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Technical drawings — Projection methods —

Part 4:
Central projection

Dessins techniques — Méthodes de projection —

Partie 4: Projection centrale

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 5456-4 was prepared by Technical Committee ISO/TC 10, *Technical drawings, product definition and related documentation*, Subcommittee SC 1, *Basic conventions*.

ISO 5456 consists of the following parts, under the general title *Technical drawings — Projection methods*:

— *Part 1: Synopsis*

— *Part 2: Orthographic representations*

— *Part 3: Axonometric representations*

— *Part 4: Central projection*

Annexes A and B of this part of ISO 5456 are for information only.

Introduction

Central projection (perspective) is a realistic pictorial representation obtained by projecting the object to be represented from a point at finite distance (projection centre) on a single projection plane (normally the drawing surface). Central projection provides excellent visual appearance of the object (monocular vision) and is often used in architectural drawings.

Technical drawings — Projection methods —

Part 4:
Central projection

1 Scope

This part of ISO 5456 specifies basic rules for the development and application of central projection in technical drawings.

2 Normative reference

The following standard contains provisions which, through reference in this text, constitute provisions of this part of ISO 5456. At the time of publication, the edition indicated was valid. All standards are subject to revision, and parties to agreements based on this part of ISO 5456 are encouraged to investigate the possibility of applying the most recent edition of the standard indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 10209-2:1993, *Technical product documentation — Vocabulary — Part 2: Terms relating to projection methods.*

3 Definitions

For the purposes of this part of ISO 5456, the definitions given in ISO 10209-2 and the following definitions apply.

3.1 alignment line: Line parallel to a given line passing through the projection centre. Its intersection with the projection plane gives the vanishing point of all lines parallel to the given line.

3.2 height of projection: Vertical distance of the projection centre from the basic plane.

3.3 horizontal distance: Distance between the projection centre and the projection plane.

3.4 projection angle: Angle formed by the projection plane and the horizon plane.

3.5 scale point: Vanishing point of the horizontal direction orthogonal to that bisecting the angle formed by the horizon line and the alignment line of the given horizontal line, and allowing the true length of the projection of the given line to be determined.

3.6 station of observation: Orthogonal projection of the projection centre onto the basic plane.

4 Symbols

Letter symbols for terms used in central projection are given in table 1 and illustrated in figures 1 and 2, as well as in the figures mentioned in table 1.

Table 1 — Letter symbols

No.	Term	Letter symbol	Figure
1)	Projection plane	T	1
1)	Basic plane	G	1
1)	Basic line	X	1
3.4	Projection angle	β	5
1)	Horizon plane	HT	1
1)	Horizon line	h	1
3.1	Alignment line	VI	4
1)	Main point	C	1
1)	Vanishing point	V	4
1)	Main projector	pL	1
1)	Projection centre	O	1
3.2	Height of projection	H	1
3.3	Horizontal distance	d	1
1)	Vision cone	K	2
1)	Circle of vision	Ks	3
1)	Vision angle	α	2
1)	Projector	PI	3
1)	Distance point	DP	13
3.5	Scale point	MP	14
3.6	Station of observation	Sp	1
1) Terms already defined in ISO 10209-2.			

5 Central projection methods

The mode of the central projection depends on the position of the object to be represented with respect to the projection plane.

For possible positions and applicable projection methods, see 5.1 to 5.4.

5.1 One-point method

A one-point projection method is a central projection of an object having its principal face parallel to the projection plane (special position). All parallel outlines and edges of the object which are parallel to the projection plane retain their direction in this represen-

tation (horizontal lines remain horizontal and vertical lines remain vertical). All lines perpendicular to the projection plane converge at the vanishing point, V, coinciding with the main point, C, (see figure 3 and 7.2.1 and 7.3).

5.2 Two-point method

A two-point projection method is a central projection of an object having its vertical outlines and edges parallel to the projection plane (particular position). All horizontal lines of a representation converge at multiple vanishing points V_1, V_2, V_3, ..., on the horizon line (see figure 4 and 7.2.2 and 7.4).

5.3 Three-point method

A three-point projection method is a central projection of an object having no outlines or edges parallel to the projection plane (any position). If the projection plane is inclined towards the projection centre, i.e. $\beta > 90°$, the vanishing point for vertical lines is situated below the horizon line (see figure 5 and 7.5.1 and 7.5.2).

5.4 Coordinate method

Representation by the coordinate method is based on simple proportions.

The coordinates, related to the main projector of all relevant points of the object to be represented, are taken by the graphic method from the basic plane and elevation. From these point coordinates, the image coordinates are obtained by a calculation method and entered to scale. The image points are connected to each other to provide a clear representation of the object (see figure 6).

6 Principle

6.1 Location and position of the projection plane

The image size of an object can be varied by parallel shifting of the projection plane. If the object is placed in front of the projection plane, the representation will be enlarged. The object behind the projection plane will result in a smaller image. Figure 7 shows the change in image size depending on the position of the object with respect to the projection plane.

Figure 8 shows the change in image size depending on the method of representation with vertical or inclined projection planes. β is the included angle between the projection plane and the basic plane near the projection centre.
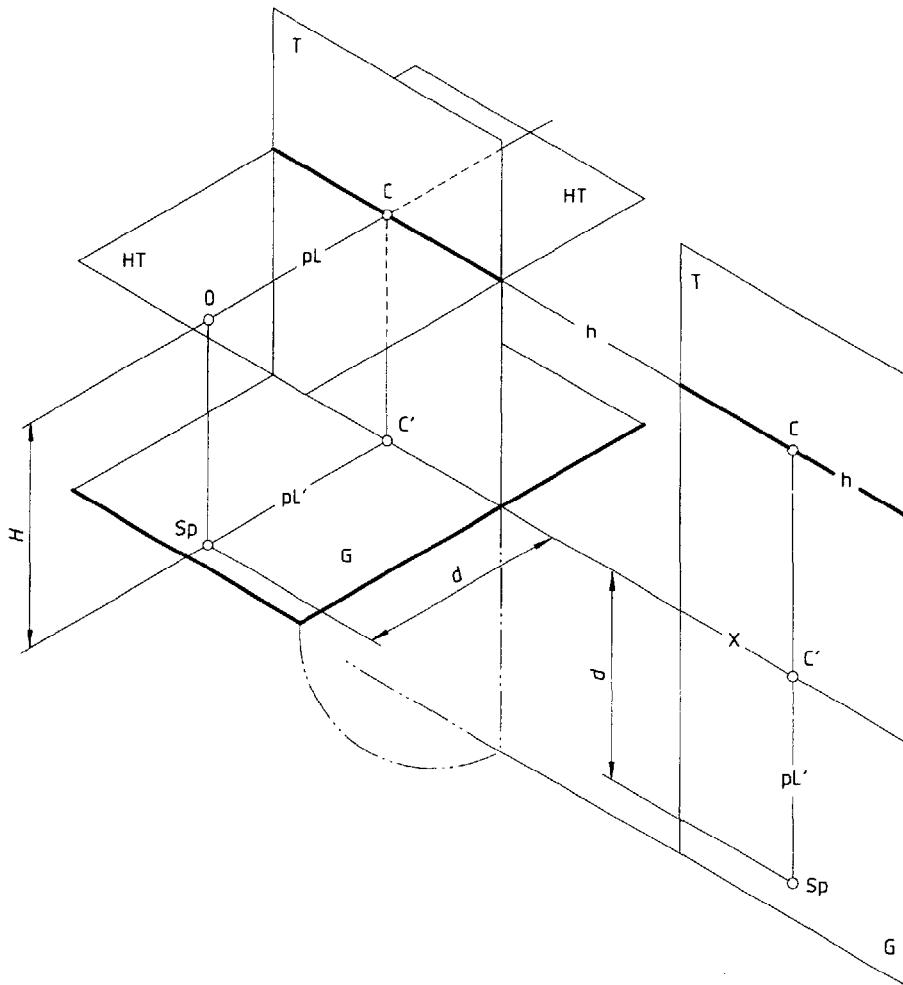
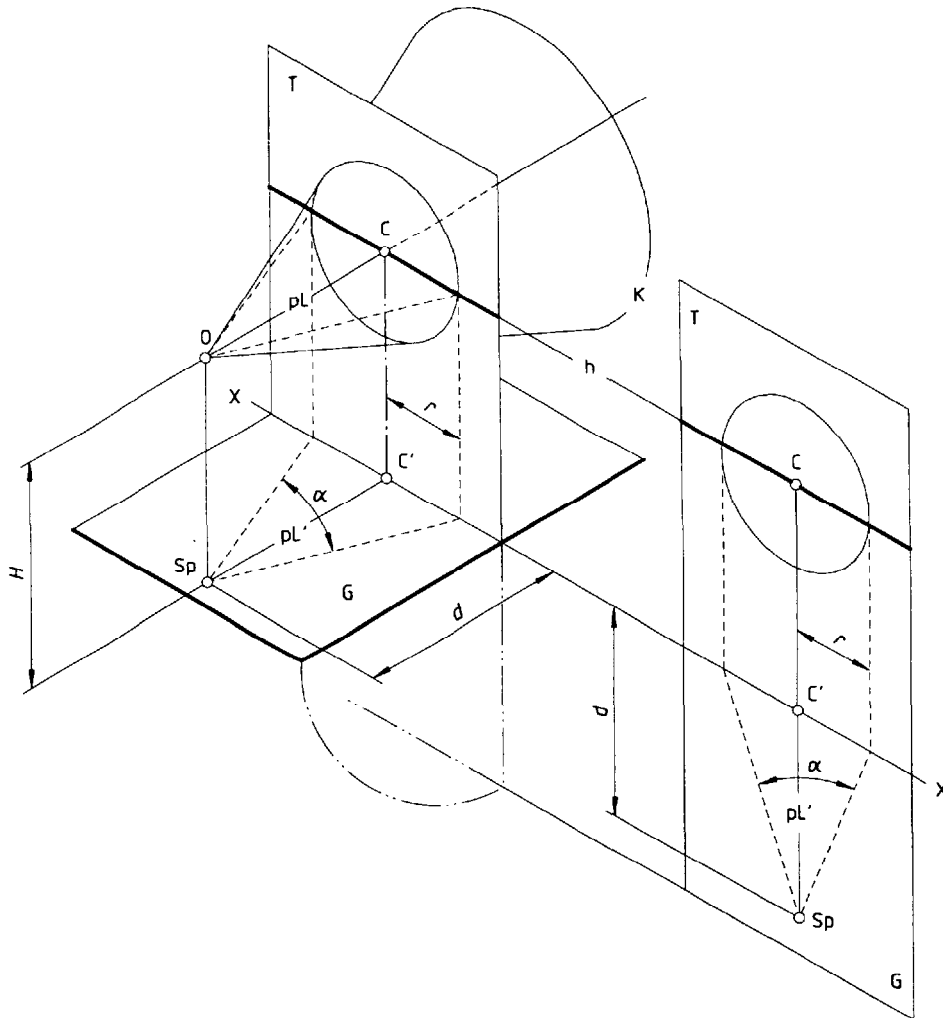**Figure 1 — Projection model of the central projection**

