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CA 2098575 C 2002/08/20

(11)(21) 2 098 575

(12) BREVET CANADIEN
CANADIAN PATENT

(13) C

(86) Date de dépôt PCT/PCT Filing Date: 1991/12/16
(87) Date publication PCT/PCT Publication Date: 1992/06/18
(45) Date de délivrance/Issue Date: 2002/08/20
(85) Entrée phase nationale/National Entry: 1993/06/16
(86) N° demande PCT/PCT Application No.: FI 1991/000390
(87) N° publication PCT/PCT Publication No.: 1992/011607
(30) Priorité/Priority: 1990/12/17 (906225) FI

(51) Cl.Int.^{5}/Int.Cl.^{5} G06K 7/14

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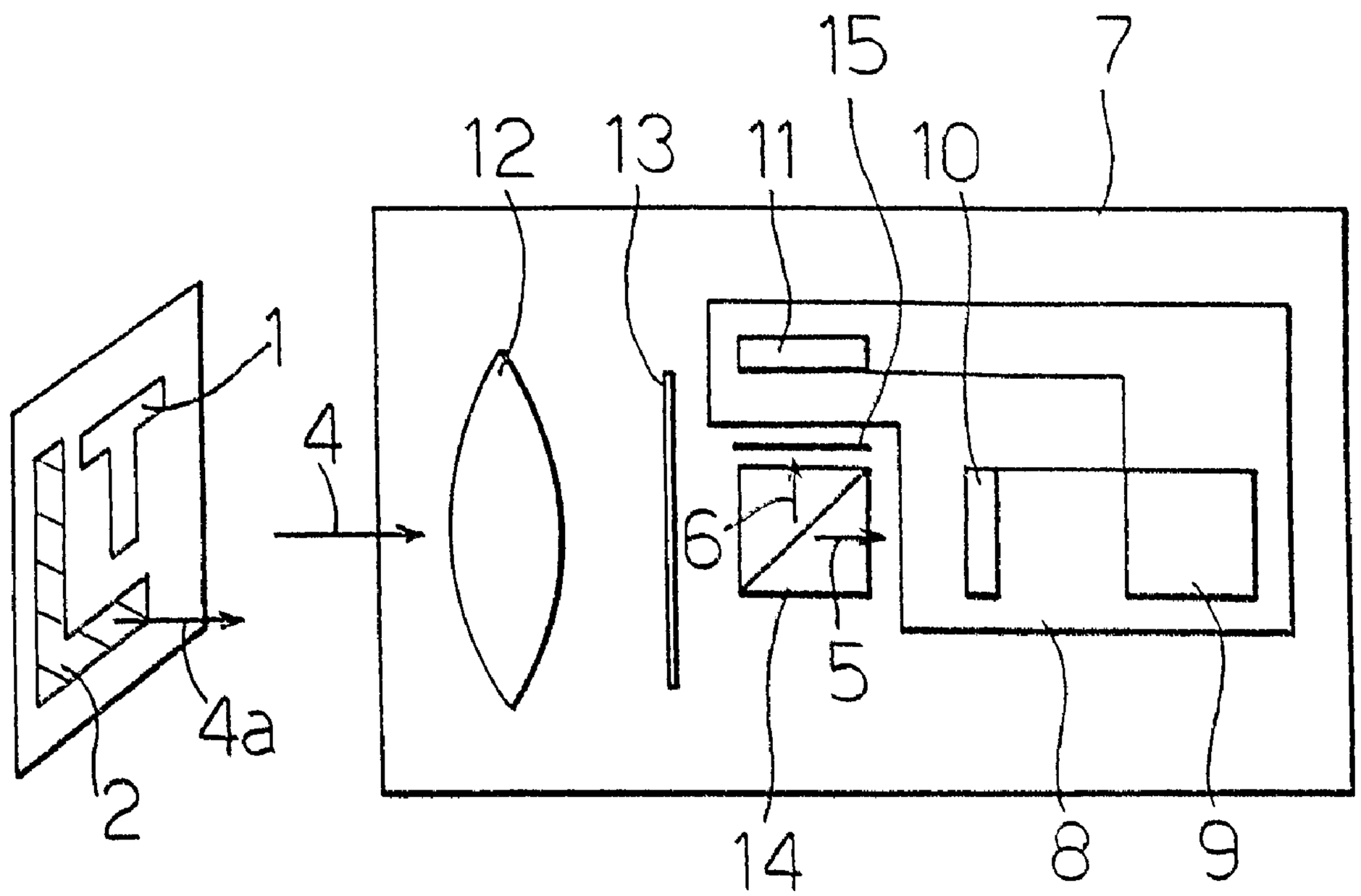
(54) Titre : PROCEDE ET SYSTEME D'IDENTIFICATION
(54) Title: IDENTIFYING PROCEDURE AND SYSTEM



(57) Abrégé/Abstract:
An identifying procedure and system for identifying a visual object, the object to be identified (I) being marked with a polarizing surface (2) provided in the region of the object. Observation of the object is accomplished by utilizing the lighting prevailing at the object and in its ambience, on the basis of the polarized light (4a) reflected by said polarizing surface.

