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[56]

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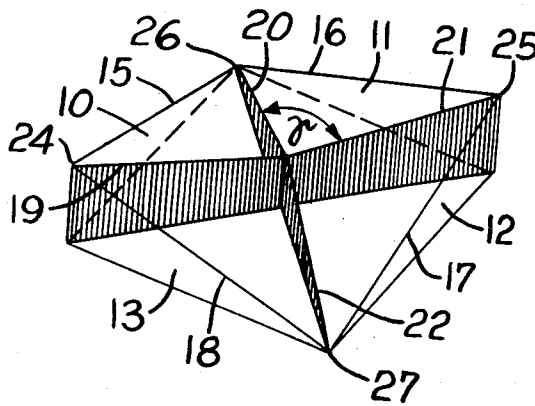
Assistant Examiner—F. L. Evans

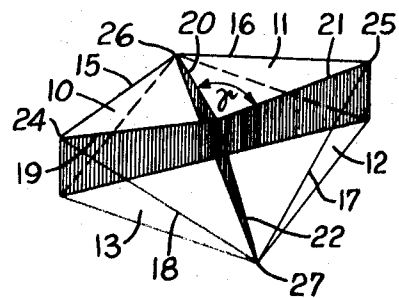
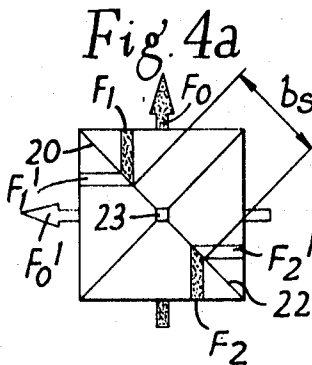
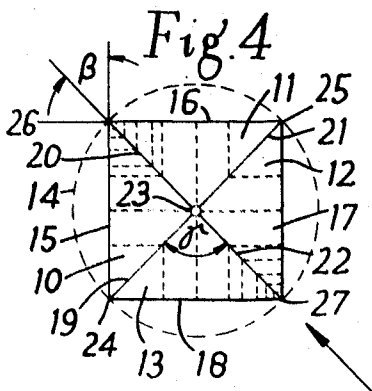
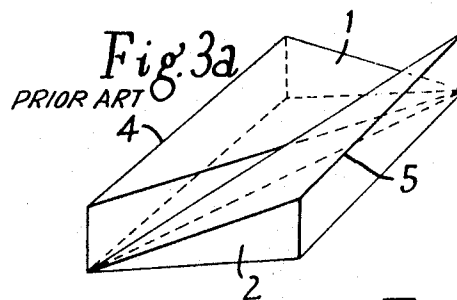
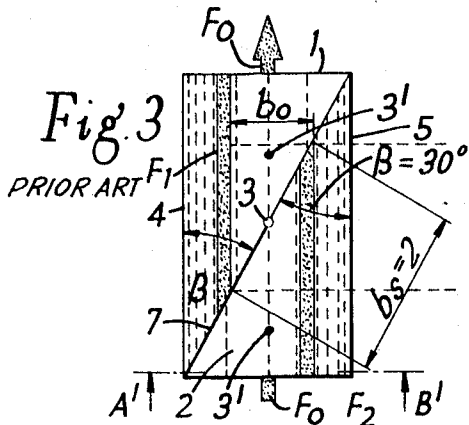
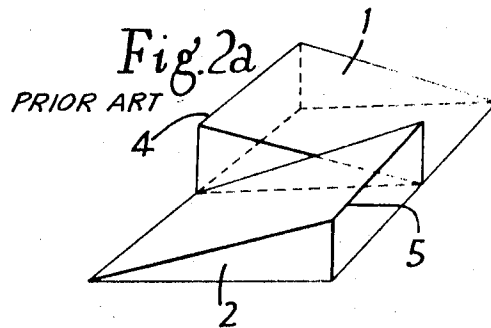
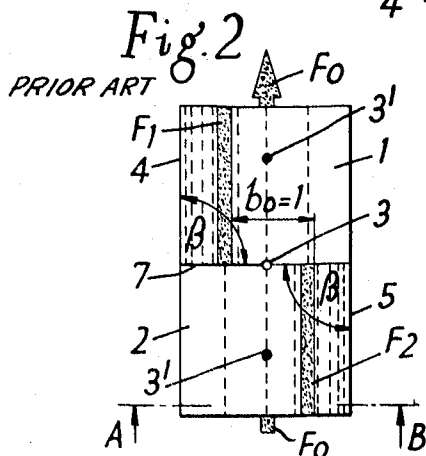
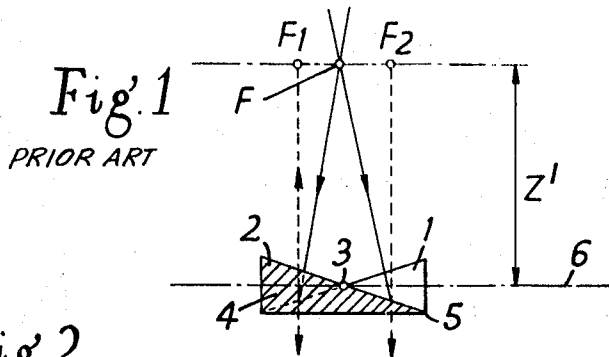
Attorney—Young & Thompson