Figure 2 — Vision cone and vision angle in the projection model of the central projection
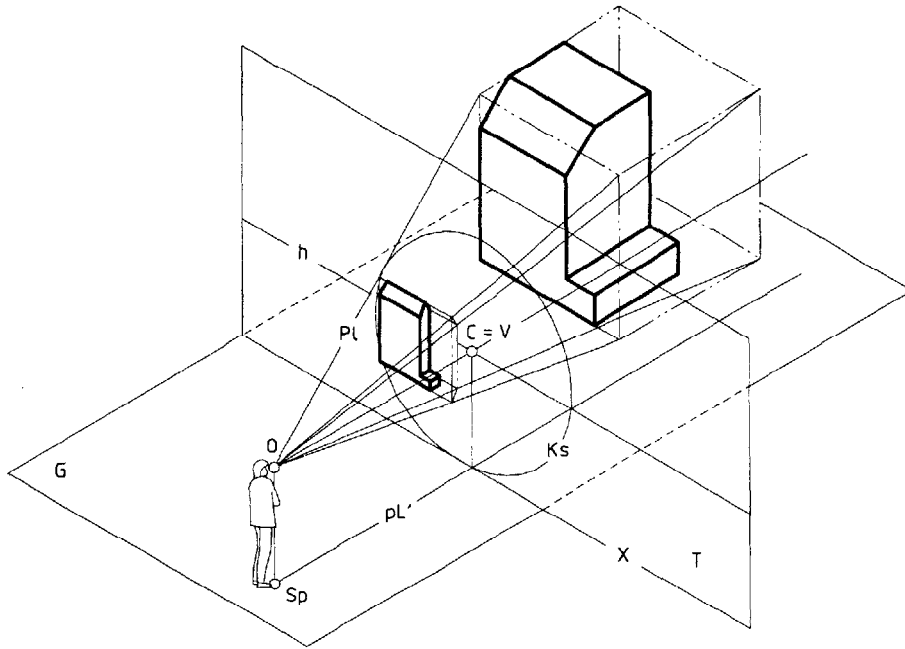
Figure 3 — Projection model with vertical projection plane and an object in a special position with respect to the projection plane
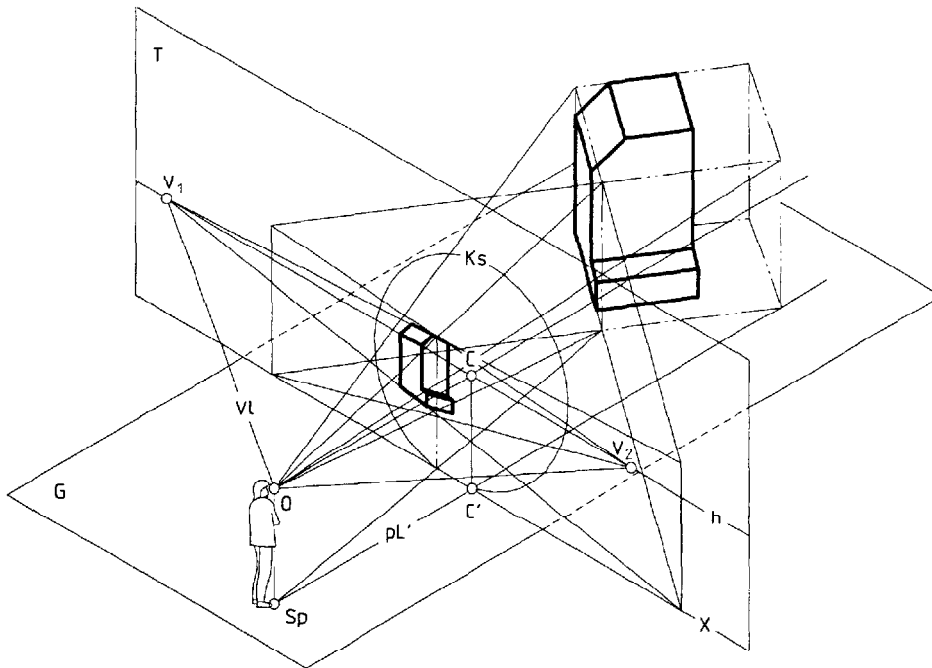

Figure 4 — Projection model with vertical projection plane and an object in a particular position with respect to the projection plane
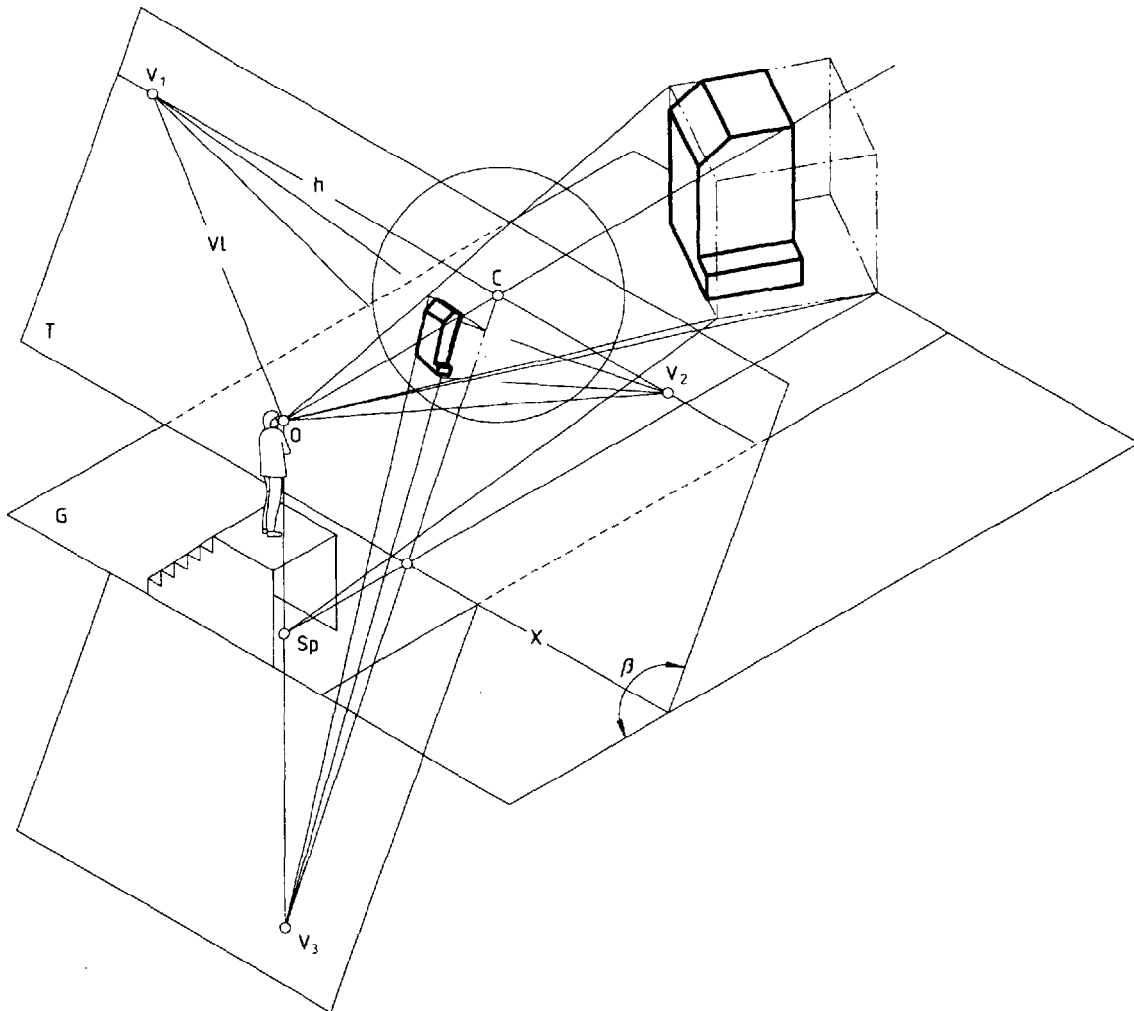
Figure 5 — Projection model with inclined projection plane and an object in any position with respect to the projection plane ($\beta > 90°$)
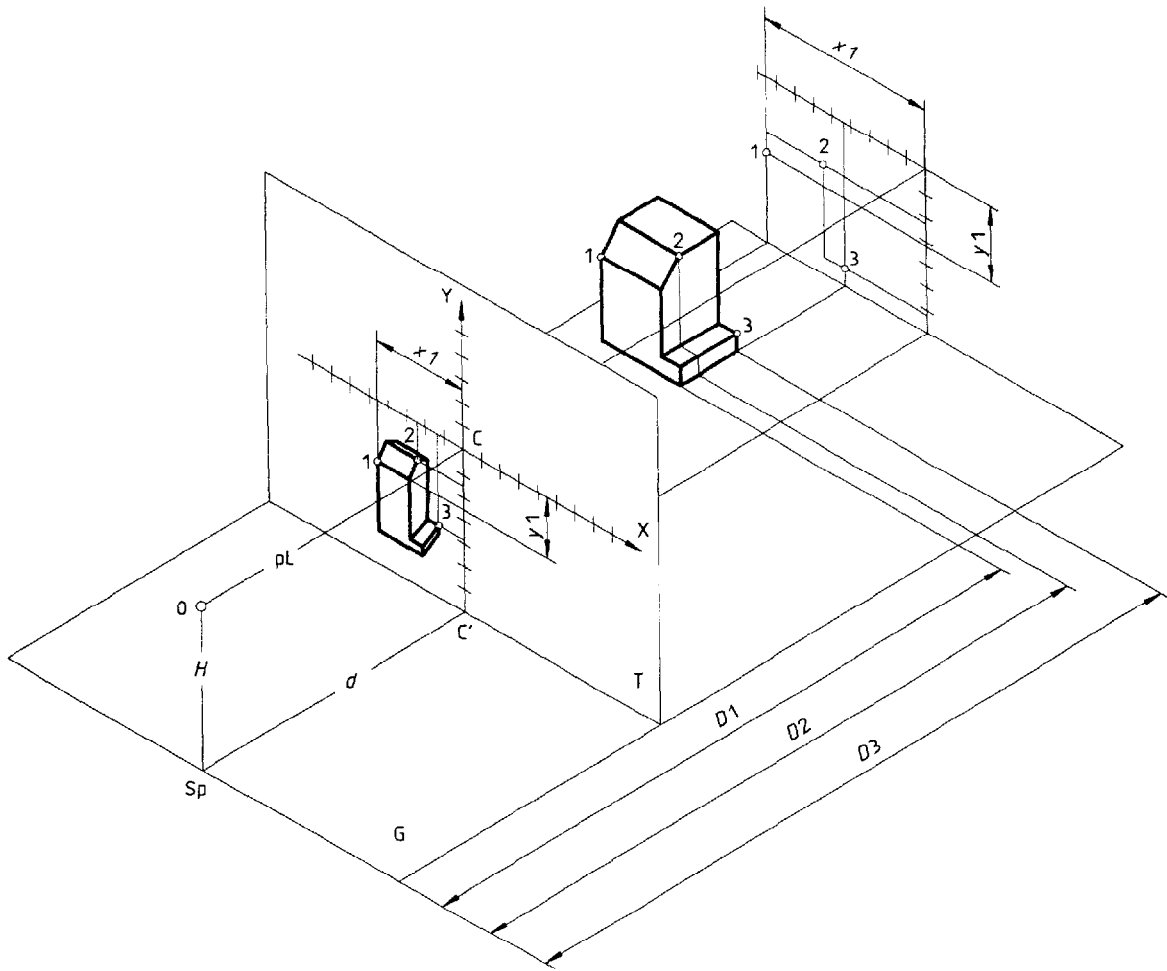
Figure 6 — Projection model with vertical projection plane and an object in special position, showing the lengths used in the mathematical formula for calculation of the perspective image
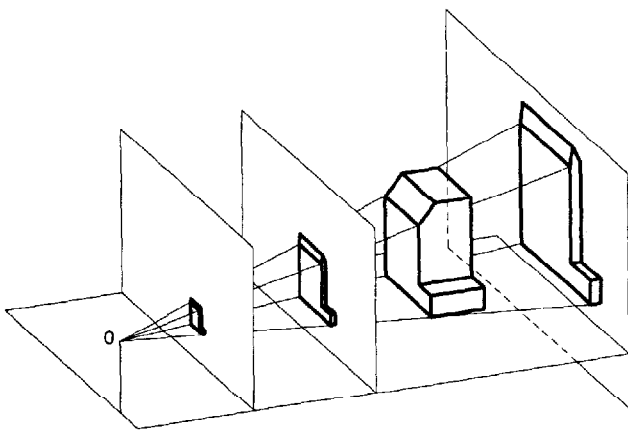
Figure 7 — Location of projection planes
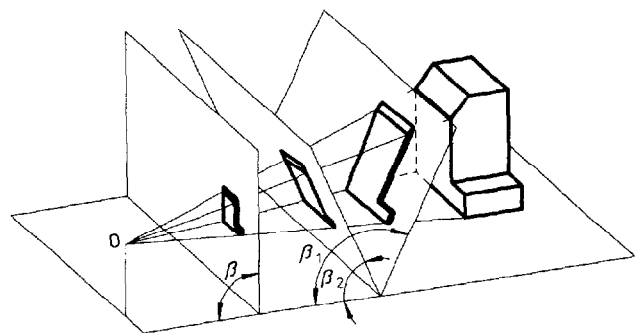
$\beta = 90°$, $\beta_1 > 90°$; $\beta_2 < 90°$

Figure 8 — Position of projection planes

6.2 Circle of vision and vision cone

To obtain a fully instructive image of an object without peripheral distortions on the projection plane, the object must be positioned within a vision cone having an aperture angle not greater than 60°.