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PCT WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 5 : G06K 7/14 2098575 A1

(11) International Publication Number: WO 92/11607

(43) International Publication Date: 9 July 1992 (09.07.92)

(21) International Application Number: PCT/FI91/00390

(22) International Filing Date: 16 December 1991 (16.12.91)

(30) Priority data:
906225 17 December 1990 (17.12.90) FI

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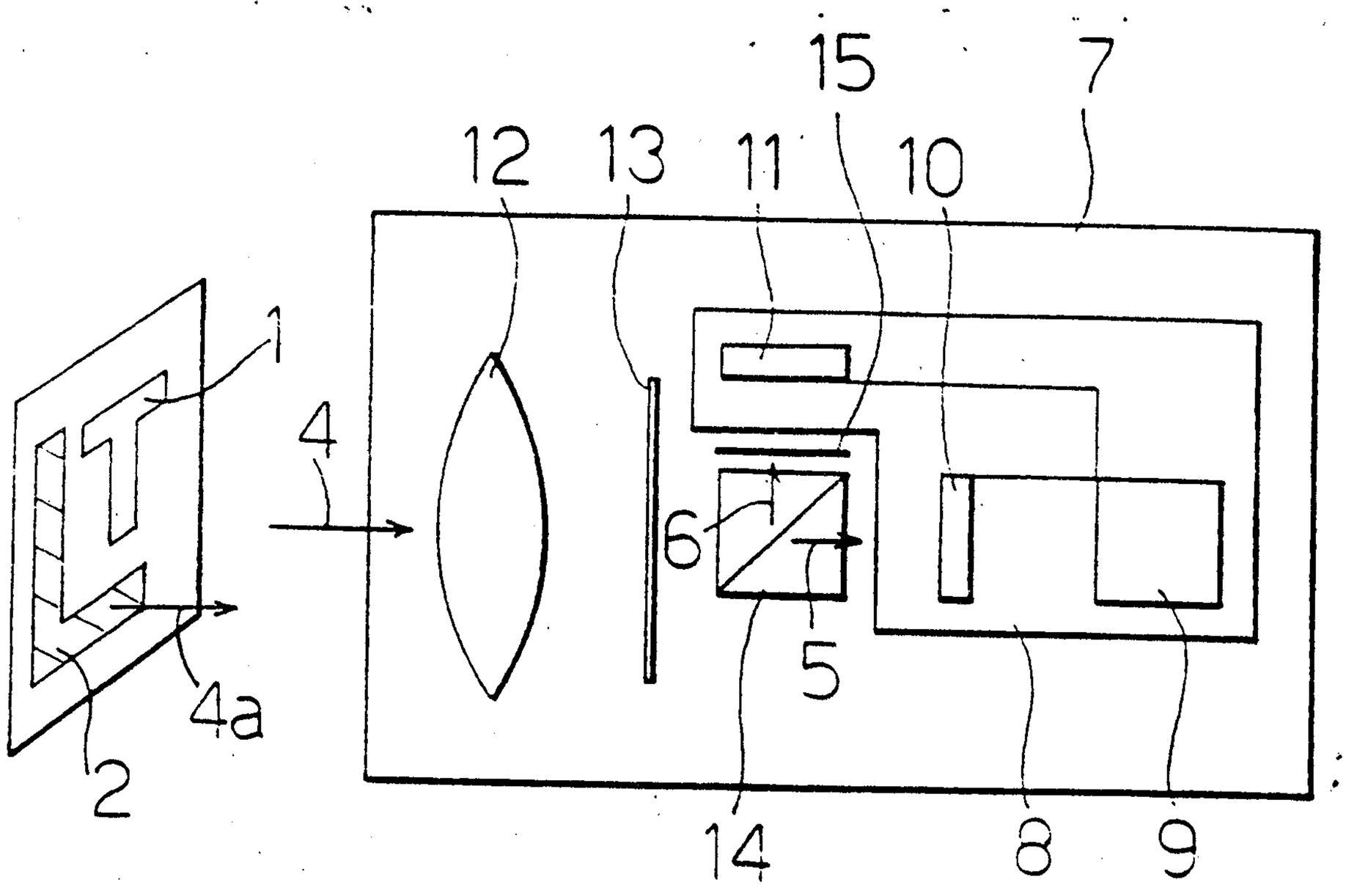
(81) Designated States: AT, AT (European patent), AU, BB, BE (European patent), BF (OAPI patent), BG, BJ (OAPI patent), BR, CA, CF (OAPI patent), CG (OAPI patent), CH, CH (European patent), CI (OAPI patent), CM (OAPI patent), CS, DE, DE (European patent), DK, DK (European patent), ES, ES (European patent), FI, FR (European patent), GA (OAPI patent), GB, GB (European patent), GN (OAPI patent), GR (European patent), HU, IT (European patent), JP, KP, KR, LK, LU, LU (European patent), MC (European patent), MG, ML (OAPI patent), MN, MR (OAPI patent), MW, NL, NL (European patent), NO, PL, RO, SD, SE, SE (European patent), SN (OAPI patent), SU+,TD (OAPI patent), TG (OAPI patent), US.