[54] **PHOTOGRAPHIC IMAGE-FOCUSING DEVICE**
3 Claims, 17 Drawing Figs.

[52] U.S. Cl. **88/1.5 R,**
 95/44 R, 350/167, 350/189, 350/193, 350/286
 [51] Int. Cl. **G03b 13/18**
 350/286,
 [50] Field of Search. 287, 167, 189, 193; 88/1.5; 95/44

ABSTRACT: An image-focusing plate for cameras comprises two or four parts formed from wedge prisms arranged to form an image-intersection line which is displaced along its length through an angle not exceeding 100° or intersects another image intersection line at an angle γ not exceeding 100° . The image-intersection line or lines where they intersect a center of symmetry of the plate are at an angle β smaller than 46° relative to an end of maximum cross-sectional area of a wedge from which a part is formed.





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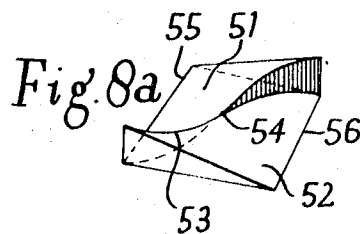
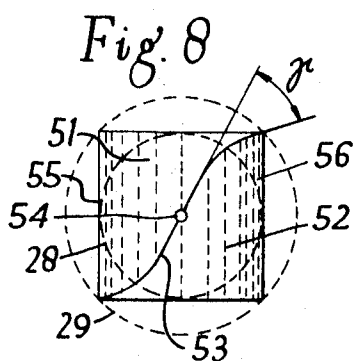
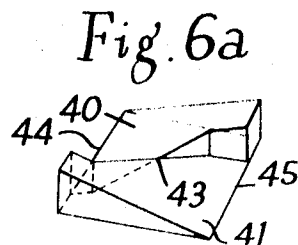
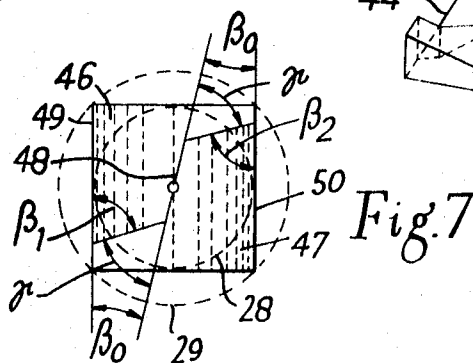
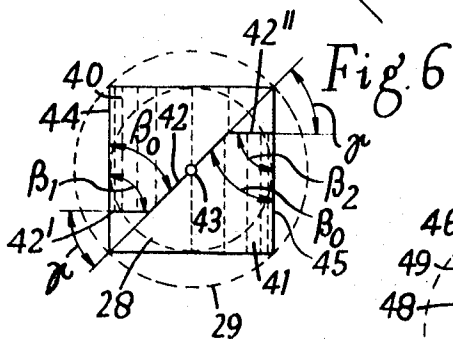
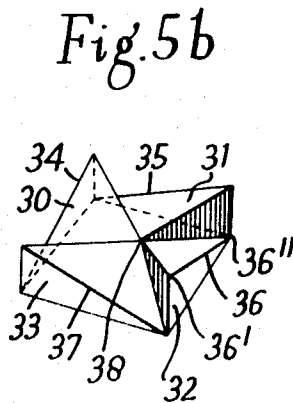
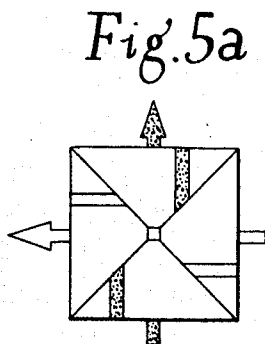
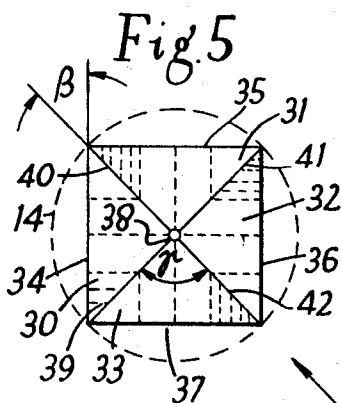
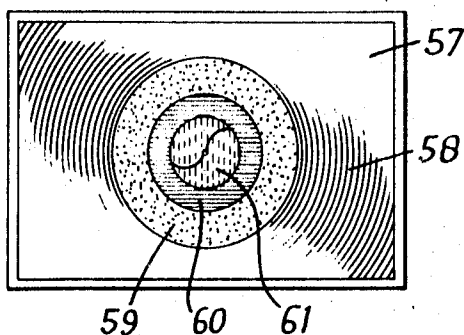


Fig. 9



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PHOTOGRAPHIC IMAGE-FOCUSING DEVICE

BACKGROUND OF INVENTION

The invention relates to an image-focusing plate with biprism coincidence focusing means or a biprism group for photographic and cinematographic cameras, the biprism being formed with an acute angle enclosed by the refracting wedge edge and the image-intersection line, such angle advantageously being in the mean measurement range of smaller than 46° .

The known biprisms of the focusing plates are constructed from triangular wedge prisms and mainly have one common feature, which is that the angle between the image-intersection line and the parallel thin-and-thick edges of the wedge is 90° . Generally speaking, the image-intersection line, which