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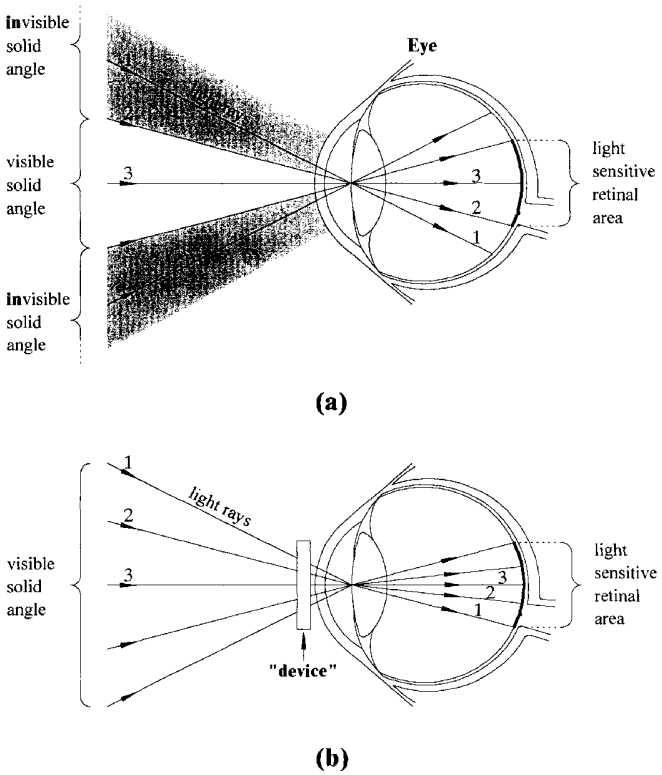
(54) Title: OPHTHALMIC VISUAL FIELD EXTENSION DEVICE



Horizontal section of the eye (schematic).
(a): Vision **without the device** by an eye with reduced light sensitive retinal area.
(b): Vision **using the device** by the same eye.

(57) Abstract: A visual aid device is proposed that enhances or restores peripheral vision. The device, which consists, among other parts, of optical elements, may take the form of eyeglasses, or may be placed in contact with the eye, or may be implanted in the eye. This device may be useful to persons with a partial or complete loss of peripheral vision due to ailments, or to persons who wish to extend their field of natural vision. The essential novel idea of the device is the stratagem to project the scenery to be viewed on a smaller area of the retina than the area on which the scenery is projected without the use of the device. This smaller area is chosen to be that area which is capable of perceiving the image.

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OPHTHALMIC VISUAL FIELD EXTENSION DEVICE

Introduction

Some frequently occurring eye ailments, such as glaucoma, result in a phenomenon popularly called "tunnel vision". Approximately 2% of the population of the US over the age of 40 years is affected by glaucoma. Looking straight ahead the afflicted person sees the objects or landscape in or close to his line of vision clearly, but peripheral objects or landscape (which would be seen by a healthy person) are only dimly visible or are completely dark. The afflicted person has the impression of being in a dark tunnel seeing light only through the tunnel exit, hence the name "tunnel vision". Persons suffering of this ailment often bump into objects on their side or trip over obstacles on the ground. They do not see the borders of the road while driving, especially at night.

The physiological reason for this vision impairment is a degeneration of the visual nerves. In particular, these nerves do not respond to the light that falls on the peripheral part of the retina. The retina covers the inner back surface of the eyeball. In general, the nerve endings that are spread over the central part of the retina, close to the fovea, are less degenerate, and respond to the light.

In the process of vision, the lens of the eye projects an image of the outside world on the retina. The image of peripheral objects is projected on the peripheral part of the retina: hence, if the peripheral part of the retina has lost its sensitivity these peripheral objets are not seen.

The objective of this invention is to enable a person afflicted with loss of peripheral vision to nevertheless see the peripheral objects. For this purpose a

visual aid device, which may take the form of special eyeglasses, is proposed. In the sequel, this will be called the *device*. The device, in combination with the eye lens, projects that part of the outside world which in the healthy eye is projected on the normally light sensitive part of the retina, on the smaller, still light sensitive, usually central part of the retina of the afflicted eye.