Published
With international search report.
In English translation (filed in Finnish).

(54) Title: IDENTIFYING PROCEDURE AND SYSTEM



(57) Abstract

An identifying procedure and system for identifying a visual object, the object to be identified (1) being marked with a polarizing surface (2) provided in the region of the object. Observation of the object is accomplished by utilizing the lighting prevailing at the object and in its ambience, on the basis of the polarized light (4a) reflected by said polarizing surface.

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IDENTIFYING PROCEDURE AND SYSTEM

The present invention relates to a procedure and system for locating and identifying a visual object.

Automatic identification of a visual object or mark is difficult owing to the abundance of signals. The location and attitude of the object to be identified are not always known in advance. The object may be partly covered with dirt or the like, so that observation of the object and, for instance, aiming and focussing a camera or equivalent serving as identifier, on the object to be identified is impossible, or difficult at least.

The object of the invention is to eliminate the drawbacks mentioned. It is particularly an object of the invention to enable locating and identifying of various visual objects in a reliable, accurate and rapid manner even if the object should be located far away.

In the identifying procedure of the invention the object to be identified is marked with at least one polarizing surface area provided either on the object or in conjunction with the object, i.e., in the region, or vicinity, of the object, observation of the object being accomplished with the aid of polarized light reflected by the polarizing surface. It is thus understood that observation of the object takes place, in the invention, by utilizing the illumination present at the object and in its ambience, on the basis of polarized light coming from the polarizing surface. Since no similar polarized light exists inherently in nature, the polarized light emitted by the surfaces serving as markers is easy to distinguish from other ambient light and radiation. As taught by the

invention, the polarizing surfaces act merely as locators of the object that is to be identified.

The invention may be summarized as procedure for locating and identifying a visual object wherein: the visual object is marked with a separate polarizing surface provided in a region of the object; the observation of the existence and the location of the polarizing surface is accomplished by utilizing lighting prevailing at the surface and in its ambience, on the basis of polarized light coming from said polarizing surface; characterized in that the relative positioning of the surface and the visual object is known and the location of the object to be identified is accomplished on the basis of said known relative positioning after which the object is identified in a way other than on the basis of polarization.

Advantageously in the procedure of the invention, a polarized surface is placed in the vicinity of the object to be identified, so that the positioning of the polarizing surface and of the object to be identified is known, in which case when the easily observable polarizing surface is first found, the object meant to be identified can also be located with its aid.

Since polarizing surface coatings do not alter the appearance of an object, one may upon the object to be identified attach a transparent polarizing film which supplies the information needed in the locating process, while identification of the object itself is accomplished in another way. It should be noted, however, that at a location with black background no polarization can be

discerned because a black area reflects no radiation whatsoever.

If the object to be examined may present itself in arbitrary attitude relative to the identifying apparatus, it will be advantageous to use a polarizer producing light with circular polarization. The attitude and inclination of the object can be found by calculation if the polarized area is made asymmetric, e.g. in the shape of a letter L. It is then possible from the image to calculate the true attitude relative to the identifier from the ratio of the side lengths and from the angle between the sides and, if desired, to rotate the object in the image into normal position.

The attitude of the object can also be determined if the object is marked with two different-handed circular polarizers which are positioned in known manner relative to the object.

If the size of the object is known, the distance of the object can be calculated with the aid of

the angle of view. The object may itself carry information on the object's size.

If the object is far away, or if the image of the object is small for any other reason, it is conceivable that both polarized light and unpolarized light from an adjacent area impinge on one surface element in the identifying apparatus. The identifying apparatus will then identify the light falling on such an area as partly polarized. It is then possible to examine such a location by zooming on it, and to check whether there is an object in the area.

It is advantageous to use for image identifying means a camera in which the image is formed at two separate locations so that the light which is horizontally polarized relative to the camera and that which is vertically polarized thereto are directed to go to separate images. If the object is marked with circular polarizers, the circularly polarized light is converted to linearly polarized light prior to its division into separate images. This conversion can be accomplished with a suitable delay element, such as a lambda/4 plate for instance, which is placed under a suitable angle relative to the camera. It is possible by comparing, in the images, the luminance values of equivalent points to find the polarized areas, if any, and the object to be identified can be observed. The object may also be transferred to a monitor or recorded for later scrutiny.

The visual object-identifying system of the invention comprises appropriate image identifying means, for which suitable cameras, for instance may be used. As taught by the invention, the system comprises a polarizing surface, or several surfaces, of known shape and with known polarizing characteristics, placed in the region of the object to be identified. Furthermore, in the system the image identifying means are incorporated in an identifying apparatus, which, if

required, includes a suitable delay element for converting circularly polarized light to linearly polarized light, and a divider means by which the incoming light is divided into two parts in accordance with its direction of polarization.