is defined as a line which within the biprisms divides an image of a subject being viewed. The image-intersection line is the contact line between two prism sections or pairs of prism sections as shown in FIGS. 2 and 2a by line 7. With biprism groups for use in transverse and upright format, a vertical image-intersection line has also been proposed in conjunction with the horizontal image-intersection line. The maximum possible measurement sensitivity with these biprism arrangements is then obtained when the object edge, during the focusing, is disposed at right angles to the image-intersection line. The maximum measurement sensitivity which can be produced in this way, is here to be designated as $b_0=1$ (100 percent). When the object edge is arranged obliquely to the image-intersection line, the result is a reduced measurement sensitivity following the cosine.

In order to use the single biprism for transverse and upright format, it has been proposed to rotate the biprisms through 45° , so that also the image-intersection line is arranged at an angle of 45° to the format sides, and is usable to focus vertical and horizontal object edges. A disadvantage of such an arrangement is of the wedge that due to the oblique position of the image-intersection line relative to horizontal and vertical object edges, the measurement sensitivity only amounts to approximately 70 percent of the sensitivity when the object edge is arranged at right angles to the image-intersection line which corresponds, when expressed mathematically, to: measurement sensitivity

$$b_\beta = b_0 \cos 45^\circ = 1 \cdot 0.707 = 0.707$$

where b_0 is the maximum sensitivity when the object edge is at right angles to the image-intersection line. For objectives of normal focal length the reduction of sensitivity is at least 40 percent while for objectives of short focal length, e.g. wide-angle objectives, the measurement sensitivity is reduced by at least 70 percent.

