Axonometry New Practical Graphical Methods For Determining System Parameters

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Abstract

Some practical graphical method of determining the coefficients of variation and angles between them, which are the main parameters of the axonometric system, first describes the development of a model for generating axonometric projections and using it to determine the basic parameters of axonometry graphically.

Key words: Axonometry, isometry, projection, transformation, parallel, plane, perpendicular, horizontal, bisector plane.

Introduction.

The practical graphical method of determining the coefficients of variation of the axes of the axonometric system and the angles between them has not been raised as a problem until now [1]. Because the results obtained were graphic works performed manually, they were approximately 0.5-1 mm accurate. Therefore, graphical methods were of great importance in their time, although they could not compete with analytical methods for high-precision results.

In one of his collections, Monge compared his creative research and applied stereometry to planametry, telling his colleague Oliver: I would suggest that the solution of these examples be done by means of graphical constructions. Students would be amazed to see the accuracy and ease of the second column's solutions and proofs. "

For now, in the development of science and technology, we will consider the graphical definition of the above problem, as the creation of graphics using information and computer technology, for example, in Auto CAD provides very high accuracy (0.00000001-one hundred million).

In Fig. 1, the plane of axonometric projections Q and the coordinates in space are 100 mm long and intersect at a homogeneous angle 35□15'52 ", the Cartesian coordinate plane system intersects to form a triangle of Gaussian traces. The resulting axonometric projection is isometry, in which the axonometric axes from one point-coordinates are shortened, the angular values between them do not change, and the triangle of traces is an equilateral triangle, as noted above, described in the Q plane in their true magnitude.

Therefore, all elements of isometry, i.e. axonometric axes, are reduced to a theoretically determined coefficient of variation of 81.6496 mm and the angular values between them are described as 1200. The triangle of traces is also depicted in real terms with sides of 141.4214 mm.

Figure 2 shows a dimetric representation of the Cartesian coordinate system when the axonometric Y axis is at an angle of 61□52'28 " to the plane of the axonometric projection plane Q, and its tip touches Q [2].

In this case, the trace triangle of the Cartesian system is depicted at an angle of 26□46'42 " to the plane Q.

The analysis of the elements of dimetry formed by the applied graphical method showed that they are equivalent to the parameters determined by the theoretical analytical method. The coefficients of variation were 0.9428 along the X and Z axes and 0.4714 along the Y axis, and the angles between the axes were ∠XOZ = ∠YOZ = 131□25'36 " and ∠XOY = 97□10'54 ". And the trace triangle showed that the length of the base of an equilateral triangle is 141.4214 mm and the length of the sides of an equilateral triangle is 131.6197 mm.

Figure 3 shows a triangle of traces formed by the intersection of the plane of axonometric projections Q with the Cartesian system in space.

It was observed that all the parameters of the dimetry did not change and the upper right part of

the Y axis was visible, and the equilateral sides of the triangle of traces formed were 106.9341 mm.