According to this aspect the invention may be summarized as system for locating and identifying a visual object comprising: in a region of the visual object a separate polarizing surface or separate polarizing surfaces; means for observing the existence of and locating the polarizing surface or surfaces by utilizing the lighting prevailing at the surface thereof and in its/their ambience, on the basis of the polarized light coming from said polarizing surface or surfaces, said means comprising an identifying apparatus including image identifying means, in which is provided a divider means for dividing the polarized light reflected by the polarized surface or surfaces into two parts on the basis of polarization, characterized in that the separate polarizing surface has a known shape and/or known direction of polarization or the separate polarizing surfaces have different polarizing properties, and the relative positioning of the polarizing surface or surfaces and the visual object is known, and that it further comprises means for determining the location of the visual object to be identified on the basis of said known relative positioning; and means for identifying the object in a way other than on the basis of polarization.

For divider, a crystal is advantageously used which has a division interface admitting light with a given direction of polarization to pass through but reflecting any

light which is polarized at right angles against the first direction. It is also feasible to use for divider, a birefringent crystal or a semitransparent mirror in conjunction with which polarization filters are provided.

If the camera which is employed handles a two-dimensional image, the object can be observed and identified with one single exposure even if the image should be two-dimensional and even if it should present itself with arbitrary attitude.

If the camera only handles a one-dimensional image, it is advantageous to use a one-dimensional object on which the information has been encoded in bar code fashion. The polarized area is positioned in a line with the code. When the identifier apparatus observes a polarized area, the code itself is also readable in the same image. If the attitude of the object is not known in advance, the code may be composed of concentric rings, and the polarizing area used as detector is placed in the centre of the area. When the identifying apparatus observes a polarized area, the code will be found in the image on either side of the polarized area. In order to bring the object into the image, it may be necessary to move either the object or the identifying apparatus.

The procedure and system of the invention may be used in the following applications, among others.

Various traffic signs and signals used in road traffic can be marked with a suitable polarizing sur-

face, whereby they can be automatically recorded with appropriate instruments and displayed in a suitable manner and at a suitable occasion e.g. before the driver's eyes. Speed limits, for instance may be automatically recorded by an apparatus provided in the vehicle, where they can be looked up when needed.

Another potential application of the invention is marking pieces and goods in automated production, transport and storage. In storage operations, when the objects to be stored are marked with codes, such code markings as are used may be encircled, or otherwise marked, with polarizing surfaces so that they are easy to observe, and to record, with automatic identifying apparatus, even from great distance. Likewise, the system is applicable e.g. in goods transport in recording the flow of wagons and case goods, and in production plants in recording and directing the products moving on production lines.

The invention may also be applied in determining the location and/or attitude of a body, or of another equivalent object. The body is marked with a polarizing surface, or surfaces, placed in known manner relative to the body. As soon as the location and attitude of the polarizing surface have been found, the location and attitude of the body itself can also be determined.

With the aid of observations which are consecutive in time, the quantities associated with a body's state of motion can be found, such as its velocity, acceleration, speed of rotation, etc.

The advantage afforded by the procedure and system of the invention over the state of art is simple, fast and accurate automatic observation and identification of various objects, signs, codes, signals and equivalent. Since the analysis is made within one image frame, any proper movement of the object exerts an influence only within the limits of the time of

exposure.

The invention differs from the methods of prior art in that the object is marked with a polarizing surface, or surfaces, and the identifying apparatus analyses the sector of space in front of it, searching for polarized areas therein. As soon as a polarized area or areas have been observed, the location and attitude of the object are known on the basis thereof. Identification of the object itself thereafter takes place otherwise than on the basis of polarization. In connection with the identification system, aimed lighting may be used in order to increase the lighting intensity, but no scanning beam is required for identification. In other words, it is not necessary in the system of the invention to hunt for polarizing surfaces or objects in presumed areas by means of light beams which go through, or sweep, such areas; instead, the general illumination prevailing in the space under observation, such as natural light outdoors, is enough for the system of the invention to find in this space any completely polarized light and, on its basis, the object to be identified.

Electromagnetic radiation with a wavelength shorter or longer than that of visible light may equally be used to observe and identify the object.

Also elements other than a polarizing plate or sheet may be used towards marking the object: for instance, a plate or sheet reflecting or transmitting only certain given wavelengths from the radiation. The marker plate/sheet can then be distinguished from the ambience at large with the aid of the spectrum coming from the plate/sheet. Different wavelengths are directed to go to different images in the identifier. This is accomplished either in that a divider means divides the radiation on the basis of wavelength, or in that filters are used after the divider.

In the following the invention is described in

detail with reference to the attached drawing, wherein
Fig. 1 presents, schematically, an identifying system according to the invention,
Fig. 2 presents a practical application of the invention,
Fig. 3 illustrates a practical application of the invention in which the task is to identify a one-dimensional code with known attitude, and
Fig. 4 illustrates an application in which the task is to identify a one-dimensional code with arbitrary attitude.