It has also been proposed to overcome these disadvantages by forming the biprism from two wedge prisms cut so that an angle β between the image-intersection line and the parallel thick-and-thin edges of the triangular wedge is about 30° (see FIG. 3). For an angle $\beta=30^\circ$, there is then produced a doubling of the image displacement path $b_\beta=2$, see FIG. 3, and this also means a doubling of the measurement sensitivity. In theory, an increase in the measurement sensitivity up to about 5.75 times can still be efficiently utilized, that is to say, up to about $\beta=10^\circ$.

For the focusing of normal objectives, where the focal length is approximately equal to the format diagonal, an angle $\beta=45^\circ$ is already sufficient, since by this means the measurement sensitivity can be increased to $b_\beta=1.414$, i.e. by 41.4 percent.

Since only half of the width of the biprism can be utilized at $\beta=30^\circ$, assuming a square biprism boundary, it has also been proposed to use two wedge intersection lines offset in parallel relationship, so that the left wedge intersection line ends in the left lower corner and the right wedge intersection line ends in the right upper corner. With this arrangement, however, it was necessary to accept the disadvantage that the focusing is made difficult because of the existence of three intersected images

and thus the simplicity of the focusing operation is lost. Another disadvantage is that the arrangement can only be used for one format position, e.g. a transverse format.

The object of the invention is to obviate the said disadvantages by including both vertical and horizontal object edges without having to readjust the camera during the image focusing.

BRIEF SUMMARY OF INVENTION

The invention achieves this object by providing an image-focusing device for cameras comprising two parts formed from wedge prisms, each triangular wedge prism having a face comprising the hypotenuse of the triangle of the wedge having a first edge at the thin end of the wedge and a second edge at the end of the wedge of maximum cross-sectional area of the wedge and parallel to said first edge; the parts being arranged reversed relative to each other so that the first edge of each wedge is adjacent and parallel to the second edge of the other wedge, wherein between the parts there is provided an image-intersection line which extends from a position one end of the second edge of one prism to the corresponding position the corresponding end of the second edge of the other prism, the image-intersection line having a first part passing through a center of symmetry which is midway between the ends of the image-intersection line, wherein the included angle between said first part and the second edges of said prisms is less than 46° , the image-intersection line also having a second part which is displaced through an angle no greater than 100° from said first part.

According to another aspect of the invention there is provided an image-focusing device for cameras comprising four parts formed from triangular wedge prisms, each wedge prism having a face comprising the hypotenuse of the triangle of the wedge, a first edge at the thin end of the wedge and a second edge at the end of the wedge of maximum cross-sectional area of the wedge and parallel to said first edge, the parts being arranged in pairs having two parts reversed relative to each other so that the first edge of each wedge of a pair of parts is adjacent and parallel to the second edge of the other wedge of the pair of parts, said adjacent and parallel edges of the wedges of one pair of parts being arranged perpendicularly to said adjacent and parallel edges of the other pairs of parts so that in plan view the four parts each form a triangle and together form a rectangle having one image-intersection line which extends from one corner of the rectangle to the opposite corner thereof and passes through the center of the rectangle, and a second image-intersection line which extends through the other two corners of the rectangle and passes through the center of the rectangle.

In a further embodiment of the invention, the image-intersection line comprises outside its middle region, curvatures of which the tangents to the mean intersection line show an angle which is at a maximum $\gamma \leq 90^\circ$.

By contrast with the known coincidence-focusing means, the advantages which arise from the invention make possible general measurements outside the middle region and as far as the margin, the image-intersection line being provided with a portion displaced relative to another portion guaranteeing in a middle region very accurate coincidence measurements with high measurement sensitivity.