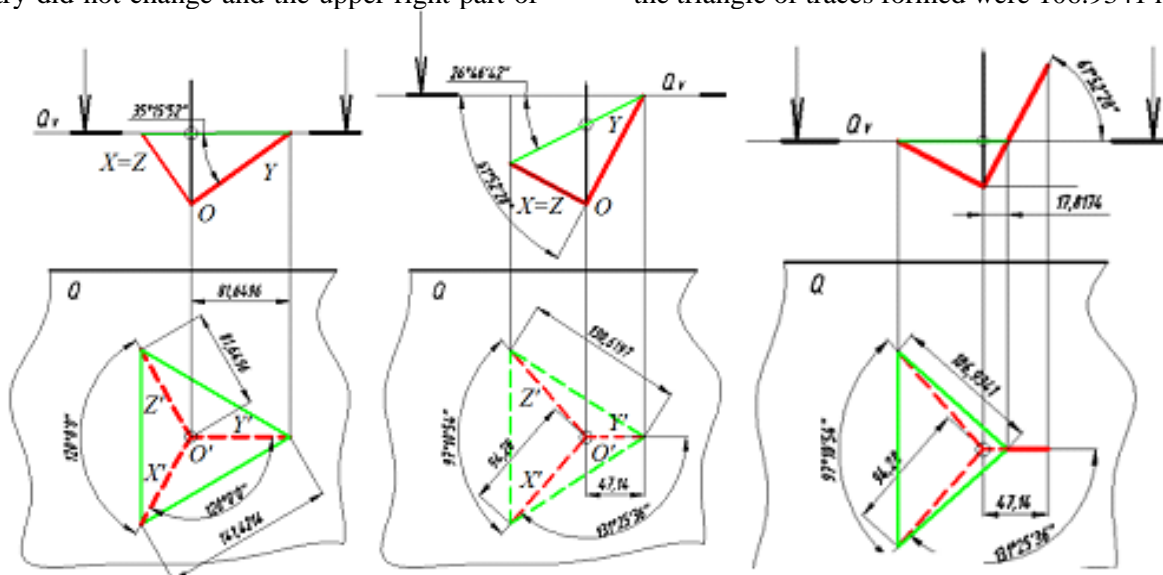

Figure 1   Figure 2   Figure 3   Thus, the Auto CAD program, which

is a modern graphics program, has sufficient capabilities to determine the coefficients of variation of the axes of the axonometric system and the angles between them in a practical graphical way.

The main part

In determining the standard axonometric parameters using the auxiliary right-angled projection method, we obtained the Moon axis at an angle of 35□15'52 'and 61□52'28' 'to the axonometric plane, respectively, in the graphical determination of the basic parameters of the standard isometry and dimetry.

We consider that the above standard axonometric parameters can also be determined directly using

right-angled projections of objects. Such attempts have been made by many scientists and researchers. Of particular importance is the construction of standard axonometrics in the method of additional right-angled projection, developed by Kolotov.

The first essence of this method is that the projections of geometric figures given in an arbitrary situation are intended to construct and bring to a point their true appearance or length or size by depicting them in a new projection direction at right angles to an imaginary plane parallel or perpendicular to them in thought space.
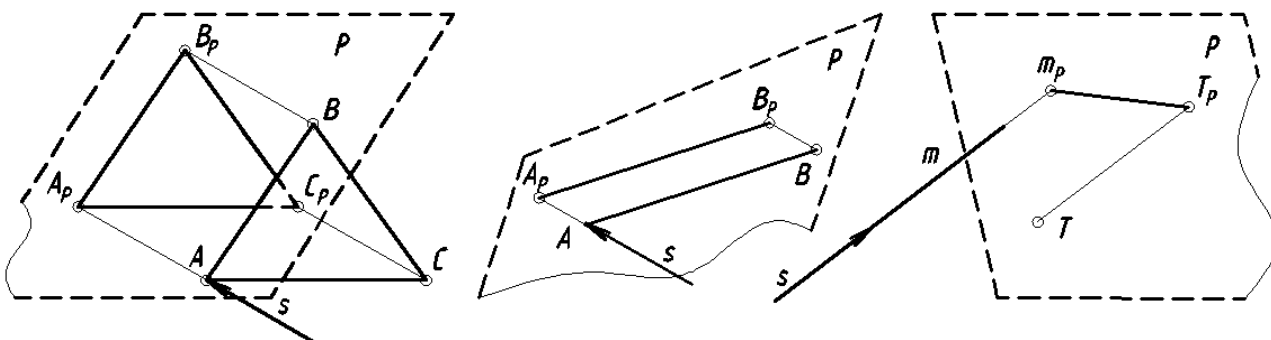

Figure 4

In this case, the new projection direction s is obtained perpendicular to the imaginary plane R bounded by the dashed lines: s ⊥ R.

Also, the second essence of this method is the indirect representation - transformation of all points of the thought plane R and the figures lying in it to the V plane. In this case, the plane R is located on the plane V as R1 - it merges.

To understand the content and essence of this method, let's take an AV cut in an arbitrary situation and take a creative approach to determining its true length, Figure 4. Some sources have shown that this problem can be solved using the auxiliary right-angled projection method. Since this method is rare in most publications published in recent years, we will consider it in a clear picture and drawing [3,3,4].