The visual object-identifying system depicted in Fig. 1 comprises an identifying apparatus 7 including an image identifying means 8 consisting of an analyzer 9 and image surfaces 10 and 11. The light 4 incident on the apparatus is after the objective 12 directed to a crystal 14 provided with a dividing interface and serving as divider means, where the vertically polarized component 5 and the horizontally polarized component 6 of the incident light 4 are separated. The images are formed on the image surfaces 10 and 11.

In the vicinity of the object 1 a letter L-shaped polarizing surface 2 has been placed.

The system according to the invention is operated as follows. When one desires to find and identify the object 1, it is observed with the aid of the polarized light 4a emitted by the polarizing surface 2, because no such light normally occurs in nature. In order that the object 1 could be identified with ease and accuracy, its direction and attitude must be discovered. Since the object 1 which shall be identified is known to be in a certain position relative to the polarizing surface 2, definition of the exact location and attitude of the polarizing surface is enough. This is accomplished as follows.

On the image surfaces 10 and 11 of the identifying apparatus 7 two images of the space sector in

front of the identifying apparatus are formed. One image is produced by the horizontal and the other by the vertical component of the light incident on the divider. If the object is marked with a circularly polarizing surface, the circularly polarizes light must prior to the divider be converted to linearly polarized light. This is accomplished e.g. with a lambda/4 plate 13 in appropriate position.

When there is an object marked with a polarized area in front of the identifier, the two images differ at the location of the polarized area so that the luminosity is significantly higher in one image than in the other. If only one kind of polarizer plate/sheet is used, the brighter image of the polarized area will always be seen on one and the same image surface. The search for the polarized area can be simplified, and interference can be reduced, by placing an attenuator 15 before the respective image surface. Suitable for use as attenuator is a polarizer plate; the strength of attenuation can then be regulated by rotating the plate. The power of the attenuator is adjusted to be such that at the locations of polarized areas the points of said image surface are brighter than the equivalent points on the other image surface, while at any other location the image is less bright than in the other image.

The attitude and shape of the polarized area on the image surface are then found by comparing luminosity values at equivalent points in both images.

When furthermore the true shape of the polarizing surface 2 is known, it becomes possible with the aid of the length ratios and angles in the projection image to determine the attitude of the object and its inclination against the direction of observation. The image obtained from the image surface of the camera can be converted to its normal position by calculation. The object 1 to be identified is thereafter easy to record

and to identify. If the size of the object is known, its distance can be calculated. Or, if the distance is known, the size can be calculated.

In Fig. 2 is depicted another embodiment of the invention wherein the object 1 to be identified, a suitable code of letters or numerals, is encircled with a polarizing surface 2b. Hereby the polarizing surface delimits from a larger area a sharply defined area in which the code that is being used is rather easy to read with the aid of conventional image identifying means.

In Fig. 3 is shown an example of an embodiment in which the object to be identified is a one-dimensional code 1b in known attitude. The polarizer 2c has been placed in a line with the code, in front of the initial end of the code. The object is easy to observe and to identify with an identifier handling a one-dimensional image. When there is an image of the space slice 16 on the image surfaces of the identifier, the polarization is observed, and the code can be interpreted at the moment.

In Fig. 4 is seen an example of an embodiment in which the task is to identify a one-dimensional code with arbitrary attitude. The code is represented by concentric rings 1c. The polarizer 2d is placed in the centre of these rings. When there is an image of the strip 16 in the camera, the code is found on either side of the polarized area.

In the search for a one-dimensional code which has been coded in a line with known attitude or in the form of concentric rings, the amount of light incident on the image surfaces of the identifier can be augmented by reducing the image formed in the identifier, in the direction perpendicular against the space slice.

In the foregoing the invention has been described by way of example with the aid of the attached drawings, while different embodiments of the invention

are conceivable within the scope of the inventive idea delimited by the claims.

CLAIMS:

1. Procedure for locating and identifying a visual object wherein:

the visual object is marked with a separate polarizing surface provided in a region of the object;

the observation of the existence and the location of the polarizing surface is accomplished by utilizing lighting prevailing at the surface and in its ambience, on the basis of polarized light coming from said polarizing surface;

characterized in that

the relative positioning of the surface and the visual object is known and

the location of the object to be identified is accomplished on the basis of said known relative positioning after which the object is identified in a way other than on the basis of polarization.

2. Procedure according to claim 1, characterized in that the polarizing surface is placed in the vicinity of the visual object.

3. Procedure according to claim 1, characterized in that the polarizing surface is placed to cover the visual object totally or in part.

4. Procedure according to any one of claims 1 to 3, characterized in that a surface with asymmetric shape is used as said polarizing surface.

5. Procedure according to any one of claims 1 to 3, characterized in that polarizing surfaces with different polarizing properties are used to mark the visual object.