DESCRIPTION OF DRAWINGS

Embodiments of the invention will now be described by way of example with reference to the accompanying drawings, wherein:

FIG. 1 shows diagrammatically the action of the known biprisms;

FIG. 2 shows known biprisms with $\beta=90^\circ$ and a horizontal image-intersection line and indicating the image displacement;

FIG. 2a is a perspective view of a biprism according to FIG.

FIG. 3 shows known biprisms with $\beta=30^\circ$ and an oblique image-intersection line with the image displacement indicated;

FIG. 3a is a perspective view of a biprism according to FIG. 3;

FIG. 4 shows a pair of biprisms with an image-intersection line bent in the center of symmetry in each separate prism with a bending angle $\gamma=90^\circ$;

FIG. 4a shows a biprism as in FIG. 4, indicating the image displacement for vertical and horizontal objects;

FIG. 4b is a pair of biprisms, as in FIG. 4, seen in perspective;

FIG. 5 shows a pair of biprisms with the image-intersection line of each separate prism bent in the center of symmetry with a bending angle $\gamma=90^\circ$;

FIG. 5a shows a pair of biprisms as in FIG. 5, with the image displacement indicated for vertical and horizontal objects;

FIG. 5b is a perspective view of a pair of biprisms as in FIG. 5;

FIG. 6 is a biprism having an image-intersection line which is bent twice;

FIG. 6a is a perspective view of the biprism of FIG. 6;

FIG. 7 is a biprism with an image-intersection line bent outside the center of symmetry;

FIG. 8 is a biprism with a curvilinear image-intersection line;

FIG. 8a shows the biprism as in FIG. 8 in perspective;

FIG. 9 shows an image-focusing plate with biprisms according to FIG. 8, with a horizontal microcoincidence screen in ring form.

DESCRIPTION OF EMBODIMENTS

For the sake of easier understanding, zones with the same height above the bases are indicated by broken lines in FIGS. 2, 3, 4, 5, 6, 7, 8 and 9. Positions at a lower level are represented by closer spacings and positions at a higher level by wider spacings between these broken lines.

The action of the biprisms 1 and 2 is represented in known manner in FIGS. 1, 2 and 2a. The oblique prism surfaces intersect at the wedge intersection point 3. The edge 4 belongs to the prism 1 and the likewise horizontally extending wedge edge 5 to the prism 2 which is shown in section. The two beams extending through the image point F in the direction of the arrow come from an objective which is not shown and reach the observer's eye after having each been deflected by a wedge. The image point F is seen by the eye through the prism 1 as lying at F_1 and through the prism 2 as lying at F_2 . The image displacement is indicated by the distance $F_1 F_2$. The distance from F to the wedge intersection point 3 then corresponds to the travel z' of the objective. If an image of the image point F is formed in the chain-dotted plane passing through the point 3, then the image displacement is zero, i.e. the component images coincide.

The representation of the prisms in FIG. 1 corresponds to the sections A-B and A'-B' of the known arrangements according to FIGS. 2 and 3. FIG. 2 is a plan view of known biprisms with $\beta=90^\circ$. The image-intersection line 7 extends horizontally. Extending at right angles thereto through the wedge intersection point 3 is the common height line 3' of the prisms 1 and 2. The image displacement path in the image-intersection line is $b_o=1$. All other references are identical with those in FIG. 1.

FIGS. 3 and 3a show another known arrangement of biprisms with an image-intersection line 7 extending at an angle $\beta=30^\circ$ between the prisms 1 and 2 which, in plan, are made triangular. Measured horizontally, an image spacing b_o is produced in FIG. 3 exactly as in FIG. 2. However, since the eye automatically follows the image-intersection line 7 in FIG. 3, in order to judge the displacement spacing of the component images F_1 and F_2 , hence the image displacement appears greater as an apparent value b_s . This can simply be calculated as $b_s=2b_o$, hence the measurement sensitivity has been

doubled by comparison with FIG. 2. The geometrical relationships according to FIG. 3 are made clearly apparent by b_o , the hypotenuse b_s and the angle β shown in FIGS. 2 and 3.