This problem is solved by the following algorithm based on the content and essence of this method:

1. According to the property of parallel projections, if the AV cross-section is projected onto a plane parallel to it, it is described in this plane at its true length. Based on this, the new projection direction s (s ', s ") perpendicular to it is determined by passing the plane R in the projection position through the AV section (or parallel to it). For example, if the R plane passes through the AV section, A'V' ≡ RN and s' ⊥ RN; s "⊥ will be RV, Fig. 5. The thought R forms a two-sided angle with the edge RV, with the plane V and the position itself being V1 to R1.

If this R plane is joined to the V plane using the rotation method, then all the lying geometric figures, especially the AV cross-section and the bounded scale itself, will be depicted in the real V1 plane. To do this, the plane R is rotated around its frontal trace (as the axis of rotation) and merged with the plane V. As a result, the actual length of the AV section lying in it is described in A1'V1 ': A1'V1' ≡ AV. Because its ends A1 'and V1' are placed on V using arcs of radius RXA 'and RXV'. Then the AV cross section comes to the frontal position. The frontal projections of the intersection ends intersect with the connecting lines passing through A1 'and V1' and the arcs of radius RXA 'and RXV' passing through the A and B ends of the section in space to form the frontal projections A1 "and V1". In the plane V, the projections of these arcs are straight lines A "A1" and V "V1" parallel to s ".

2. Since the plane R is a horizontal projection, for indirect projection-transformation of the AV section is carried out with R and V and using the bisector plane (Qbis) of the planes R1, which are expected to be placed on V as follows:

2.1. The trace of the bisector plane is drawn by dividing QbisN by R and the angle between the horizontal traces of the planes R1 and V, which are expected to be located. In the drawing, the trace of this plane is the line QbisN, the bisector line dividing the angle between Rn and Vn and the horizontal R1n of R1, which is expected to lie on top of it (Vn≡R1n).

3. To place all points of the plane R and itself in the plane V as R1, a new projection light direction perpendicular to the plane R is projected along the s (s', s ') to the bisector plane of its points, and then to the plane V in the direction of the returning light.

This can be seen in the example of point A in Figure 5. However, in the method of rotation of point A, it was noted in detail above that the position A1 "is determined by rotating it around Rv and joining it with V. A new projection of point A in the direction of light s (s', s ') at an angle d to the bisector plane, then The projection returned from point D 'is projected onto the plane V using light directions.
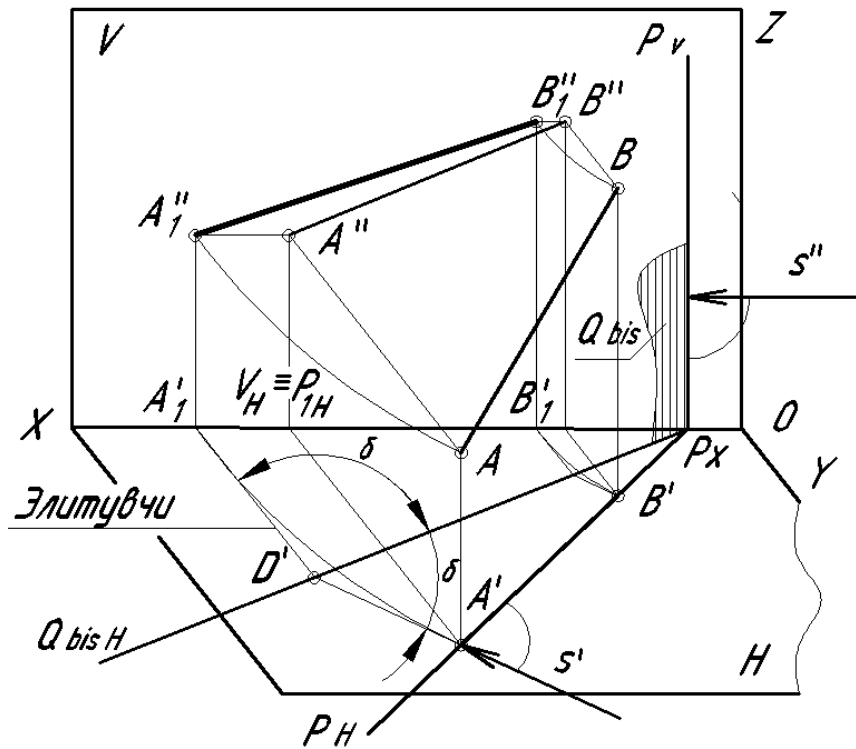
Figure 5

In this case, the direction of the projection light returning to D'A1 'is parallel to the main projection direction in the drawing, since the plane R is the projection. This projection direction intersects with a connecting line running parallel from A "to s " to form a projection of point A on the plane V, i.e., point A1" constructed using the exact rotation method above. In this case, the projection on the connecting line D'A1 'is called the elliptical line. The elliptical line is perpendicular to R1n as it is s'⊥ RN: the elite ⊥ R1N.