Heavy peripheral distortions occur on images outside the circle of vision; the image does not appear fully instructive since length, width and height do not match the object's inherent proportions (see figure 9).

An object can be depicted nearly undistorted if the projectors result in a bundle of rays inclined not more than 30° with respect to the main projector. At this aperture angle the vision cone provides only a small distortion on the projection plane.
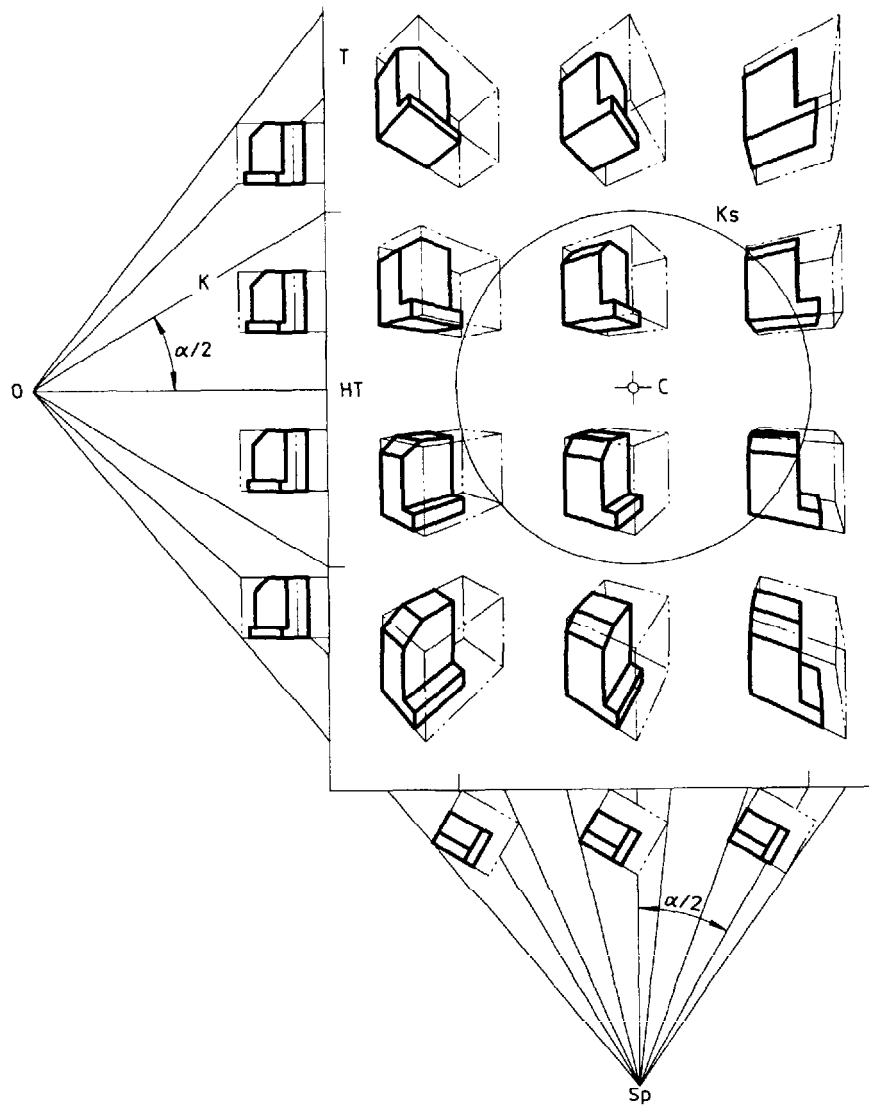
Figure 9 — Object, framed in a cube, within and outside the circle of vision

The main projector should hit the object to be depicted in a part which is visually important, so that the object is contained within the minimum vision cone.

6.3 Distance

Different relative distances influence the image size and its appearance. When the distance between the object and the projection plane is fixed and the projection centre and the object lie on opposite sides of the projection plane, increasing the distance (d) between the projection centre and the projection plane gives enlarged and flattened representations. When the distance (d) is fixed and the object and the projection centre lie on opposite sides of the projection plane, increasing the distance between the object and the projection plane gives reduced and flattened representations.

7 Principles and methods of depiction

7.1 Piercing method

Using the piercing method, the piercing points of projectors with the projection plane are shown by basic plane and elevation, and may be determined either by drawing or by calculation (see figure 10).

The piercing method allows even complex objects (round shapes, helicoids, etc.) to be easily represented in central projection.
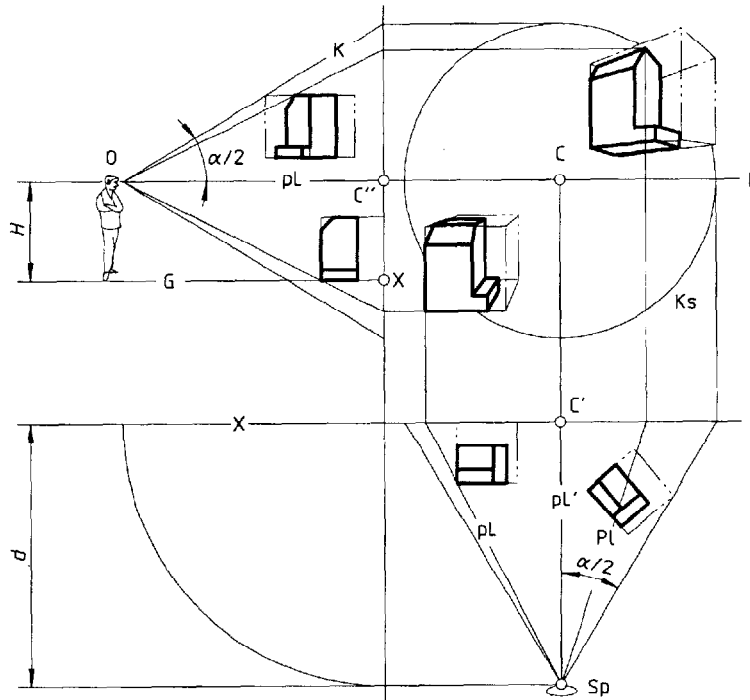

Figure 10 — Projection model turned into the drawing surface with side view

7.2 Trace point — vanishing point methods

With the trace point — vanishing point methods, the outlines and edges of the object to be depicted are imaged from basic plane and elevation.

7.2.1 Trace point — vanishing point method A
(special position of the object)

In method A, one vertical face of the object is parallel to the vertical projection plane (special position of the object with respect to the projection plane), so that the vanishing point for those edges parallel to the

projection plane is situated at infinity and the vanishing point for those edges perpendicular to the projection plane is the main point (see figure 11).

7.2.2 Trace point — vanishing point method B
(particular position of the object)

In method B, horizontal faces of the object are perpendicular to the vertical projection plane (particular position of the object with respect to the projection plane) so that the lines are represented by their trace on the projection plane and by their vanishing point (see figure 12).
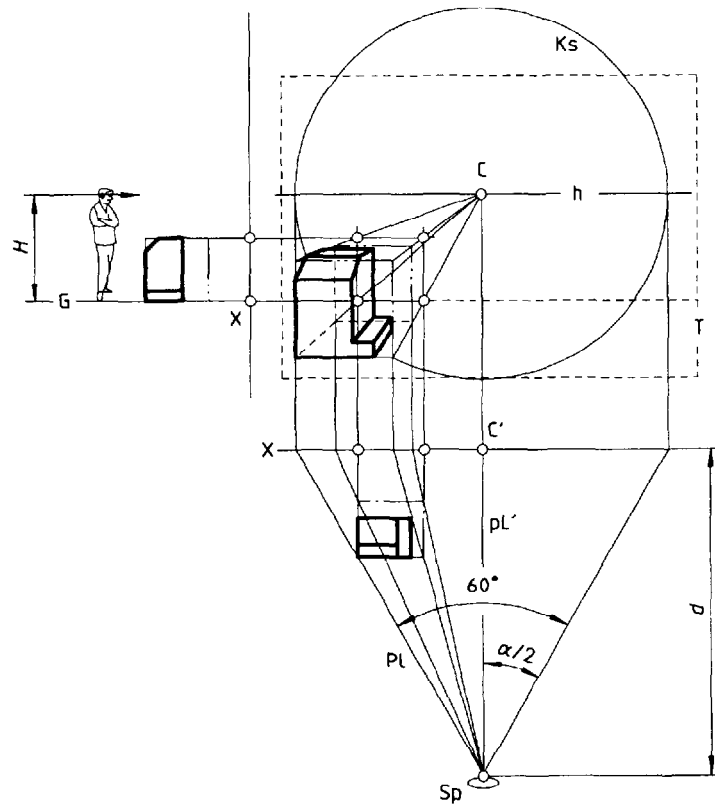
Figure 11 — Object, framed in a cube (indicated by a double-dashed line), in special position with respect to the projection plane according to method A
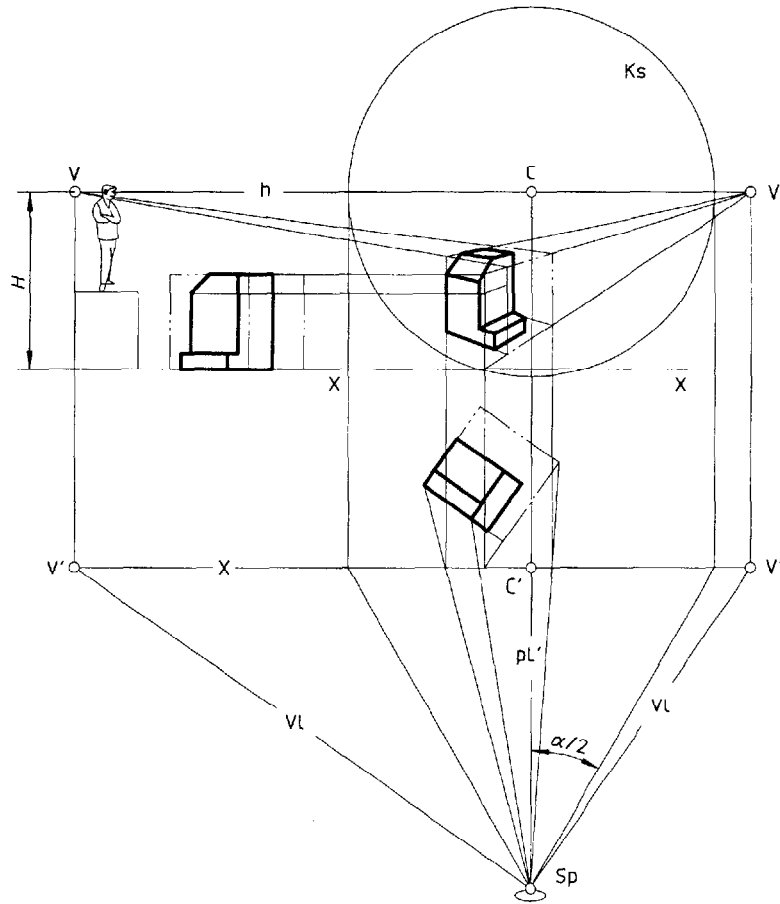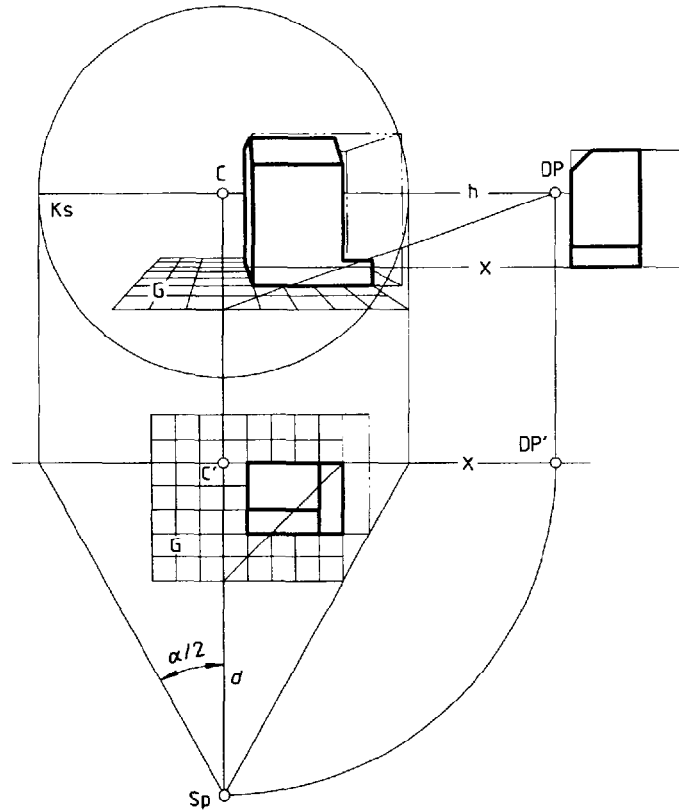
Figure 12 — Object, framed in a cube (indicated by a double-dashed line), in particular position with respect to the projection plane according to method B

7.3 Distance point method
(special position of the object)

The distance point method gives the central projection of an object without its basic plane, by setting up a perspective grid. The outlines and edges are parallel or perpendicular to the projection plane (special posi-tion). The distance point has the same distance from the main point as the projection centre from the projection plane. All horizontal lines inclined at 45° with respect to the projection plane align to the distance point. The vanishing point of the depth lines of the grid is the main point (see figure 13).