The measurement sensitivity can in known manner be improved, for example, by 1.414 times, if the outsides of the biprisms are made square or round and the image-intersection line forms an angle of 45° in relation to the wedge edge.

Various embodiments of the arrangement according to the invention are shown in FIGS. 4-9.

By contrast with the constructional forms which are shown in FIGS. 2a and 3a, the triangular wedges 10, 11 and 12, 13 which are shown in FIG. 4 each form part of a separate triangular wedge prism and are all of equal size and are assembled without any break and without any change in level into a square formation. Where the biprisms have a round outer boundary, as indicated by the broken line 14, sector-shaped wedges would be produced. In relation to the obliquely extending wedge edges 15, 16, 17 and 18, the image-intersection lines 19 to 20 and 21 and 22 meet at an angle of γ in a common intersection point 23, which is lower relatively to the corner points 24 and 25 of the wedge edges but is higher in relation to the corner points 26 and 27, see FIG. 4b. It can be seen that the angle is about 90° in each case. The part 13 of the wedge prism, for example, is thus defined by the edge 18 descending obliquely relatively to the horizontal plane and the image-intersection lines 19 and 22 joining at the intersection point 23. Because of an intersection point 23 which, common to all prism wedge parts 10 to 13, lies in the center of symmetry it becomes possible simultaneously to include vertical and horizontal object edges for both upright and transverse format. This is due to the fact that the measurement points lying outside the intersection point 23 of each individual wedge are at the same height. This is an advantage over previously known image-focusing plates.

In FIG. 4a, there are shown the image displacements F_1 and F_2 for the vertical object F_o and the image displacements F_1' and F_2' for the horizontal object F_o' , as well as the image displacement path $b_s=1.414$ of the two image-intersection lines 20, 22.

FIG. 4b is a view in perspective of the biprism group, when FIG. 4 is observed in the direction of the arrow. In order better to show the differences in height within a single wedge prism and to show that the image-intersection line bent in the intersection point starts from a highest point of the wedge edge and extends via the intersection point lying at somewhat lower level as far as the lowest wedge edge point, the cross sections made by the center of symmetry of the pair of biprisms are shown crosshatched.

FIGS. 5 to 5b show another embodiment of a biprism group with the image-intersection lines of the prisms intersecting at the center of symmetry.

As in FIG. 4, the square biprism pair can be visualized as being composed of four separate parts 30, 31, 32 and 33 cut from triangular wedge prisms. The steps or breaks between the separate parts 30 to 33 are formed by the edges 34, 35, 36 and 37 descending obliquely in relation to the horizontal, the corner point of one part, lying at low level, coinciding with the corner point at high level of the other part. Each of the four parts 30 to 33 forms a separate measurement wedge, each of said wedges being defined by the descending edge and image-intersection lines 39 to 40 and 41 to 42 intersecting at the center of symmetry 38. Said center 38 consequently lies lower, for example, relatively to the corner point 36' but higher relatively to the corner point 36''. The center of symmetry 38 of the pair of biprisms forms the coincidence center of the measuring arrangement. The image displacement in the two main directions is shown in FIG. 5a. The perspective view according to FIG. 5b clearly shows the common symmetry center 38 of all four parts 30 to 33 and the obliquely extending edges 34 to 37 with the steps or breaks between the separate prisms.

FIGS. 6 to 8 show in simplified form prism arrangements formed from triangular wedge prisms having a bent or curved

image-intersection line with horizontally extending edges. Using these biprisms, vertical object edges can be focused.

FIG. 6 shows a pair of prisms 40, 41 having an image-intersection line 42 which is displaced twice, the displacement being situated outside the center of symmetry 43. The angles included between the image-intersection line 42, both the obliquely and the horizontally extending parts 42', 42'' thereof, and the image edges 44 and 45 are β_1 and $\beta_2=90^\circ$, whereas $\beta_0=45^\circ$. The bending angles γ are 45° .