Let us now consider the determination of the true length of an arbitrary AV cross-section by the auxiliary right-angled projection method in the drawing, Fig. 6. To do this, in order to facilitate the creation of graphs, we take the tip A in the plane V and solve the problem according to the algorithm developed above.

1. A horizontal projection plane R (RN≡A'V ') is passed through the AV section and the new projection light direction s is taken perpendicular to it;

2. As a result of placing the plane R in the position R1 on V, the bisector plane of the planes R and R1, ie V, is transferred. Its QbisN trace will be a bisector line dividing the angle between Rn and Vn into two equal parts. The direction of the line of new projections is determined using the property of the incident light in the direction s' and

the return light from it at an equal angle: ⊥ A1 "V1";

3. The bisector Q of the two-sided planes R and V and the planes R1 located on it is drawn. Since the angle between them (∠V'A'V1 ') is projected unchanged into the N plane, its horizontal QbisN trace overlaps with the bisector line of the angle ∠V'A'V1'. By projecting the point V 'in the direction s' of light to Qbis, the direction of the light returning from it - the beam - is determined. In this case, the angles between the incident light V'D 'and the incident light returning from it are mutually equal: ∠ V'A'D' = ∠V1'A'D = d. A projection s " perpendicular to the RV exiting the point V 'with the elliptical line intersects to form V1'. Combining it with A " determines the actual length of the given cross section.

In Figure 7, this problem is solved by the above algorithm by taking the direction of the projection light s perpendicular to the horizontal AV cross-section and the projection plane R passing through it. In this case, the line passing through the point D 'is perpendicular to R1N and A"V1' '. This is because the projection of the direction of light returning from D intersects with the direction of light s' 'and forms a point V1 ": D'V1' ∩ s' '= V1". , lies in its horizontal VN and R1N traces:

$$s' \cap \text{Light returning from } QbisN = D \cap s' '=$$
$$V1\ "$$
$$\text{and A "V1"} \equiv R1N \text{ and } R1N \equiv VN$$

(1)

In addition to the right-angled projection from expression 1, the horizontal traces of the position R1 (since R is the horizontal projection plane) and the plane of the frontal projections, which are placed in the plane V, are added. Accordingly, the projection of the frontal A "V1" equal to the actual length of the AV section lies at R1N, and the elliptical D'V1 "line is perpendicular to them.

If the construction of a horizontal trace of a bisector plane is approached creatively as follows, it can also be easily transferred:

If we analyze the triangles ΔV'A'D 'and ΔV1"A"D', they are equal and form an equilateral (V'A'≡A "V1") triangle yonV'A'V1 ". From this it

was found that the horizontal QbisN trace of the bisector plane overlaps with the height of ΔB'A'B1 ", Fig. 8.

The result is a plane R with a plane V and a plane R! the bisector formed by the planes is divided into a plane Q and a second, easier method of constructing its horizontal trace. That is, to create an equilateral ΔV'A'V1 "in the direction of projection s' 'passing through V", the cross section A'V' is placed V1 ", then ΔV'A'V1" is constructed, and its height - QbisN trace of the bisector plane is constructed.

