¹. in the perspective to give the required position of the point at A³.

The perspective positions of all other points may be found in similar fashion by measuring and projecting their heights above or below the Eye Level on either side of the Central Visual Ray in plan. No Vanishing points are thus used.

**Method 5.** *The Centrolinead.* The efficiency of various types of Centrolinead varies according to their complexity and expense. All are based on the principle illustrated in Figure 3, where the angular base of the T-square is moved in contact with the two fixed pins P¹. and P⁴. to give the converging lines which vanish to V.P¹. If the pins are placed nearer together as at P². and P³., the resulting lines would converge more rapidly to a nearer Vanishing Point, V.P².

This fixed Centrolinead is known as the Shuttleworth type.* Figure 3, Diagram 14.

If the two short arms are pivoted at E., the angle between them may be varied and the pins may be fixed at any convenient distance apart with similar results.

The calculation of the requisite angle at which these arms should be set in order to produce lines which would converge to a Vanishing Point at some given distance from the Centre of Vision is a complicated one. The angle may be decided upon by trial and error if only two Vanishing Lines are first drawn to the distant Vanishing Point, but this is unsatisfactory because the Centrolinead is used in order to avoid such inconvenience.

The difficulty may be overcome by drawing Vanishing Parallels to a reduced scale and marking the angular arms of the Centrolinead with divisions which correspond to this scale. The A.H. Centrolinead is so designed that it may be set to produce converging lines to Vanishing Points at any given distance, without the preliminary fixing of such points off the board.

Directions for setting and using this type of Centrolinead are given in the Appendix, page 54.

A further method of overcoming the inconvenience of the distant Vanishing Point is to prepare a series of charts showing typical Vanishing Lines for a limited number of Eye positions and Visual Angles. The method is that shown in Diagram 12, Figure 3, page 46, but the Vanishing Lines are ruled in as strong black lines and the equal spaces between them arranged according to some predetermined unit. The chart is placed under a fairly transparent sheet of drawing paper, so that chosen Perspective Lines may be traced through. It is possible to buy such charts already prepared and showing not only Vanishing Lines but also Measuring Lines for perspective widths and heights. Such charts are of undoubted convenience when used with knowledge of the basic laws of perspective. Each chart is, of course, limited to one Eye position and one Angle of Vision.

* *Drawing and Mathematical Instruments,* by William Ford Stanley.

# APPENDIX

## DIRECTIONS FOR USING THE "A.H." CENTROLINEAD

The chief advantage of the "A.H." Centrolinead is the simplicity of setting, as it is only necessary to fix two ordinary draper's pins in the Drawing Board in order to make a Perspective drawing, having a vanishing point which may be some considerable distance off the board. The "A.H." Centrolinead can be used for any number of vanishing points at the same time.

When set up for use the "A.H." Centrolinead is quite rigid, and cannot be put out of adjustment by an accidental blow. When not in use the blade is easily removed by undoing two thumb screws, and the instrument then occupies very little space.

The determination of the vanishing points is a very simple matter, and the following brief instructions will be sufficient to enable the user of the "A.H." Centrolinead to calculate the vanishing points for any perspective drawing.

In Fig. 1, the shaded portion represents the plan of a house, P.P. being the picture plane, and S. the station point of the observer, 41 in. from C. (the centre of vision), C.S. being at right angles to P.P. To find the vanishing points, draw lines through $s$ parallel to the sides of the building, and also to the angles of the bay window. The points of intersection of these lines with P.P. are the required vanishing point. One vanishing point, $v^1$, and one diagonal point $d^1$ are simple to find, but the determination of the other two is complicated by the fact that they occur off the drawing board.
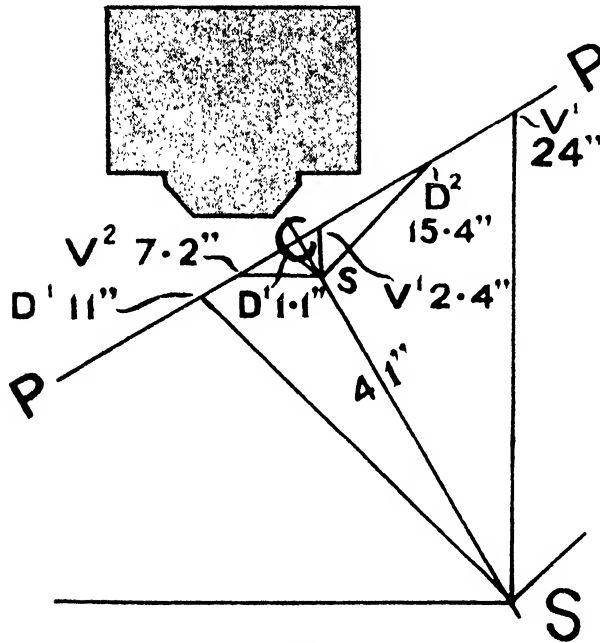
Fig. 1

This difficulty is easily overcome by making the diagram to a reduced scale (one-tenth full size being the most convenient). The head of the "A.H." Centrolinead being divided to inches and tenths may be used for this purpose.