FIG. 7 shows a pair of prisms 46, 47, likewise with an image-intersection line 48 which is displaced twice. The included angles between the image-intersection line 48 and the wedge edges 49 and 50 are β_1 and β_2 and these are approximately 75° , whereas β_0 is about 15° . The displacement angles γ are 60° .

FIG. 8 shows a pair of prisms 51, 52 with an image-intersection line 53 extending curvilinearly and disposed obliquely above the image center; the said line comprises outside the center of symmetry 54, curvatures of which the tangents intersect the refracting, horizontally extending edges 55, 56 at an angle of about 70° . The bending angles γ are about 40° .

For better understanding, the constructional forms of the prism groups according to FIGS. 6 and 8 are shown in perspective in FIGS. 6a and 8a, respectively. The external form of the boundary lines 28 or 29, which are shown in broken lines in FIGS. 6, 7 and 8, can for example be made round.

Technical manufacturing advantages are produced if the biprisms or biprism groups are arranged in a photographic or cinematographic camera so as to be advantageously centrally disposed on a focusing plate, Fresnel plate or field lens, for example, according to FIG. 9, and the whole is advantageously made of one piece of extruded, stamped or pressed glass or clear synthetic plastics material. Furthermore, biprism arrangements are possible which in known manner are arranged on a ground glass screen, with or without fine structures, e.g. microscreens. Constructional forms consisting of two or more parts are also envisaged, and these can for example, be assembled by cementing.

FIG. 9 shows one constructional form in which an image-focusing plate 57 consisting of one piece has the following optically refracting surfaces: Fresnel rings 58, which serve for the uniform brightening of the image; various devices for the focusing are arranged in the middle of the image-focusing screen, these being a ground glass ring 59, a microscreen 60 and finally a biprism 61 according to the invention and conforming to one of the image-focusing systems shown in FIGS.

4 to 8.

I claim:

1. An image-focusing device for cameras comprising two parts formed from triangular wedge prisms, each wedge prism having a face comprising the hypotenuse of the triangle of the wedge, a first edge at the thin end of the wedge and a second edge at the end of the wedge of maximum cross-sectional area of the wedge, said second edge being parallel to said first edge, the parts being arranged reversed relative to each other so that the first edge of each wedge is adjacent and parallel to the second edge of the other wedge, wherein between the parts there is provided an image-intersection line which extends from a position adjacent one end of the second edge of one prism to the corresponding position adjacent the corresponding end of the second edge of the other prism, the image-intersection line having a first part passing through a center of symmetry which is midway between the ends of the image-intersection line, wherein the included angle between said first part and the second edges of said prisms is less than 46° , the image-intersection line also having a second part spaced from said first part and which is displaced through an angle no greater than 100° from said first part.

2. An image-focusing plate according to claim 1, wherein the image-intersection line comprises curvatures along its length other than at its midpoint, the tangents of said curvatures intersecting said second edges of the wedges at an angle of at most 90° .

3. An image-focusing device for cameras comprising four parts formed from triangular wedge prisms, each wedge prism having a face comprising the hypotenuse of the triangle of the wedge, a first edge at the thin end of the wedge and a second edge at the end of the wedge of maximum cross-sectional area of the wedge and parallel to said first edge, the parts being arranged in pairs having two parts reversed relative to each other so that the first edge of each wedge of a pair of parts is adjacent and parallel to the second edge of the other wedge of the pair of parts, said adjacent and parallel edges of the wedges of one pair of parts being arranged perpendicularly to said adjacent and parallel edges of the other pair of parts so that in plan view the four parts each form a triangle and together form a rectangle having one image-intersection line which extends from one corner of the rectangle to the opposite corner thereof and passes through the center of the rectangle, and a second image-intersection line which extends through the other two corners of the rectangle and passes through the center of the rectangle.

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