One may compare the working of the proposed device to that of a wide-angle lens in photography. While a usual lens projects the scenery viewed on the total exposure area of the film in the camera, the wide-angle lens projects the same scenery on a smaller film area.

Description of the Principle of the Stratagem and of the Device

In scientific terms, the proposed device serves to project the light which is collected from the entire solid angle that is perceptible by the healthy eye and concentrate it within the eye into a narrower solid angle than that produced without the device. This narrower solid angle is so designed that light within its boundaries will fall on the healthy or less afflicted region of the retina. We will call the reduction of the solid angle of projected light ***collimation***.

Fig. 1 shows schematically the working principle of the proposed device using as example optical elements placed in front of the eye.

Since the proposed device projects the normally visible part of the outside world on a smaller area of the retina than in the normal eye, at first objects will appear smaller than without the use of the device. On the other hand, due to the greater collimation of the light the objects will appear more luminous than without the

device. This inventor believes that after a certain accommodation period the person wearing the device will get used to these changes of perception. The amount of collimation built into the device will vary from person to person depending on the size of the still light sensitive area of his retina. In order to facilitate accommodation and assure stereoscopic vision it is thought that it will be necessary to have the same amount of collimation for both eyes, irrespective of the differences in the losses of peripheral vision between the two eyes of the person.

The collimation required will be determined by the usual medical procedures, which measure the still sufficiently sensitive area of the retina, and will be achieved by means of appropriate optical elements. These elements will be either incorporated in eyeglasses to be worn or may be implanted in the eye. Of course, the proposed device is so constructed that it also corrects those deficiencies of the eye in question, which are corrected by eyeglasses normally worn or implanted.

The optical elements which perform the required collimation may be either of the refractive or of the diffractive (digital) type, or of the optoelectronic type, or a combination of any two of these, or a combination of all three.

It should be pointed out that the analogy with the wide-angle lens of photography, mentioned in the introduction, should not be misinterpreted as implying that a wide-angle lens placed in front of the eye will produce the required collimation. In the design of the device the optical elements naturally or artificially contained in the eye play a crucial role and only the synergy of the device and eye will produce the desired effect.

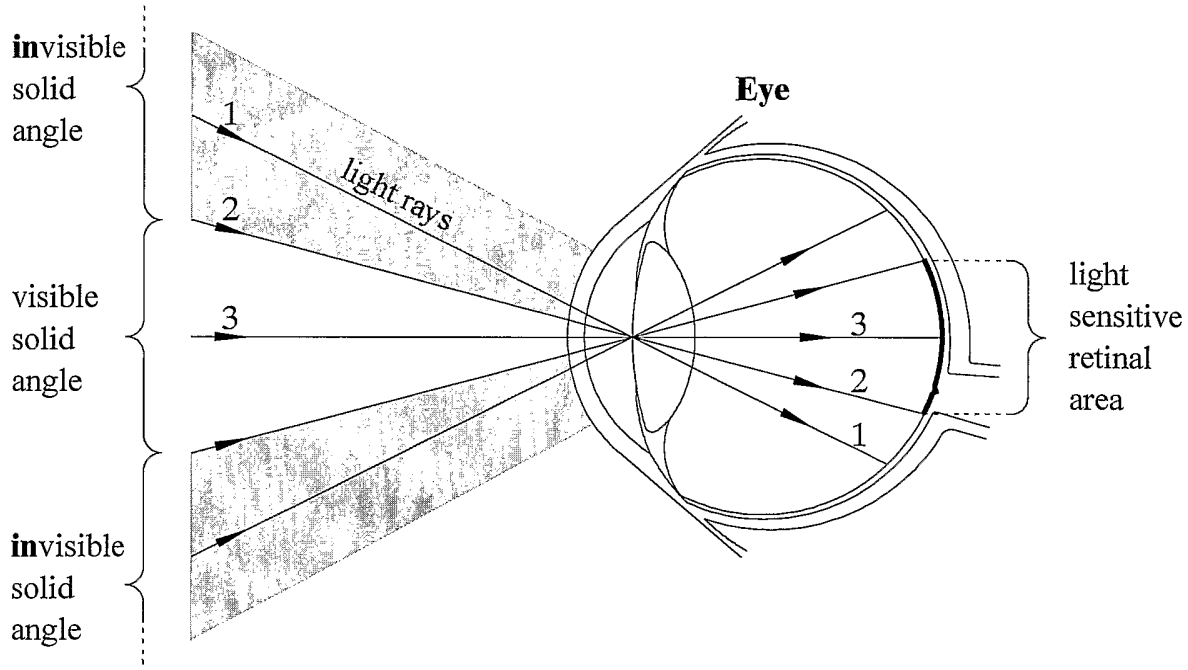
It should be cautioned that the proposed device may not be useful or advisable in all cases of lost peripheral vision. In particular, if the remaining healthy area of the retina is too small, or the accommodation capability of the person is not adequate, the device should not be recommended.