Here, too, the guide line passing through point D 'is perpendicular to line A"V1' 'and R1N.
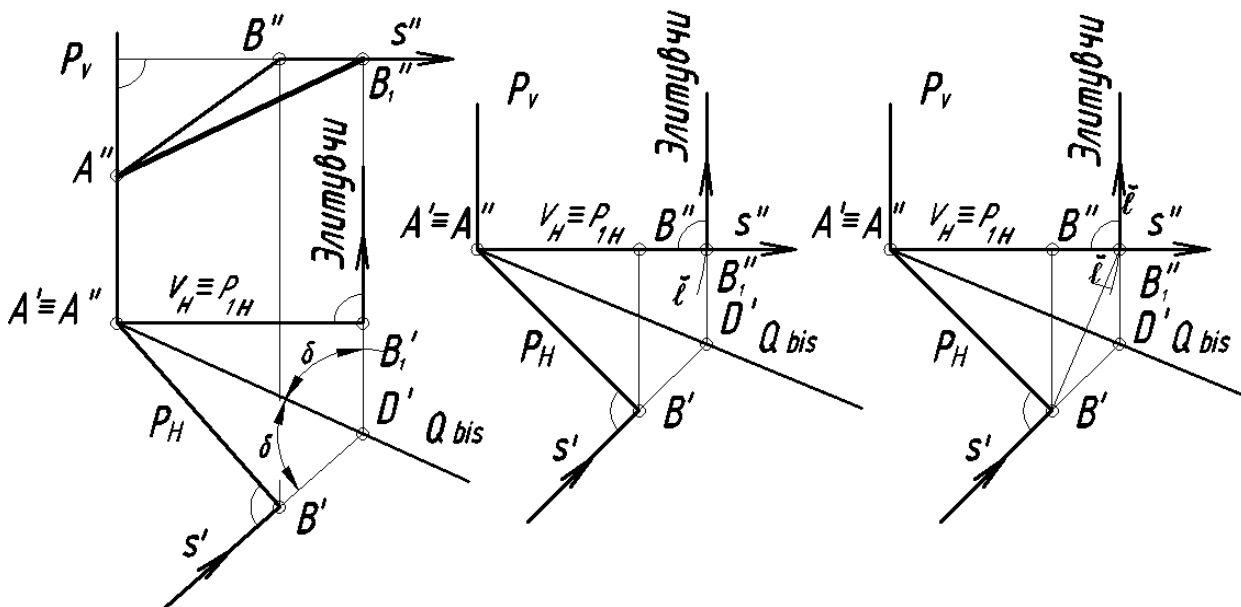

Figure 6   Figure 7   Figure 8

The solution of the problems in Figures 7 and 8, if the auxiliary right-angled projection method is a horizontal projection of the thought R (RN, RV) plane, also serves as a model or apparatus for solving such problems and the geometric figures given to them in real sizes V plane or in the form of a point is called an indirect projection-transformation model or apparatus. From the analysis of the drawings in this figure,

the following construction algorithm of the transformation model (apparatus) was determined:

1. According to the condition of the problem, the plane R and the direction of the new projection beam and the horizontal AV section perpendicular to it are made:

s ⊥ R and AV ⊥ s, AV || N;

2. The point V1 "is defined. The projection derived from U V " is formed by the intersection of

the arc bo'lgan with radius A'V 'and the center A (A', A") with the direction of light s ":

ℓ yoy ∩ s' '= V1 "and AV = A" V1 "= A'V'.

3. The trace of the bisector plane and the directions of the elliptical line are determined. By passing the height of the resulting triangle V'A'V1 ", the adjacent QbisN is constructed. The direction of the elliptical line is determined by passing the

We call this algorithm, which consists of three graphical operations, the 1st algorithm for the construction of the transformation model (apparatus).

Using this model, a true view of the horizontal projection triangle AVS, whose horizontal projection is parallel to the horizontal

projection light direction V 'to s' on QbisN, passing the point D' and perpendicular to it A" V1 ":

Δ V'A'V1 "height of the triangle - QbisN is constructed.

V '□ s' ∩ QbisN = D 'and D' □ elite ⊥ A "V1" (R1N)