Instead of S. 41 in. from C., we now have $s$ 4·1 in. from C. By drawing the parallel lines through $s$ the one-tenth scale vanishing points are obtained, measured from C., at 7·2 in., 1·1 in., 2·4 in. and 15·4 in. Multiplied by 10 the actual vanishing points are thus, to the left of C., $v^2 = 72$ in., $d^1 = 11$ in., and to the right of C., $v^1 = 24$ in., $d^2 = 154$ in.

Having obtained the vanishing points the "A.H." Centrolinead is used as follows—

Fig. 2 shows a sheet of paper pinned to an Imperial size Drawing Board. Draw the horizontal line at a suitable height, and the vertical line, the two intersecting at the centre of vision $c$, also mark $d^1$, 11 in. to the left of $c$. $v^1$, 24 in. to the right of $c$, is off the board. To fix the two pins for working the Centrolinead to $v^1$, set the working edge of the blade to the horizon, with the head to the extreme left of the board. Measure the distance from $c$ to the zero of the *left*-most scale in this case 15½ in., and *add* this to the 24 in. from $v^1$ to $c$, the total being 39½ in. Now put a pin at 39½ in. above, and another at 39½ in. below the horizon against the left-most scale. To avoid confusion mark both these points $v^1$ (39½). By

working the Centrolinead up and down against these two pins, all lines drawn against the working edge will converge towards the vanishing point $v^1$. To set the instrument for $v^2$ (72 in.) to the left of $c$, proceed as before, but move the head about 1 in. to the right, away from the pins already fixed, in order to allow for the free movement of the Centrolinead between both pairs of pins.

Measure the distance from zero of the *right*-most scale to $c$, in this case 11 in., and deduct from the 72 in. from $v^2$ to $c$, giving 61 in. Place the two pins at 61 in. below and 61 in. above on the right-most scale, and mark the two points $v^2$. The Centrolinead used against these pins will give lines converging on the inaccessible point $v^2$. Finally $d^2$, 154 in. to the right of $c$, has to be dealt with. The method is the same as in the case of $v^1$, but as the vanishing point is rather far away the *in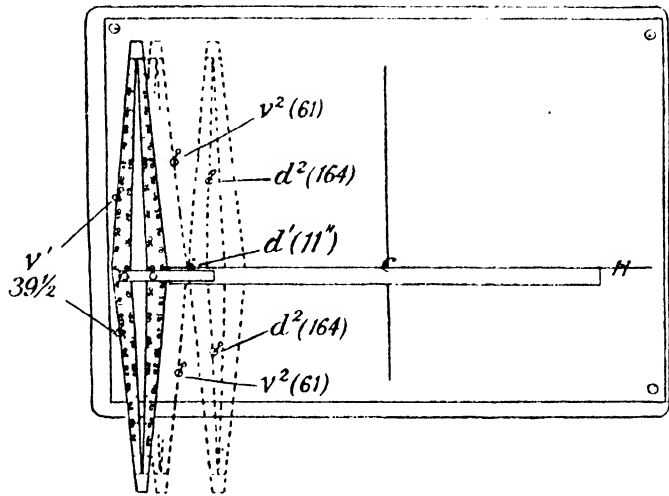ner left*-most scale is used. Placing the head again a little to the right of the pins already fixed, the distance from zero of *inner left*-most scale to $c$ is 10 in., adding this to 154 in. (from $d^2$ to $c$) gives a total of 164 in. The pins are therefore fixed at 164 above and below on the *inner left*-most scale and marked $d^2$.