Besides the purpose of partially restoring lost peripheral vision, another use of the device may be the extension of the field of vision of the healthy eye. This may be desirable to persons who have the task of supervising an extended area, such as watchmen, hunters, etc.

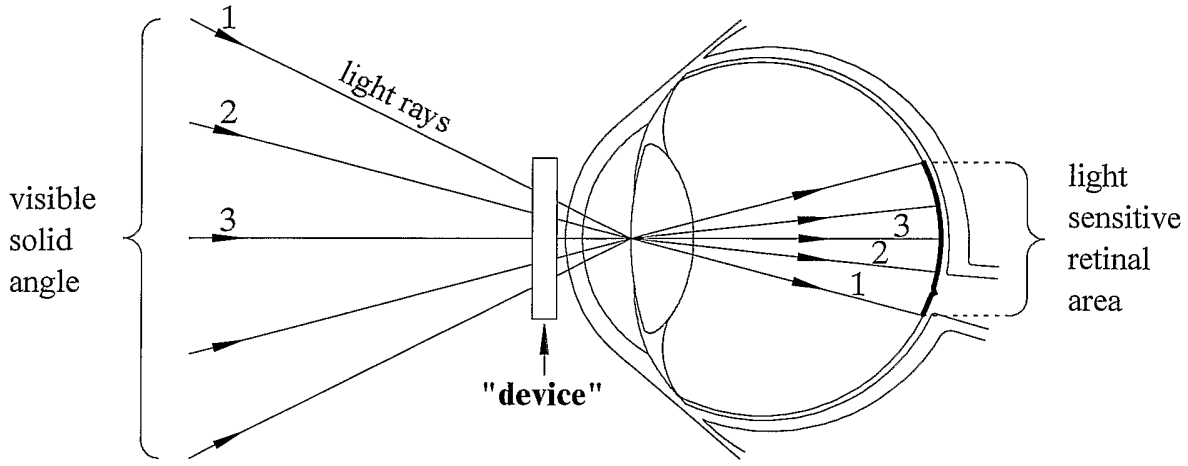
Claims

1. The invention is a device with the objective of enlarging the field of vision or visible solid angle of the human eye. One, but not sole, purpose of this enlargement is to partially restore lost or impaired peripheral vision. Another purpose of the device is to enlarge the field of vision.
2. The objective specified in claim 1 is realized with the help of specific optical or optoelectronic elements. These focus or project the light coming from the area to be viewed on a certain portion of the retina of the eye. When the device of claim 1 is used, the retinal area on which the image is focused is, in general, smaller than the one on which the light would be focused without the use of the device of claim 1. This area of the retina is so chosen that it is sufficiently sensitive to light in order to produce a visible image. Without the use of the device some of the light would be projected on a retinal area not sufficiently sensitive to light, or would not reach the retina at all.
3. The device consists of optical elements. These are either of the refractive type, such as a lens or combination of lenses, or of the diffractive (digital) type, or of the optoelectronic type, or any combination of these.
4. The device of claims 1 - 3 is, but need not be, embodied in frames to be worn in the manner of eyeglasses.
5. The device of claims 1 – 3 is, but need not be, realized in the form of an attachment or attachments to eyeglasses usually worn by the subject wishing to use the device.
6. The device of claims 1 - 3 is, but need not be, realized in the form of contact lenses.