AV intersection in Figures 7 and 8, was constructed. In this case, the triangular plane is indirectly projected onto the plane R1 ≡ V, ie transformed, using the rays incident in and out of the plane Q in its true form.
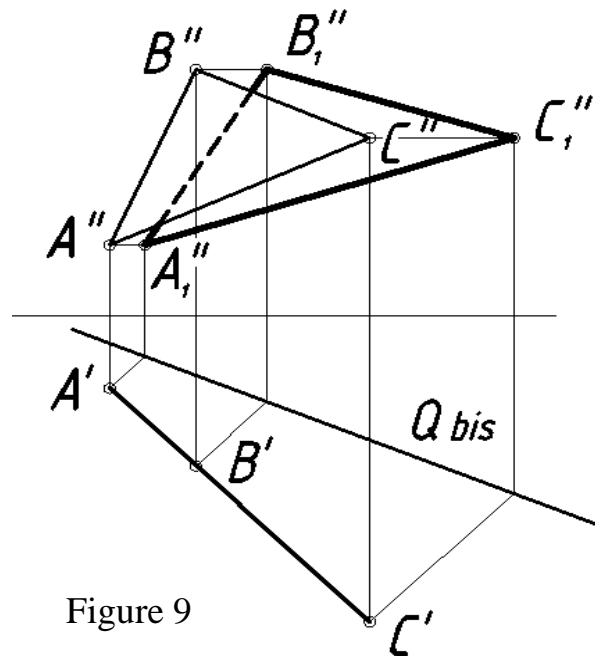

Figure 9

In Fig. 10, the cross section AV is taken in a horizontal position, the projection direction s is not perpendicular to the projection plane, as before, it is perpendicular to the plane R (RH, RV) in the arbitrary position: s⊥ R, (s'⊥RN, s"⊥RV) . To solve the problem, perform all the graphical operations as in Figures 7 or 8, and determine the direction of the line leading to new projections for the direction s (s', s' ').

In this case, since the thought plane R is not perpendicular to N, the angle ph between R and V and the new position R1 placed on it V is not described to N in real value. This is because the horizontal traces of V1 and R1 do not overlap.

Therefore, the horizontal projection R1N of the plane R1 placed on V and the frontal projection A "V1" equal to the cross section AV lying on it do not lie on the axis OX.

Based on the 2nd graphical operation of Algorithm 1, an arc V1 " with a connecting line q parallel to V " at a point A (A"A ") and a radius A'V ' is determined by intersecting with: V " □ q ‖ s " and q ∩ ℓ yoy = V1 ". Then, in both the obvious image and the drawing, by combining V1 with the point A (A'≡A"), the true length of the AV section and the overlapping R1N with it are determined: A " V1 "≡ R1N, Fig. 11, a).

The result is a horizontal projection of the angle ph in the N plane ∠V'A'V1 " between the planes R and V≡R1 with edge RV and an equilateral triangle V'A'V1 ". By dividing ∠V'A'V1 " into two equal parts or by passing the height of ΔV'A'V1 ", a horizontal QbisN trace of

the bisector Q plane is constructed. The s' incident light transferred from V 'to QbisN intersects with it at point D'. The light returning from QbisN exits point D 'and passes through V1' 'and forms an elliptical light-line, Fig. 36, b).
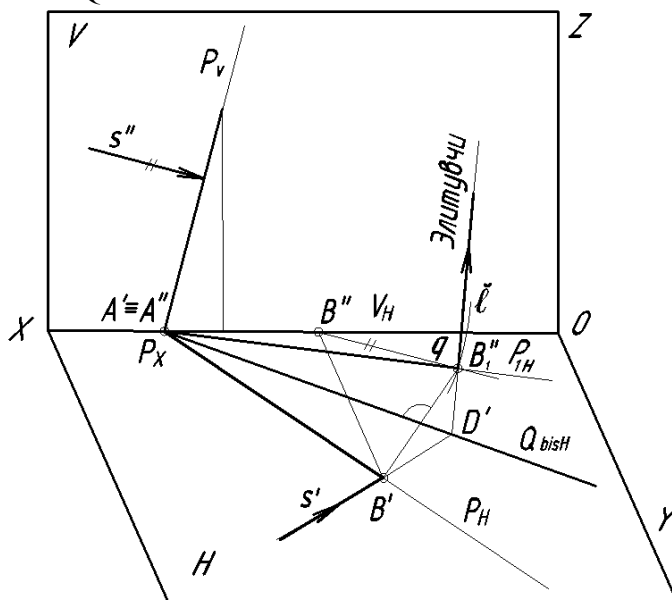