Figure 13 — Object, framed in a cube (indicated by a double-dashed line), in special position with respect to the projection plane

7.4 Scale point method
(particular position of the object)

For any vanishing point there is a corresponding scale point. With the aid of scale points, certain dimensions of the object to be depicted may be transferred from the basic line in the projection plane on depth lines (see figure 14). By means of the basic plane, a definite relation between the perspective representation of the object and the object itself may be established.
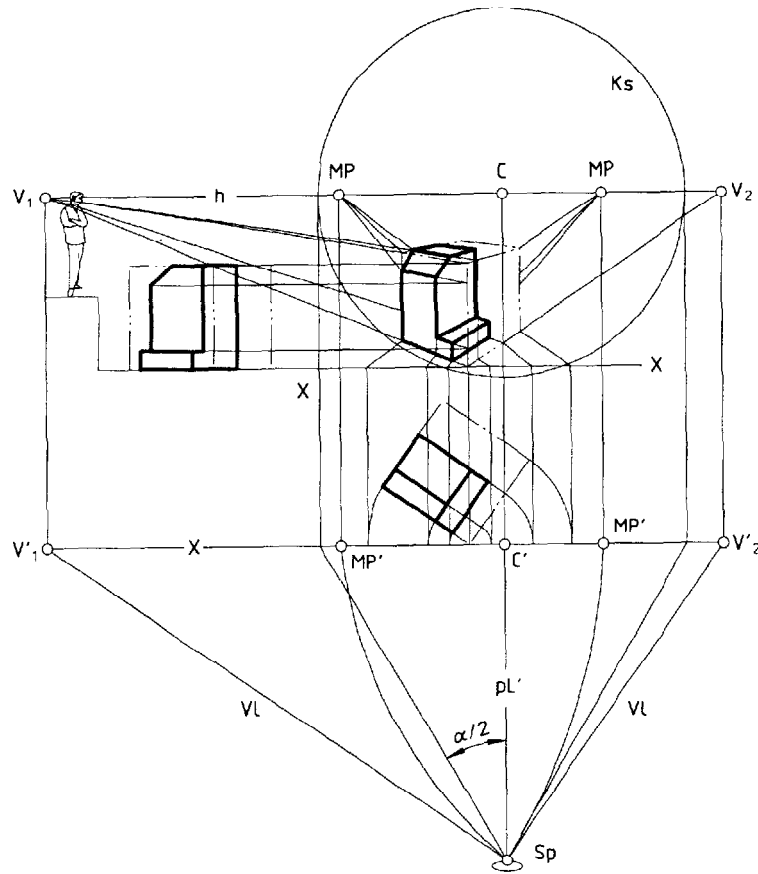

Figure 14 — Object, framed in a cube (indicated by a double-dashed line), in particular position with respect to the projection plane

7.5 Trace point method with inclined projection plane

7.5.1 Inclined projection plane $\beta < 90°$

Due to the inclination of the projection plane with respect to the horizon plane, the vanishing point for the vertical lines of the object to be depicted moves from infinite to finite. The angle β, i.e. the angle of inclination of the projection plane with respect to the horizon plane, defines the position of the vanishing point above the horizon. Vertical object lines are represented as tilting lines, which gives an optical distortion suggesting a tapering form (see figure 15).
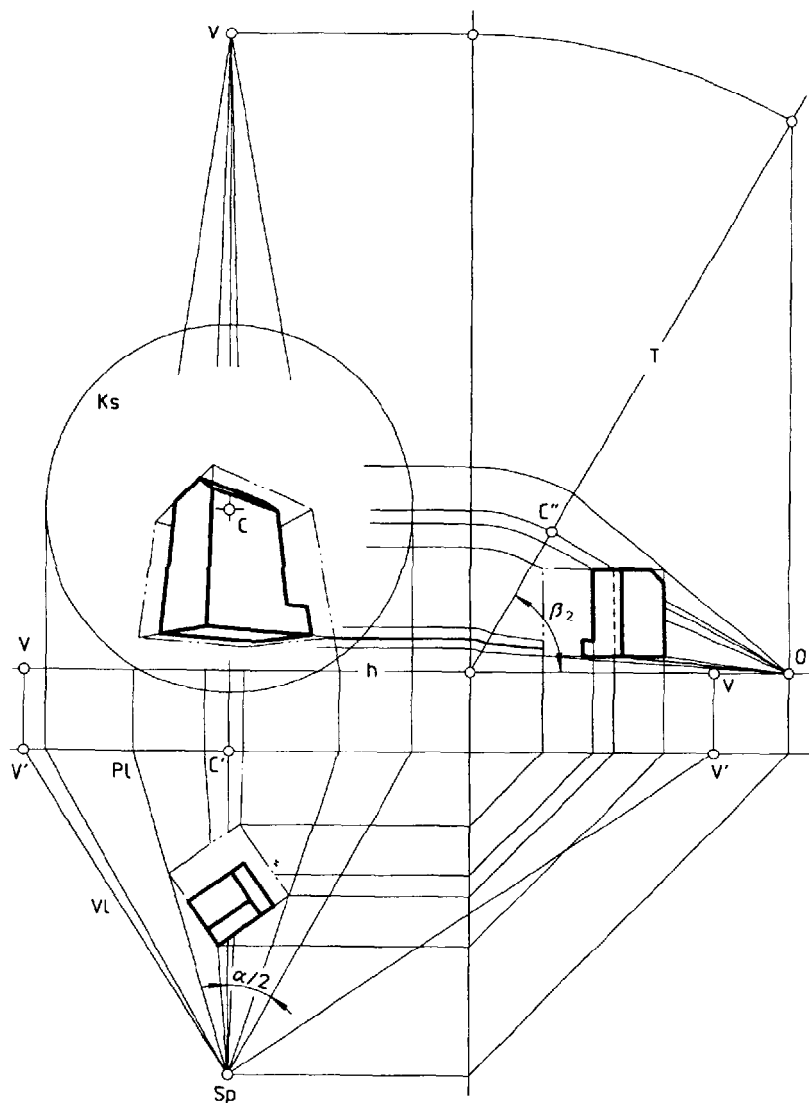
Figure 15 — Object, framed in a cube (indicated by a double-dashed line), in front of a projection plane inclined towards the projection centre

7.5.2 Inclined projection plane $\beta > 90°$

Due to the inclination away from the projection centre, the vanishing point for vertical lines of the object to be depicted moves below the horizon line from infinite to finite, so that tilting projected vertical lines provide an optical distortion suggesting a tapering form (see figure 16).
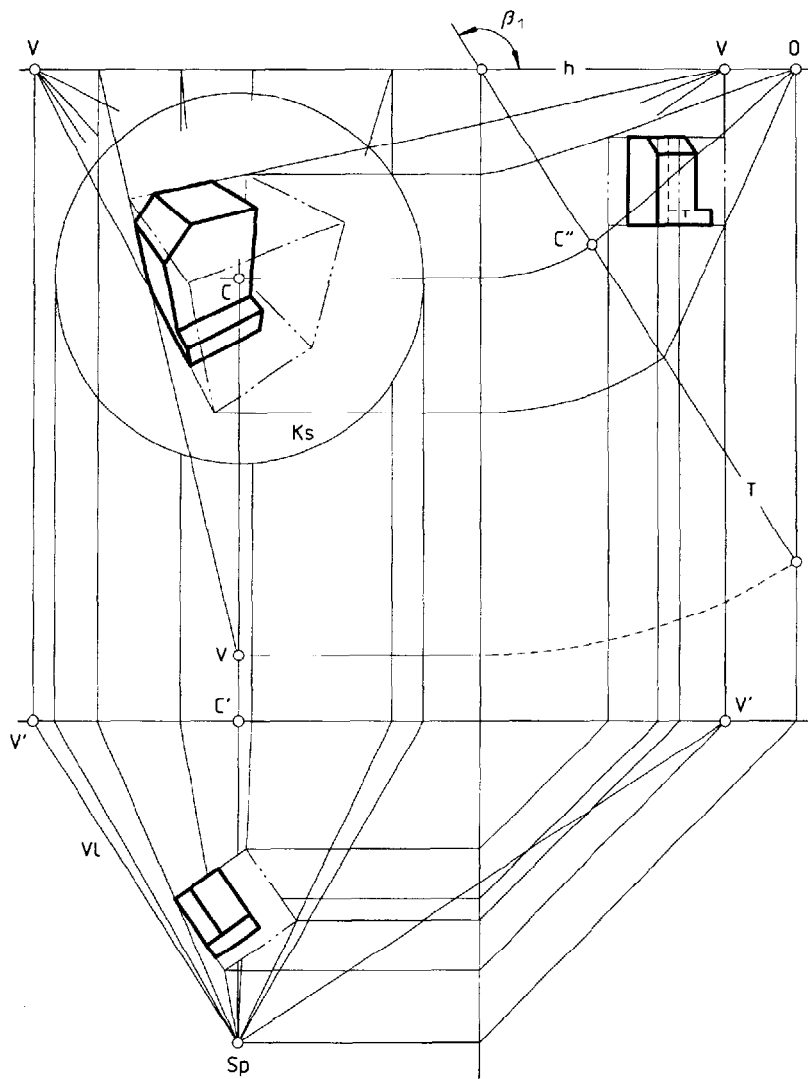
Figure 16 — Object, framed in a cube (indicated by a double-dashed line), in front of a projection plane inclined away from the projection centre

7.6 Coordinate piercing method

The coordinate piercing method is based on simple proportions, in which each piercing point of the projectors in the projection plane is not established by drawing, but by calculation. This method is based on dividing the space in four quadrants by two reference planes, one horizontal and one vertical, each perpendicular to the projection plane, their common line being the main projector. The common lines of the horizontal and vertical reference planes and the projection plane are the X and Y axes of a rectangular Cartesian coordinate system situated in the projection plane, the origin of which is the main point. The projector $\overline{OP}$ of point P pierces the projection plane at point P' (X, Y).

The coordinates X and Y of the point P' can be determined from the distances $\overline{PA_1} = \overline{B_1C_1}$ and $\overline{PB_1} = \overline{A_1C_1}$ of the point P from the reference planes, from the object distance $D = \overline{OC_1}$ and the distance $d = \overline{OC}$:

$$X = \overline{B_1C_1} \cdot d/D \text{ and } Y = \overline{A_1C_1} \cdot d/D$$

The values calculated for X and Y for all points of the object to be represented are transferred into the coordinate system to obtain the representation of the object. The dimensions needed for the calculation of $\overline{B_1C_1}$, $\overline{A_1C_1}$ and D are taken from the basic plane, elevation, side view, etc. of the object, whereby these planes may be drawn in various scales. The representation may be reduced or enlarged in a similar mode by multiplying the coordinates X and Y by the scale factor (see figure 17).

NOTE 1 $\overline{B_1C_1}$ is positive (negative) when B_1 is on the right (left) side of the main projector; $\overline{A_1C_1}$ is positive (negative) when A_1 is above (below) the main projector.

8 Development of a central projection

By turning the basic plane into the projection plane (see figure 1), it is possible to present the representation of the basic plane on the drawing surface and subsequently to create the complete representation of the dimensions taken from the elevation.