6. Procedure according to any one of claims 1 to 5, characterized in that an attitude of the visual object is identified with the aid of a shape and a position relative to each other or an asymmetric surface or of different polarizing surfaces.

7. Procedure according to any one of claims 1 to 6, characterized in that a distance of the visual object is identified with the aid of a polarizing surface of known size.

8. Procedure according to any one of claims 1 to 7, characterized in that a projection image of the visual object is rotated into an identifying position with the aid of the shape of a known polarizing surface or of the shape and position relative to each other of different polarizing surfaces.

9. Procedure according to any one of claims 1 to 8, characterized in that vertically and horizontally polarized components of incident light are separated into two separate images, comparison of said images being performed to observe the polarized light, if any and the existence of the visual object thus being ascertained.

10. Procedure according to any one of claims 1 to 9, characterized in that if at first only partially polarized light is observed, the respective location is zoomed up and an examination is made whether there is any completely polarized light.

11. Procedure according to any one of claims 1 to 10, characterized in that the procedure is used to determine an attitude and location of a body.

12. Procedure according to any one of claims 1 to 11, characterized in that with the aid of observations consecutive in time quantities associated with a body's state of motion are found.

13. Procedure according to any one of claims 1 to 12, characterized in that observation and identification of the visual object takes place with electromagnetic radiation with a wavelength longer or shorter than that of visible light instead of visible light.

14. System for locating and identifying a visual object comprising:

in a region of the visual object a separate polarizing surface or separate polarizing surfaces;

means for observing the existence of and locating the polarizing surface or surfaces by utilizing the lighting prevailing at the surface thereof and in its/their ambience, on the basis of the polarized light coming from said polarizing surface or surfaces, said means comprising an identifying apparatus including image identifying means, in which is provided a divider means for dividing the polarized light reflected by the polarized surface or surfaces into two parts on the basis of polarization,

characterized in that

the separate polarizing surface has a known shape and/or known direction of polarization or the separate

polarizing surfaces have different polarizing properties, and

the relative positioning of the polarizing surface or surfaces and the visual object is known,

and that it further comprises

means for determining the location of the visual object to be identified on the basis of said known relative positioning; and

means for identifying the object in a way other than on the basis of polarization.

15. System according to claim 14, characterized in that it comprises before the divider a delay element which converts circularly polarized light into linearly polarized light.

16. System according to claim 14 or 15, characterized in that the divider is a crystal provided with a dividing interface, a birefringent crystal or a semi-transparent mirror.

17. System according to any one of claims 14 to 16, characterized in that after the divider means one of the two parts passes through an attenuator before reaching an image surface.

18. System according to any one of claims 14 to 17, characterized in that the visual object is a numeral a series of numerals, a letter, a series of letters, a figure or any combination of these.

19. System according to any one of claims 14 to 17, characterized in that the visual object is a one-dimensional code, and the polarizing surface is in the same line with the code.

20. System according to any one of claims 14 to 17, characterized in that the visual object is a one-dimensional code consisting of concentric rings, and the polarizing surface is in the centre of said rings.

21. System according to claim 19 or 20, characterized in that the image produced on the image surfaces of the identifier is reduced in the direction perpendicular against a space slice under examination.

22. System according to any one of claims 14 to 21, characterized in that the system comprises an additional lighting source with which that space is illuminated in which visual objects are presumed to exist.