Figure 10

Thus, the projection model or apparatus developed in Fig. 11, b, indirectly equates all points of the planes in the arbitrary state and the figures lying in it in the real form to the plane V,

exactly the original, that is, the three projection directions or rays (falling s' and s' 'and return-eluting beams). This model (apparatus) is called a diagram in the Kolotov method.
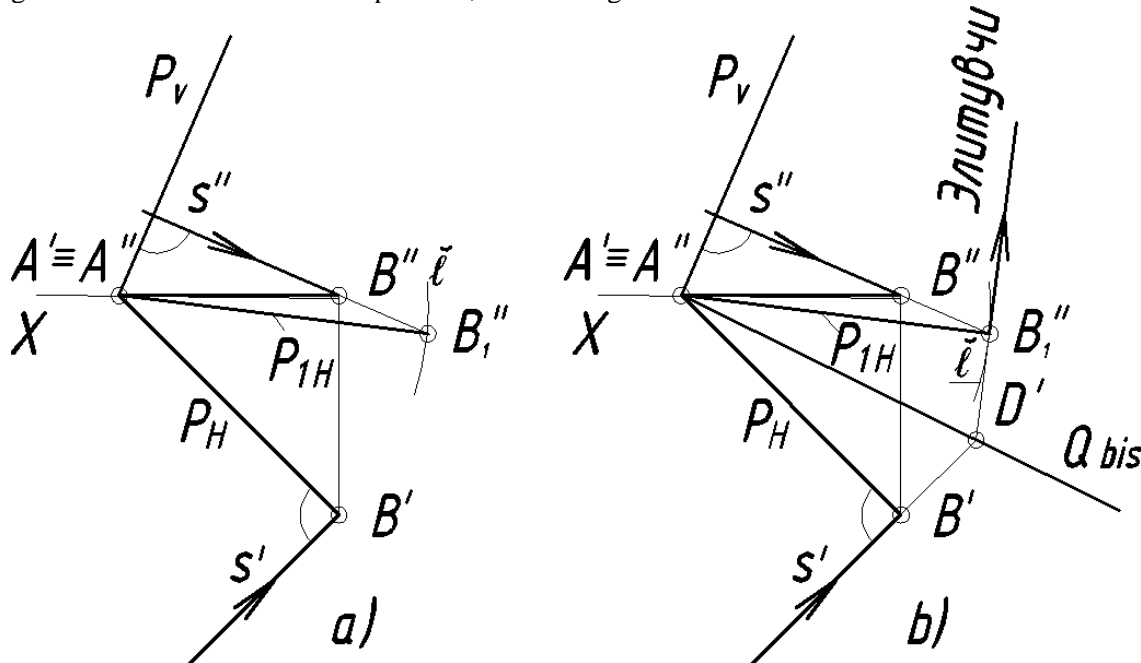

Figure 11

The transformation model (apparatus), which we have developed on the principle of didactics from easy to difficult, from simple to complex and from existing to abstract, is equivalent in all respects to the Kolotov diagram,

so that it is understandable to experts in the field, especially students.

Kolotov developed his diagram for our professors, in a more complex way, by performing

all the graphical operations in the axial plane (ie, without the N and V planes) in the axial plane [5].

Conclusion.

Thus, when the R plane we have developed is arbitrary, the transformation model (apparatus) is constructed on the basis of the following algorithm:

1. According to the condition of the problem, the plane R and the direction of the new projection beam and the horizontal AV section perpendicular to it are made:

s ⊥ R i.e. s' ⊥ RN, s"⊥RV and AV ⊥ s, AV ‖ N;

2. The point V1 "is defined. The projection derived from U V " is formed by the intersection of the arc bo'lgan with radius A'V 'and the center A (A', A") with the direction of light s ":

ℓ yoy ∩ s' '= V1 "and AV = A" V1 "= A'V'.

3. The trace of the bisector plane and the directions of the elliptical line are determined. By passing the height of the resulting triangle V'A'V1 ", the adjacent QbisN is constructed. The direction of the elliptical line is determined by passing the projection light direction V 'to s' on QbisN, passing the point D' and perpendicular to it A" V1 ":

Δ V'A'V1 "height of the triangle - QbisN is constructed.

V '□ s' ∩ QbisN = D 'and D' □ elite ⊥ A "V1" (R1N)

We call this algorithm, which consists of three graphical operations, the 2nd algorithm for building a transformation model (apparatus).

Thus, using a transformation model or apparatus of auxiliary right-angled projection, it is possible to easily depict all points and figures of the R plane, such as point V, in the original view or in sizes or lengths, or in point view of the plane V.

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