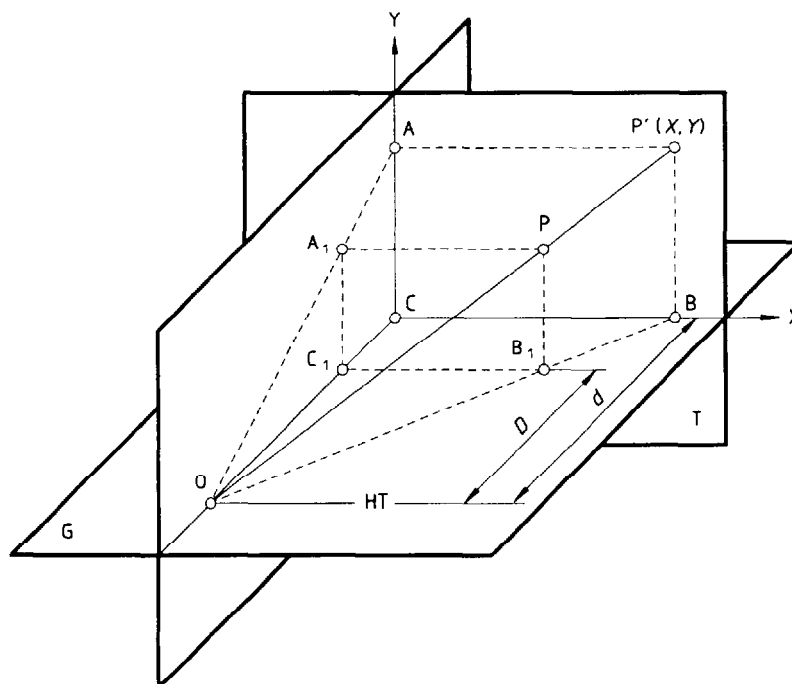There are two different ways to turn the basic plane:

Figure 17 — Coordinate piercing method

8.1 Turning the basic plane downwards

The station of observation, (Sp), is placed at the distance d from C', below the basic line (X). The representation is above, and the basic plane is below the basic line; they do not cover each other. This arrangement is called regular arrangement and gives the best survey, but requires considerable space on the drawing surface (see figure 18).

8.2 Turning the projection plane downwards

The basic line becomes the axis of symmetry. This frequently-used arrangement saves space on the drawing surface and is called economy arrangement (see figure 19).
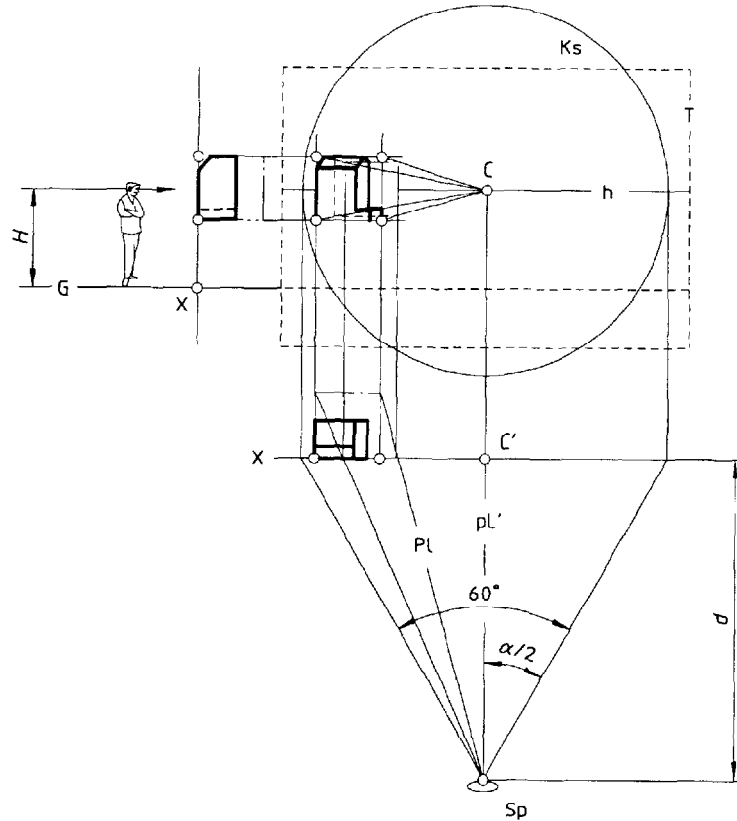
Figure 18 — Regular arrangement (the representation is placed above the basic line X)
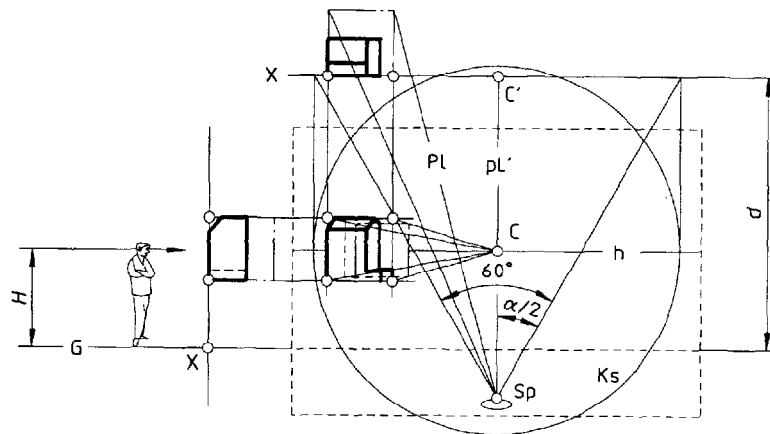
Figure 19 — Economy arrangement (the perspective representation is placed below the basic line X)

Annex A
(informative)

Examples for comparison of different depiction methods

The following figures A.1 to A.17 illustrate some of the different depiction methods described in clause 7.
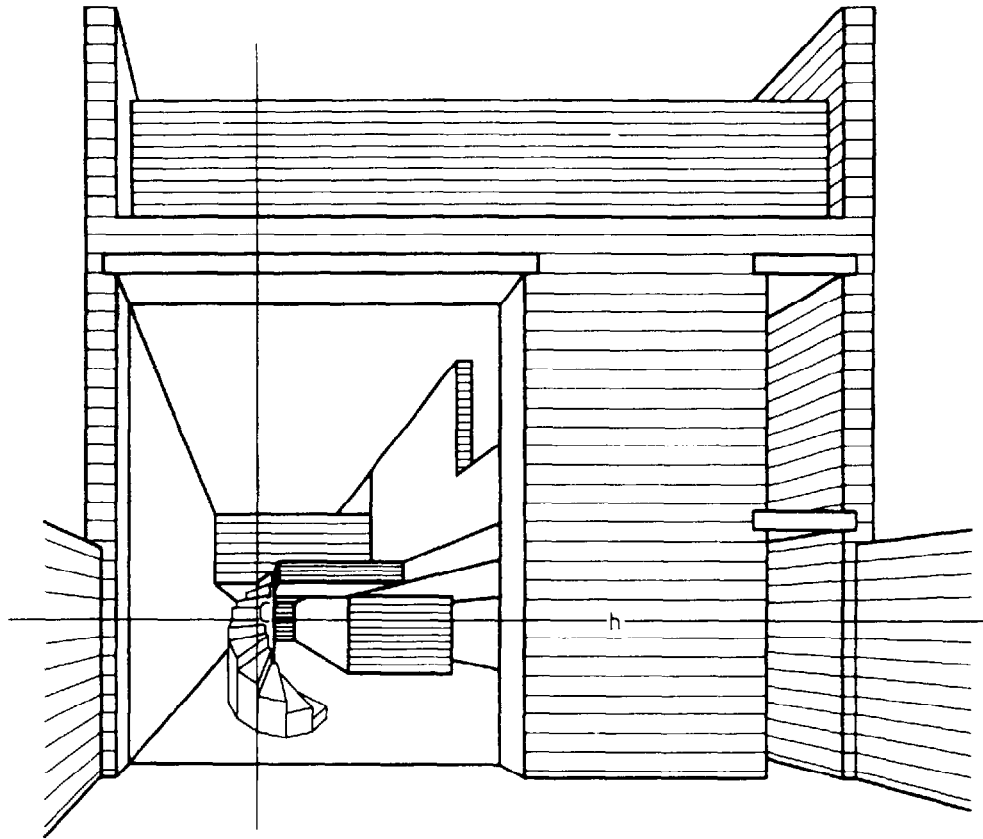
Figure A.1 — Exterior space image, projection with one vanishing point; the spiral staircase has been represented according to the method described in 7.1
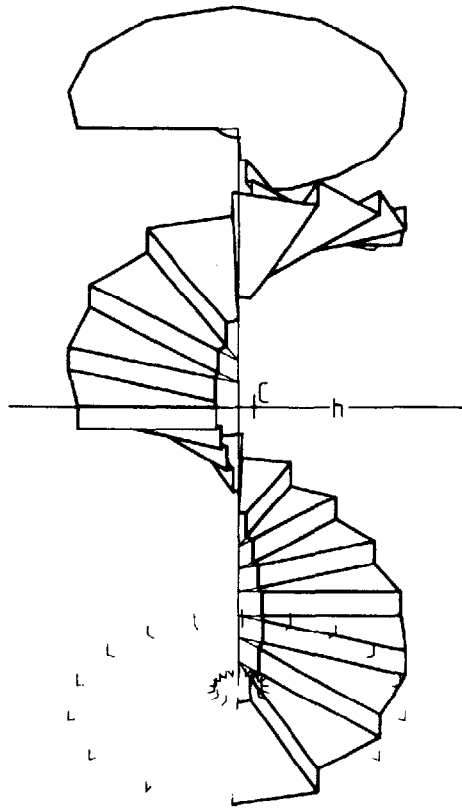
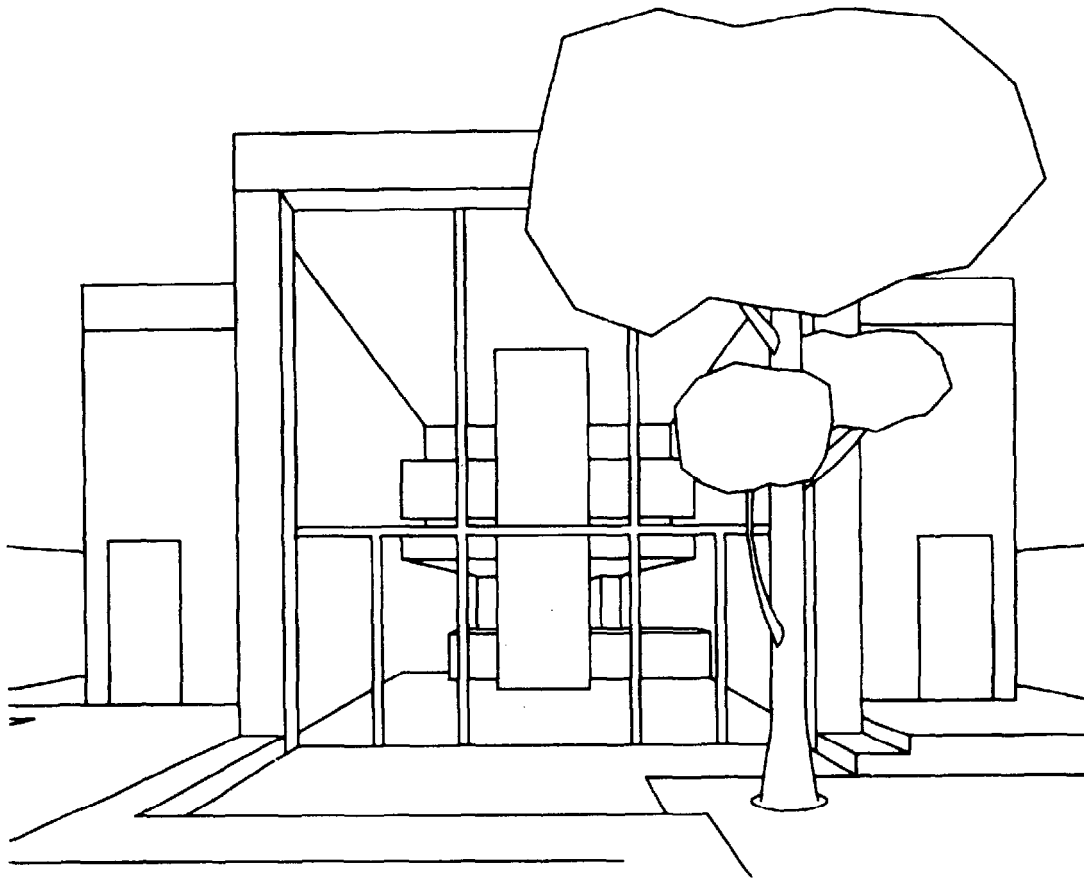**Figure A.2 — Interior space image, central projection of a spiral staircase according to the method described in 7.1**