Fig. 2

When using the pins for $v^1$, it is apparent that the higher up that the instrument is used on the drawing the nearer zero approaches the upper pin. Obviously zero must not be allowed to pass this pin, therefore just before zero is reached the pins should be reversed, e.g. suppose the upper pin is at 10 in., take out the pin and place at 10 in. below—the bottom pin will now be at $68\frac{3}{4}$ in., and must be moved to $68\frac{3}{4}$ in. above. This reversal of the pins may, of course, be repeated as often as required. It will be noticed that the aluminium bridge joining the head of the instrument to the blade is "hooped," this is to allow the head to pass the pin, allowing the operation just described to be even further simplified, i.e. the upper pin is brought to zero and only the lower pin is moved.
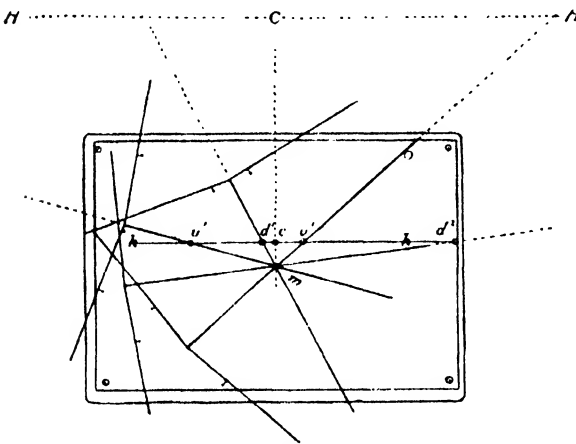
Fig. 3 shows the method of dealing with estates and the like, where not only the vanishing points, but also the horizon is off the board. In this case a one-tenth scale diagram is drawn lightly in the centre of the board. This diagram is only required for the initial stages and may then be erased. For convenience the same vanishing points as in Fig. 1 are used. H.H. is the horizon about 10 in. above top of the drawing board. Suppose it is 22 in. above $m$ (the centre of the board), then $hh$ the one-tenth horizon will be 2·2 in. from $m$. On this horizon mark off the one-tenth scale vanishing points as given by Fig. 1. By joining these points to $m$, one-tenth of the actual distances of the vanishing points from $m$ to H.H. is obtained and also the directions of the various vanishing lines. Now fix the pins as already described, using the right-hand scales for the left-hand points (and adding the distance from zero to



Fig. 3

# APPENDIX

*m* to the scaled dimensions), and the left-hand scales for right-hand points (subtracting the distance from zero to *m* to the scaled dimensions).

Fig. 4 shows the method of dealing with the sloping lines of a classical pediment. These lines have their vanishing points an equal distance above and below the ordinary vanishing
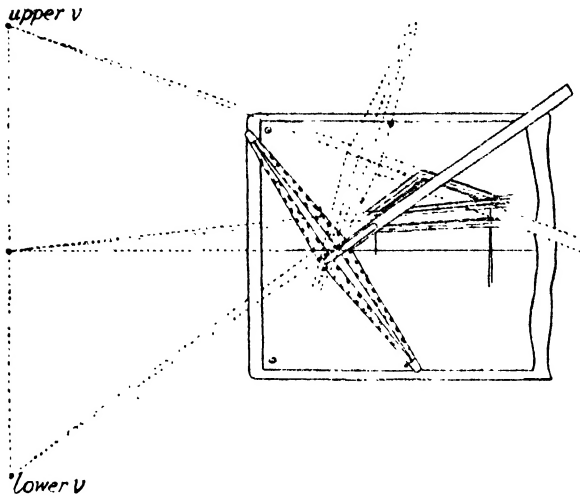


upper V

lower V

FIG. 4

upper v'

Pitch of pediment

v'

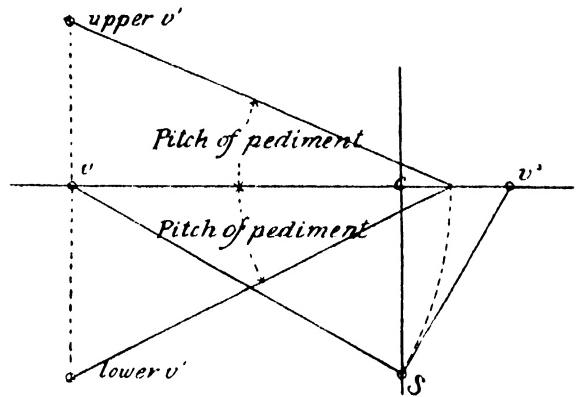Pitch of pediment

lower v'

v'

S

FIG. 5

point. The way in which these vanishing points are obtained is shown in Fig. 5, and requires no further explanation.

*The above information in connexion with "A.H." Centrolinead is supplied by Messrs. W. H. Harling, Ltd., 117 Moorgate, London, E.C.2, to whom due acknowledgment is made.*