7. The device of claims 1 – 3 is, but need not be, implanted in the eye as done, for instance, in the replacement of the eye lens in case of cataract, or by any other suitable way.
8. The device of claims 1 – 3 is, but need not be, produced by a direct surgical modification of the eye, whatever is the means of surgery.
9. The device of claims 1 – 3 will, but need not, contain optoelectronic elements. These transform the light coming from the scenery to be viewed into electric signals. One known embodiment of such an optoelectronic element is a charge-coupled device. The electric signals are, in turn, transformed back into light signals to form a real or virtual image that is viewed by the eye by projecting it on the light sensitive part of the retina. As with the other embodiments of the device, an extension of the field of vision and, in addition, an increase of light intensity is achieved. The novelty of claim 9. resides in the fact that the device can be worn by the viewer.



(a)



(b)

Fig. 1. Horizontal section of the eye (schematic).
(a): Vision **without the device** by an eye with reduced light sensitive retinal area.
(b): Vision **using the device** by the same eye.

INTERNATIONAL SEARCH REPORT

International Application No
PCT/CH 02/00181

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 G02C7/08 G02C7/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 G02C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 6 219 186 B1 (HEBERT RAYMOND T) 17 April 2001 (2001-04-17) figure 4 column 13, line 48 -column 14, line 57 ---	1-9
X	US 6 102 544 A (AHSBAHS FRANCOISE ET AL) 15 August 2000 (2000-08-15) column 2, line 8 - line 10 column 5, line 7 - line 17 ---	1-9
X	US 6 254 233 B1 (PRESTANDREA ANTHONY ET AL) 3 July 2001 (2001-07-03) page 3 ---	1-9
X	US 4 155 626 A (GRECH LEONARD) 22 May 1979 (1979-05-22) the whole document --- -/--	1-9

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
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Name and mailing address of the ISA	Authorized officer
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International Application No
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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
X	US 6 172 805 B1 (GRECH LEONARD) 9 January 2001 (2001-01-09) column 1, line 1 - line 35	1-9
X	US 5 155 508 A (ONUFRYK MICHAEL) 13 October 1992 (1992-10-13) column 10, line 59 -column 11, line 58	1-9
X	US 5 771 088 A (PERROTT COLIN M) 23 June 1998 (1998-06-23) claims 16-18	1-9
X	US 5 208 872 A (FISHER TIMOTHY E) 4 May 1993 (1993-05-04) abstract column 10, line 67 -column 11, line 4	1-9
X	US 4 555 164 A (FEINBLOOM WILLIAM) 26 November 1985 (1985-11-26) the whole document	1-9
X	US 4 498 743 A (FEINBLOOM WILLIAM) 12 February 1985 (1985-02-12) the whole document	1-9
A	US 4 573 776 A (FRIEDER PHILIP M ET AL) 4 March 1986 (1986-03-04) column 2, line 5 - line 12 column 3, line 4 - line 17	1-9

INTERNATIONAL SEARCH REPORT

Inform on patent family members

International Application No
PCT/CH 02/00181

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 6219186 B1	17-04-2001	US 6008939 A	28-12-1999
		US 5926318 A	20-07-1999
		AU 6637100 A	13-03-2001
		WO 0113160 A1	22-02-2001
		US 6040946 A	21-03-2000
		AU 2255399 A	14-10-1999
		EP 0949826 A2	13-10-1999
		JP 2000035551 A	02-02-2000
US 6102544 A	15-08-2000	NONE	
US 6254233 B1	03-07-2001	NONE	
US 4155626 A	22-05-1979	NONE	
US 6172805 B1	09-01-2001	NONE	
US 5155508 A	13-10-1992	US 4673263 A	16-06-1987
		CA 2023875 A1	21-03-1991
		US 5323190 A	21-06-1994
		CA 1242607 A1	04-10-1988
US 5771088 A	23-06-1998	AU 6490094 A	24-10-1994
		CA 2153492 A1	13-10-1994
		EP 0690997 A1	10-01-1996
		JP 8508588 T	10-09-1996
		WO 9423327 A1	13-10-1994
US 5208872 A	04-05-1993	NONE	
US 4555164 A	26-11-1985	NONE	
US 4498743 A	12-02-1985	NONE	
US 4573776 A	04-03-1986	NONE	