Figure A.3 — Outside interior space image, projection with one vanishing point
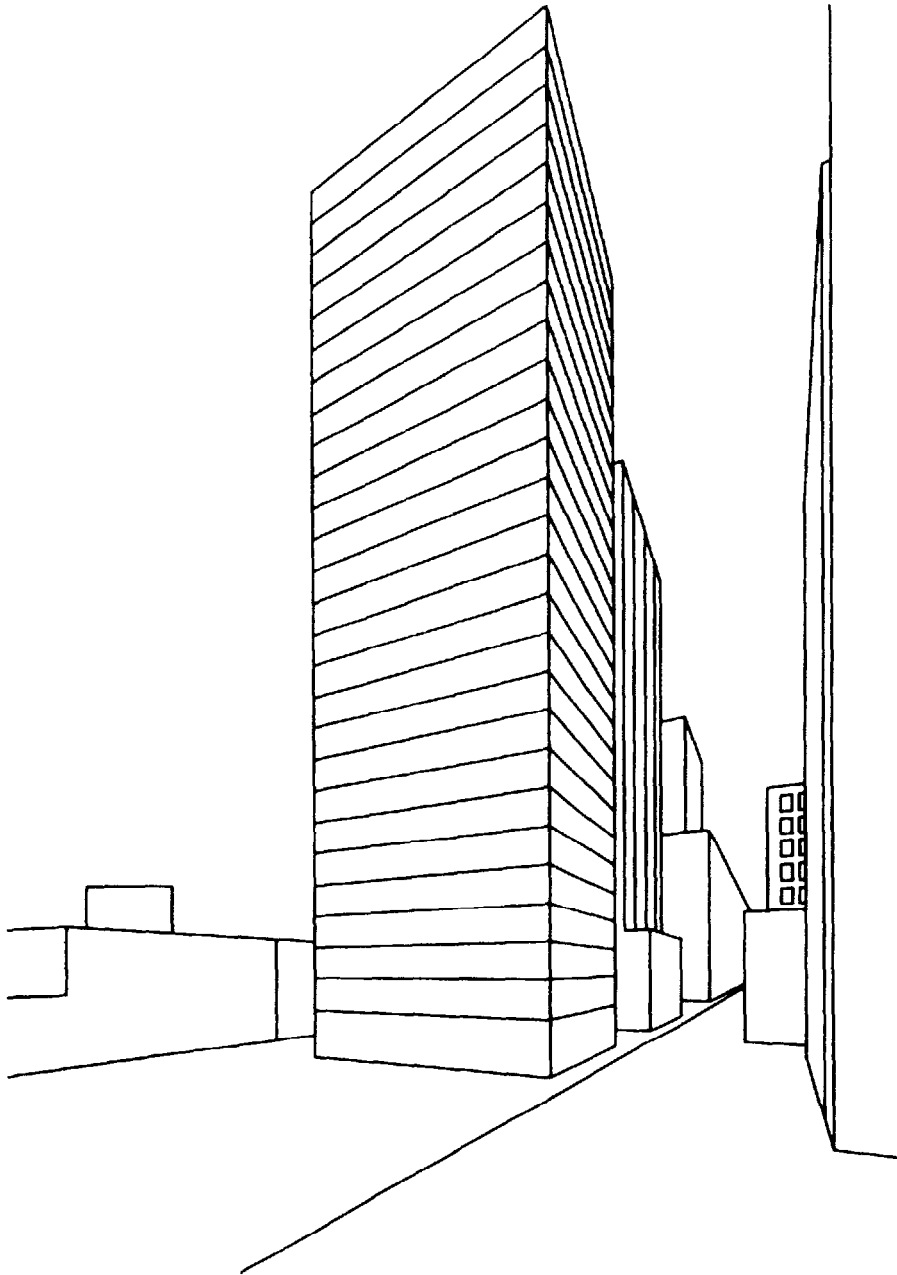
Figure A.4 — Exterior space image, central projection with two vanishing points; the representation looks unnaturally distorted because of the use of the method described in 7.2.2
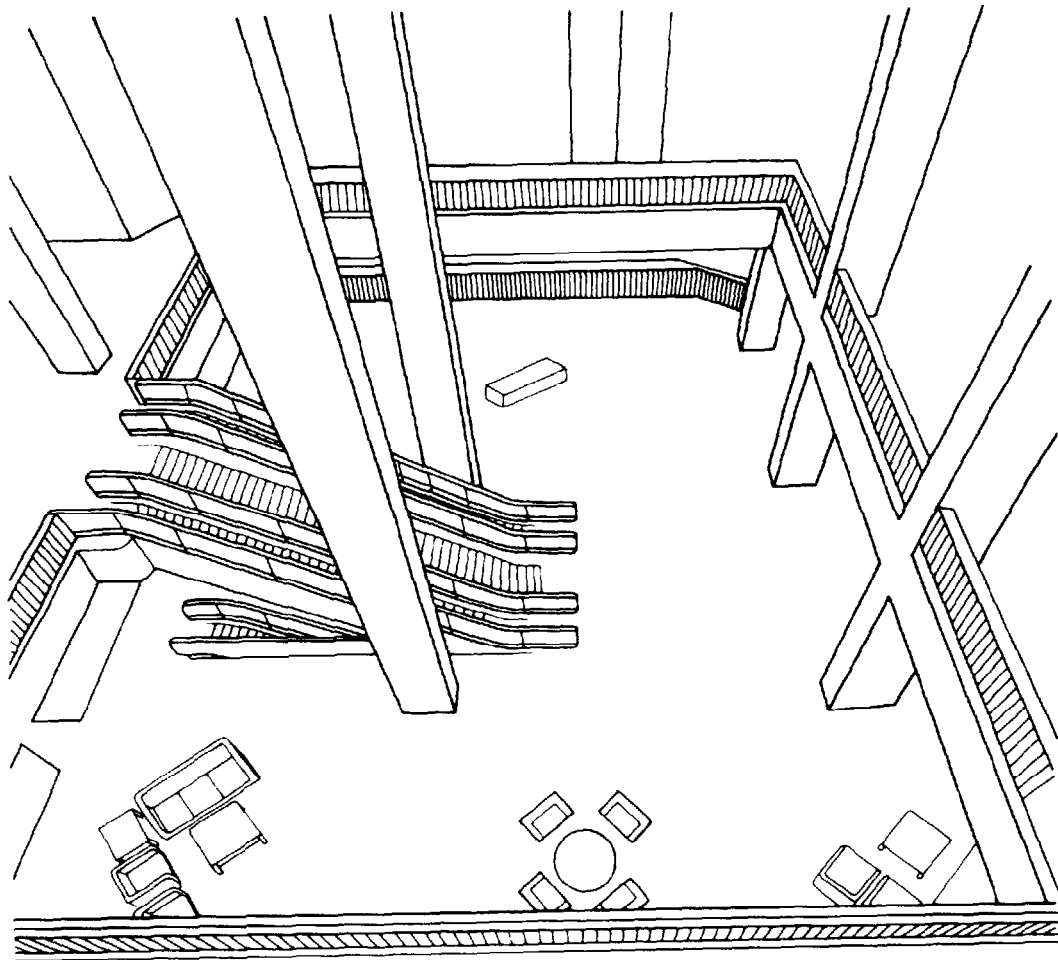
Figure A.5 — Exterior space image, projection with inclined projection plane and three vanishing points according to the method described in 7.5.1
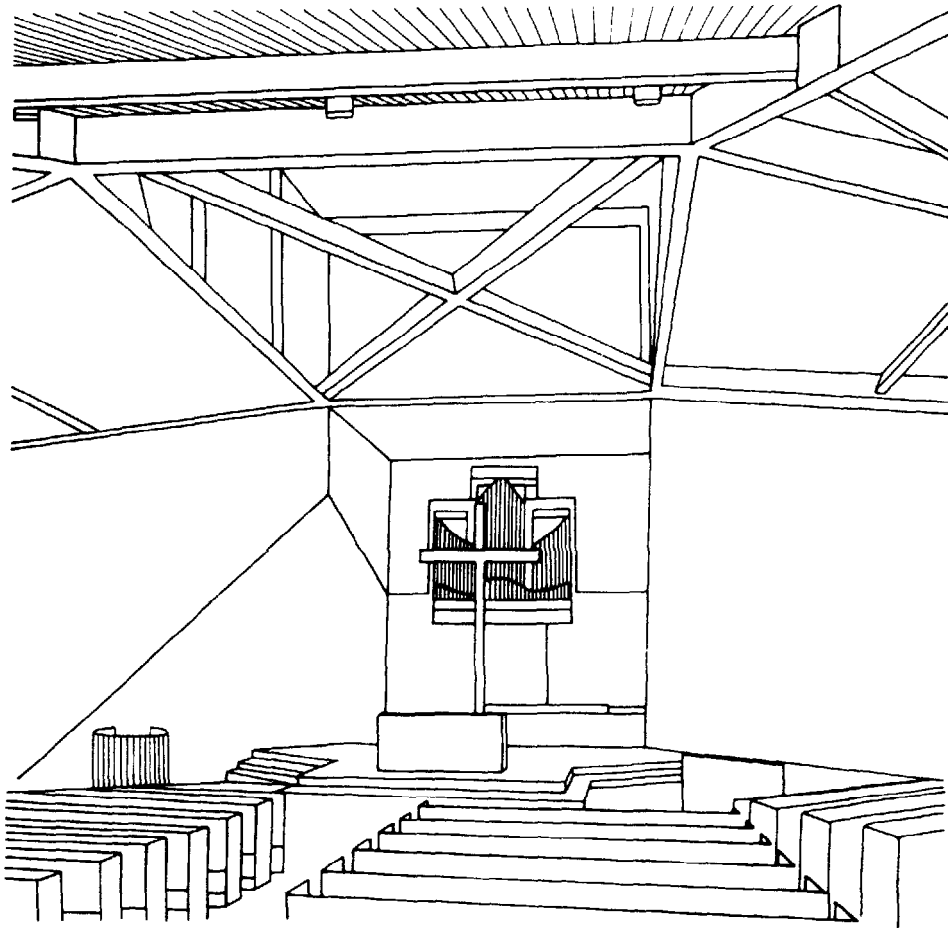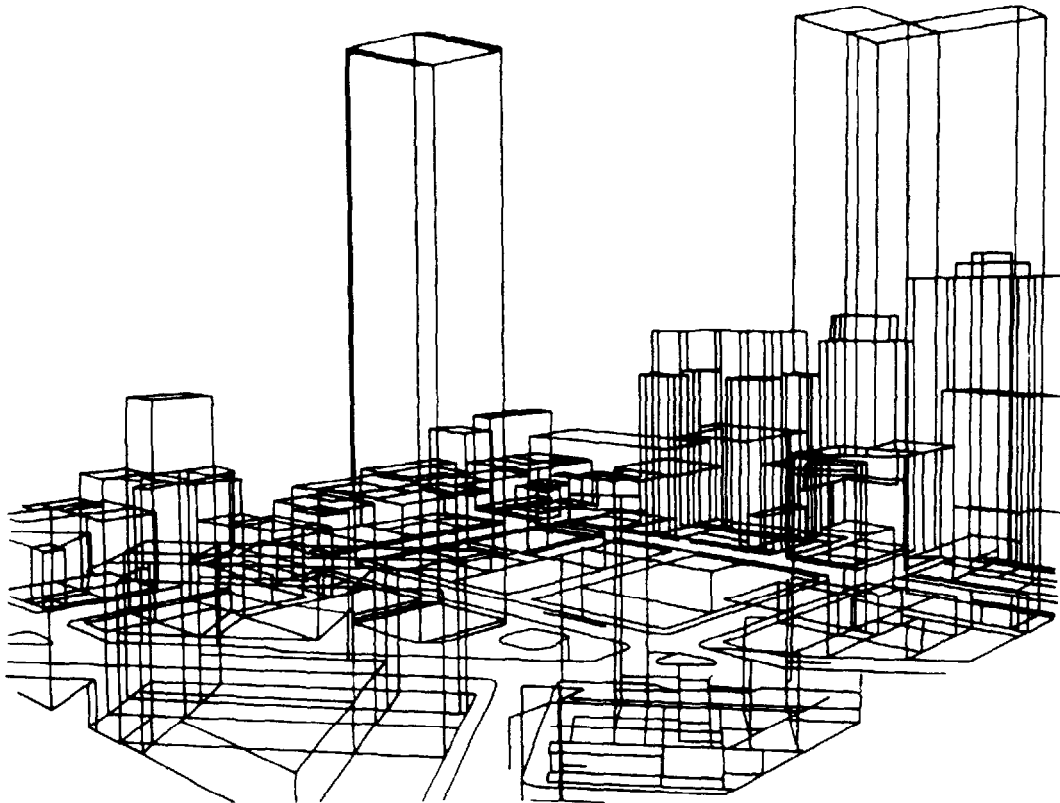
Figure A.6 — Interior space image, projection according to the method described in 7.2 with various vanishing points and the representation of inclined planes
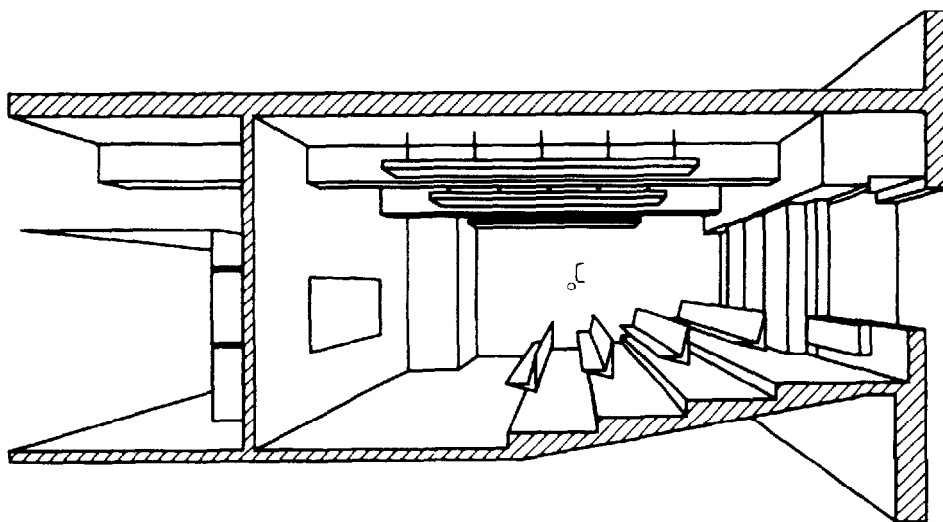
Figure A.7 — Interior space image, so-called section perspective with one vanishing point
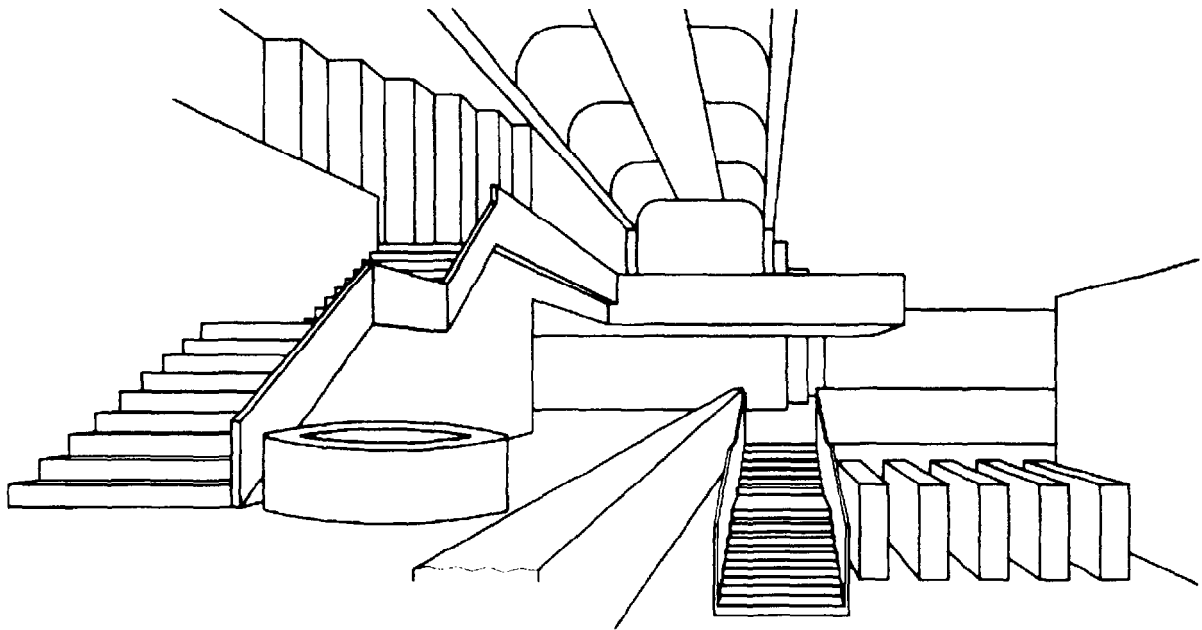
Figure A.8 — Interior space image, projection with one vanishing point and other vanishing points for inclined planes (staircases)