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PATENT AGENTS

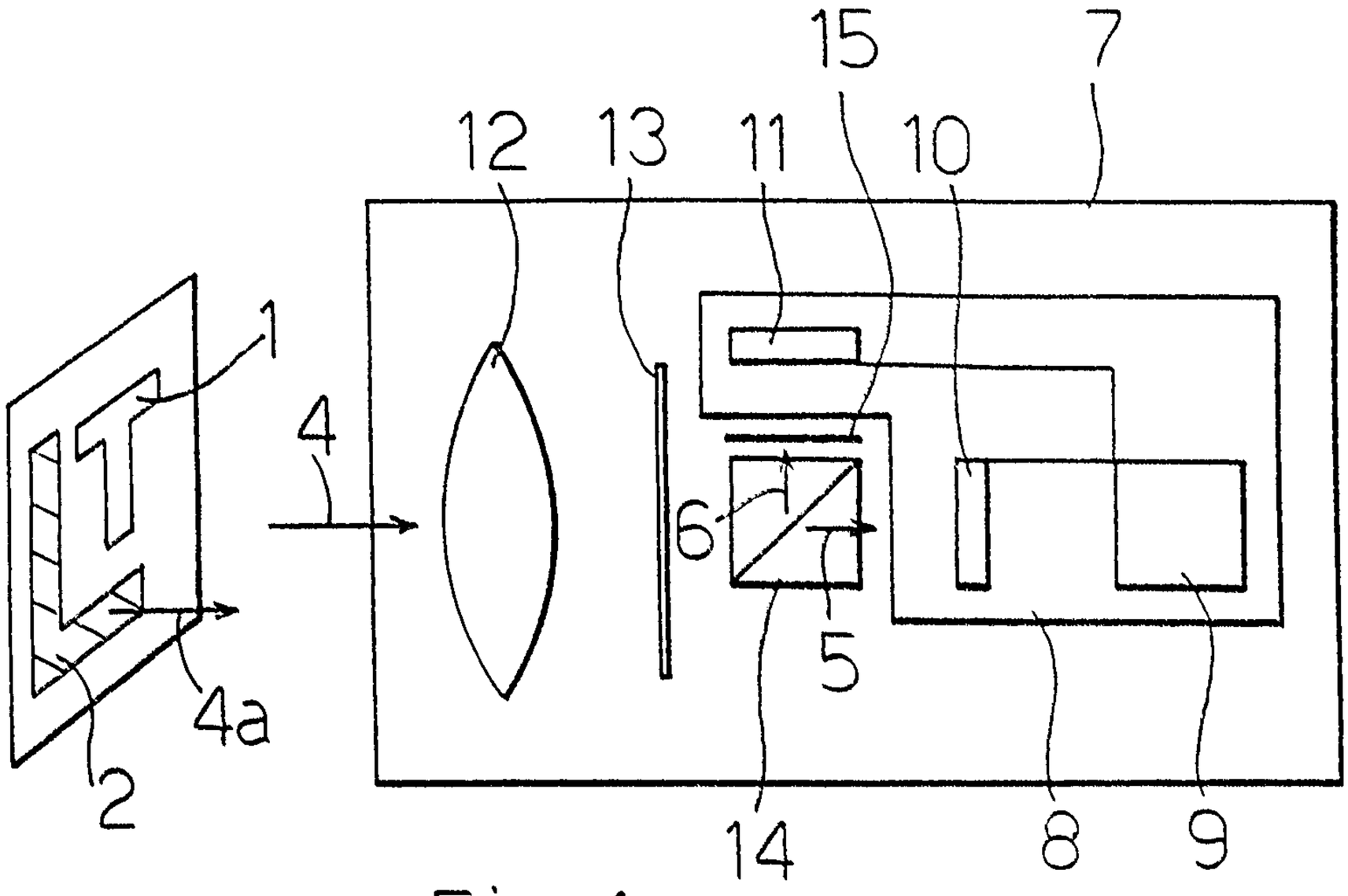


Fig. 1

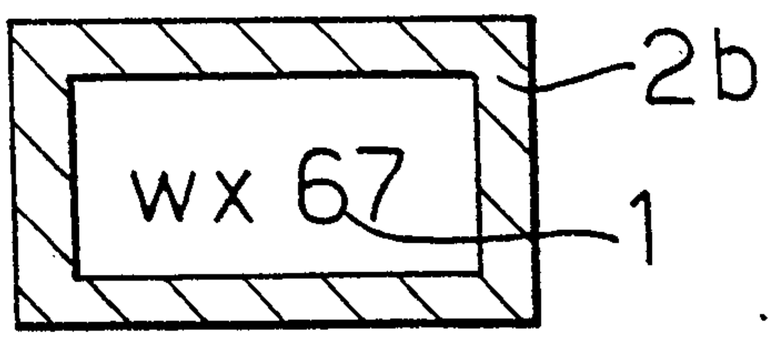


Fig. 2