Figure A.9 — Interior space image, projection with inclined projection plane and three vanishing points according to the method described in 7.5.2

Figure A.10 — Exterior space image, projection according to the method described in 7.6
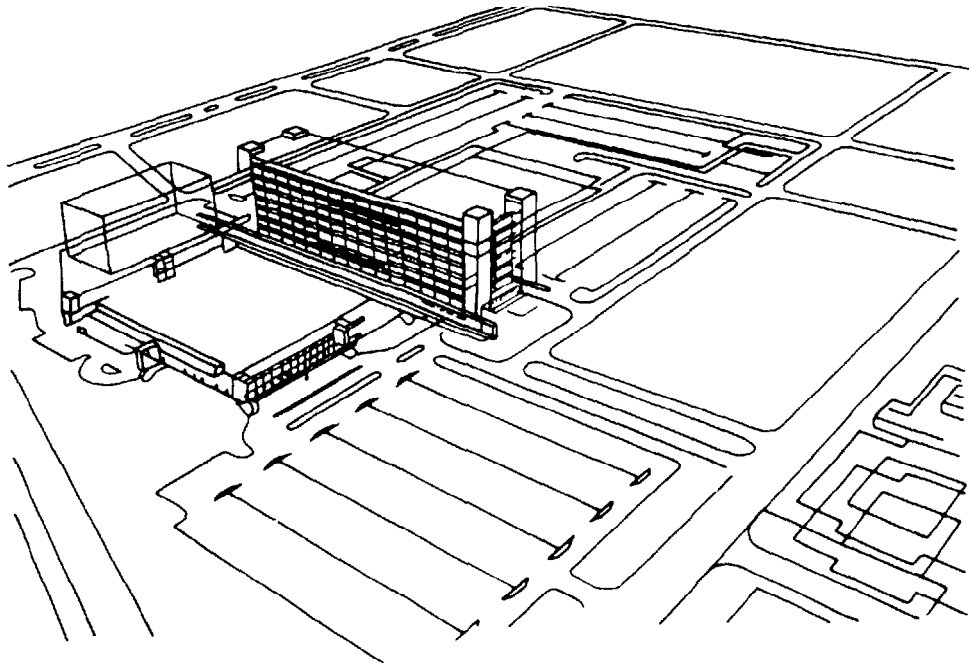(simple wire frame model and two vanishing points)

Figure A.11 — Exterior space image, projection according to the method described in 7.6
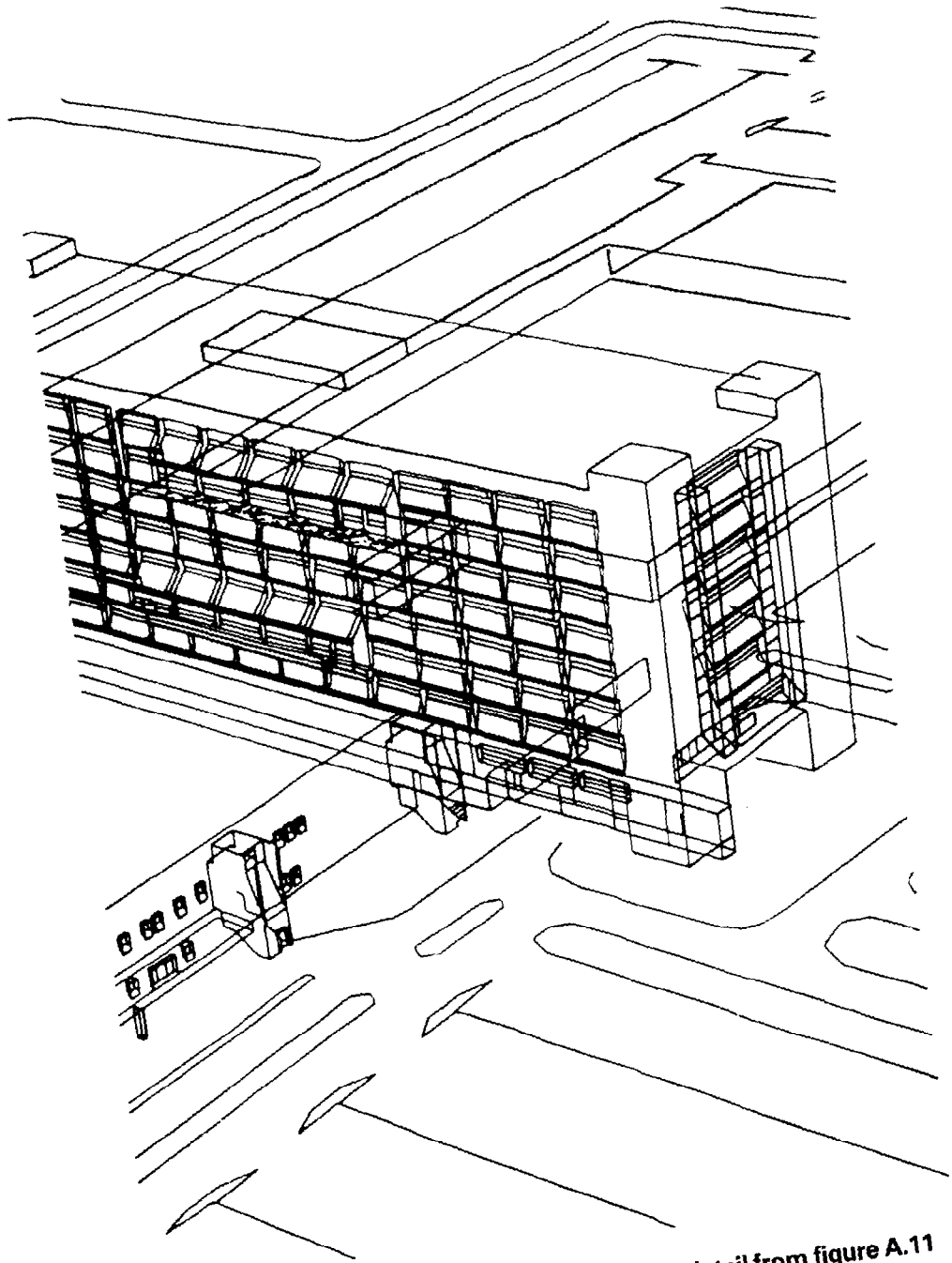(wire frame model with further detail elaboration and two vanishing points)

Figure A.12 — Exterior space image, enlarged detail from figure A.11
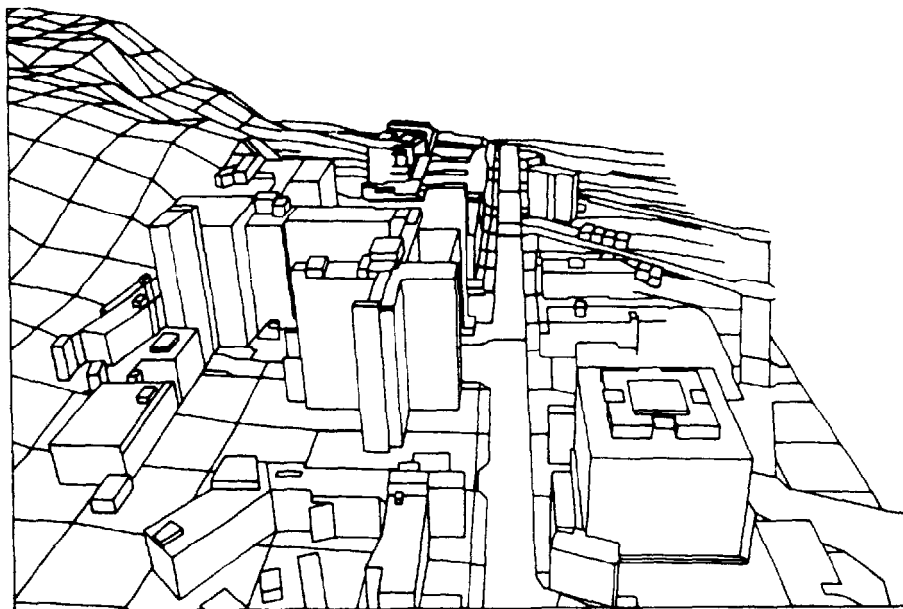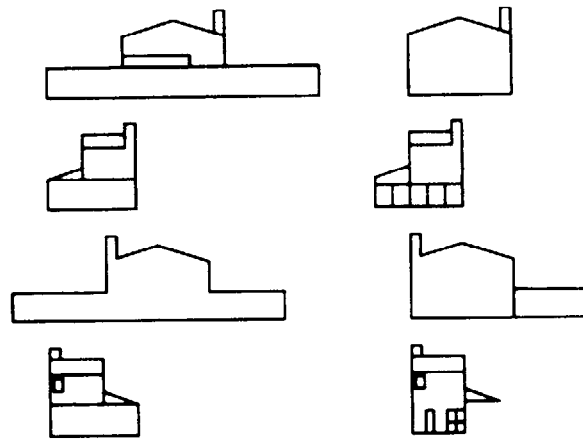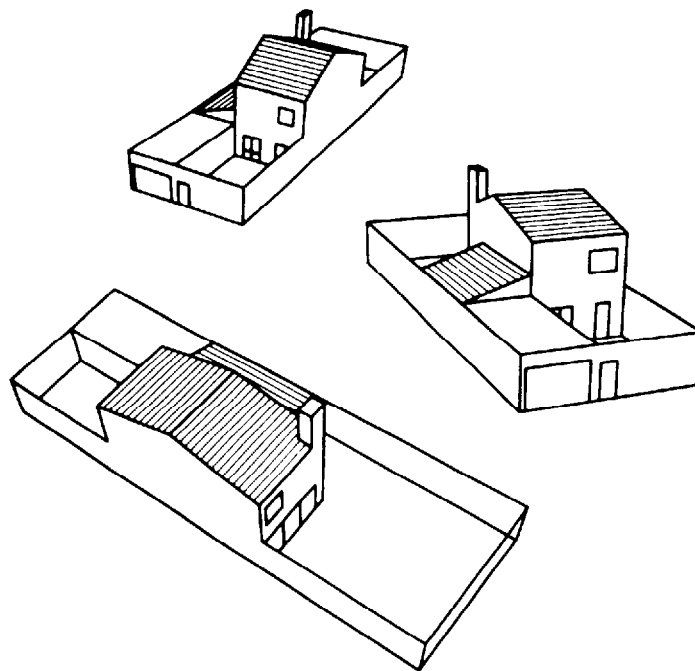
Figure A.13 — Exterior space image with the representation of surroundings, projection with inclined projection plane and vanishing points according to the method described in 7.5.2

a) Orthogonal images

b) Projection with inclined projection plane

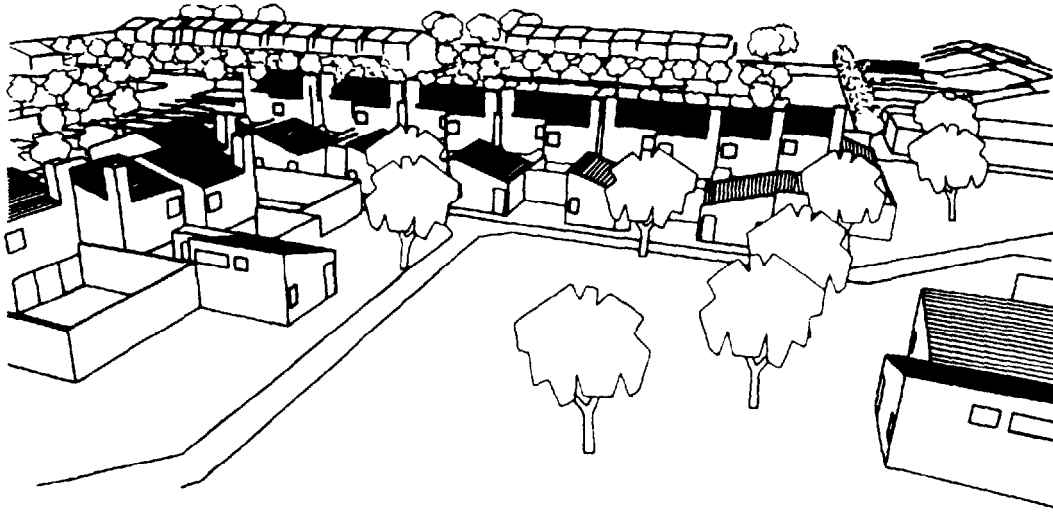**Figure A.14 — Exterior space image, representation of surroundings and accessories**

Figure A.15 — Exterior space image of a residential site, projection with three vanishing points
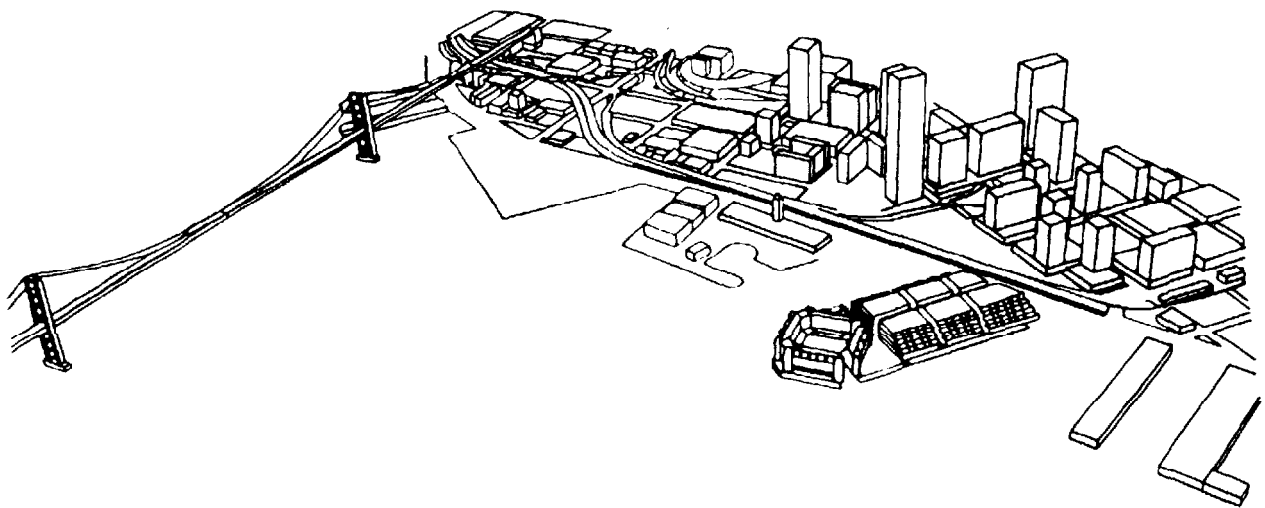

Figure A.16 — Exterior space image (bird's eye view), projection with inclined projection plane
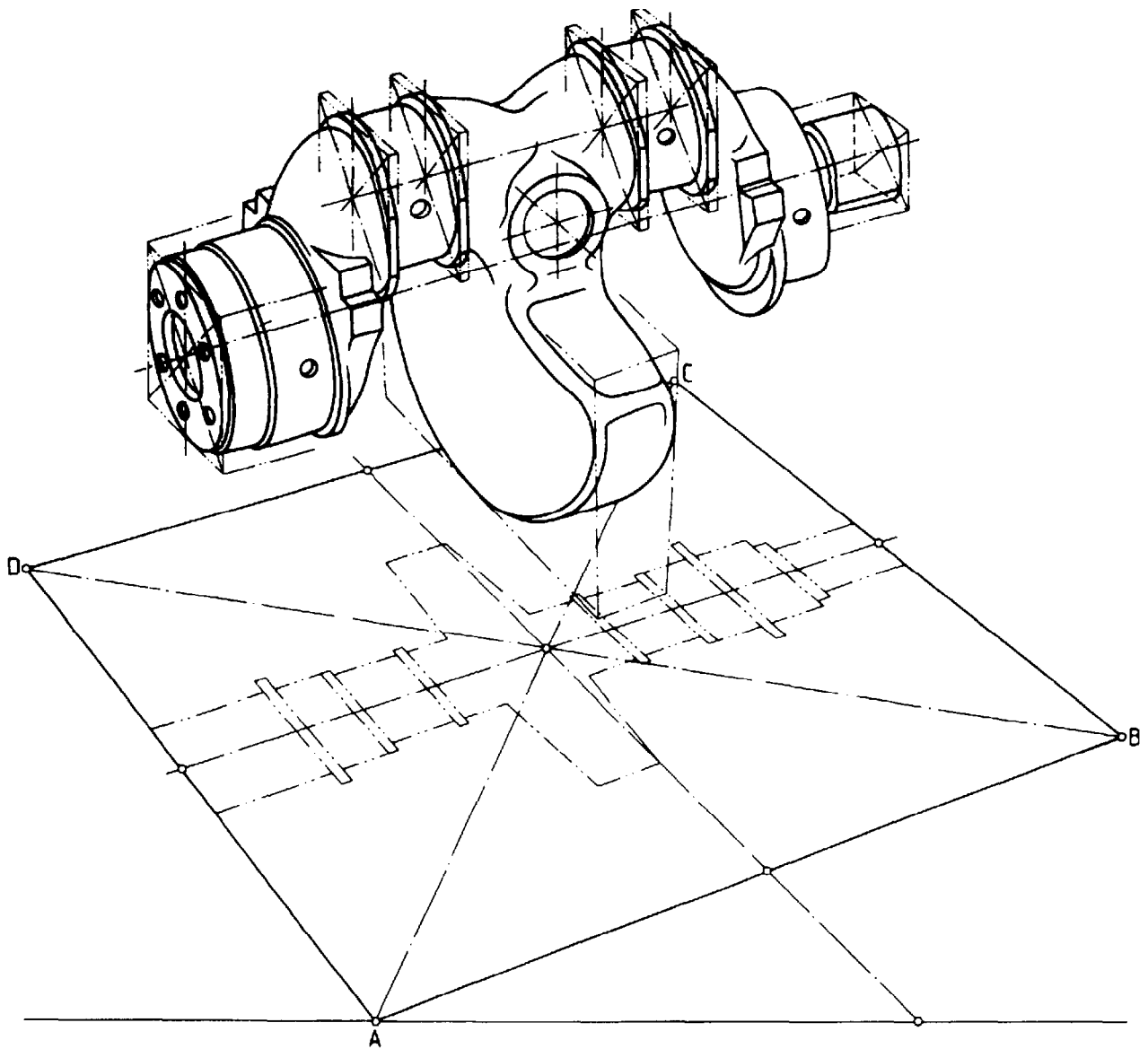
Figure A.17 — Example of dimetric axonometry, representation of an engine crankshaft

Annex B

(informative)

Bibliography

[1]   ISO 841:1974, *Numerical control of machines —
      Axis and motion nomenclature.*

[2]   ISO 1503:1977, *Geometrical orientation and
      directions of movements.*

[3]   ISO 5456-1:1996, *Technical drawings — Projec-
      tion methods — Part 1: Synopsis.*

[4]   ISO 5456-2:1996, *Technical drawings — Projec-
      tion methods — Part 2: Orthographic represen-
      tations.*

[5]   ISO 5456-3:1996, *Technical drawings — Projec-
      tion methods — Part 3: Axonometric represen-
      tations.*

[6]   ISO 10209-1:1992, *Technical product documen-
      tation — Vocabulary — Part 1: Terms relating
      to technical drawings: general and types of draw-
      ings.*

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