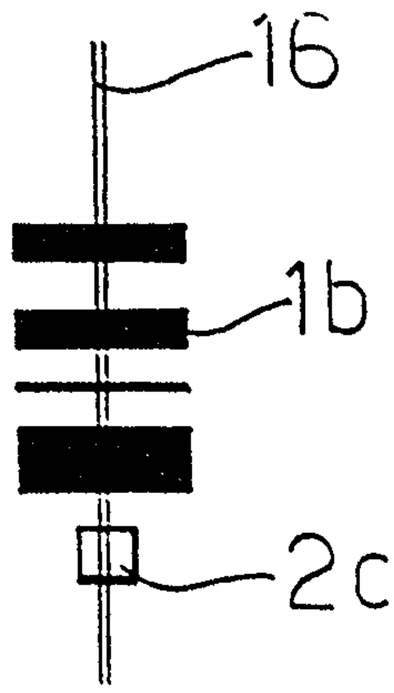


Fig. 3

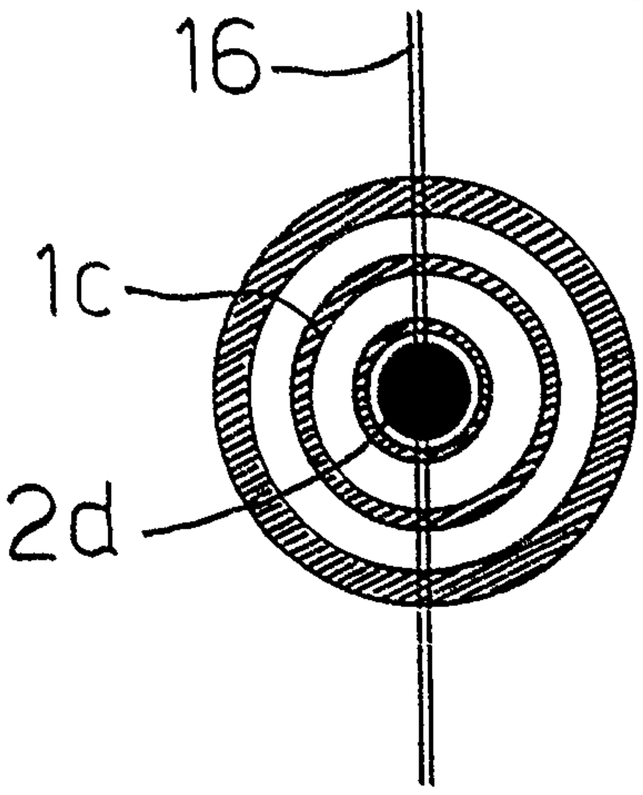
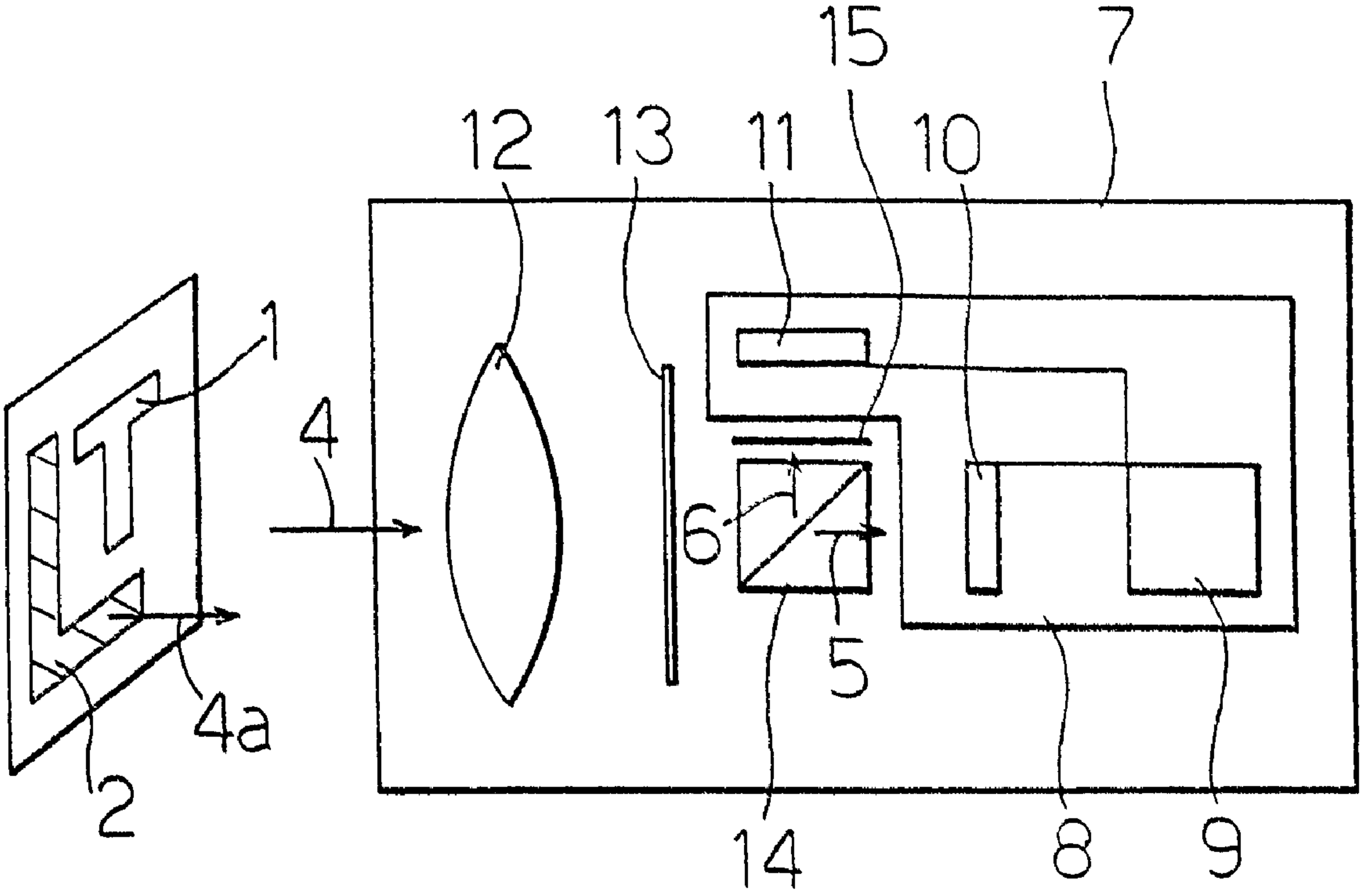


Fig. 4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