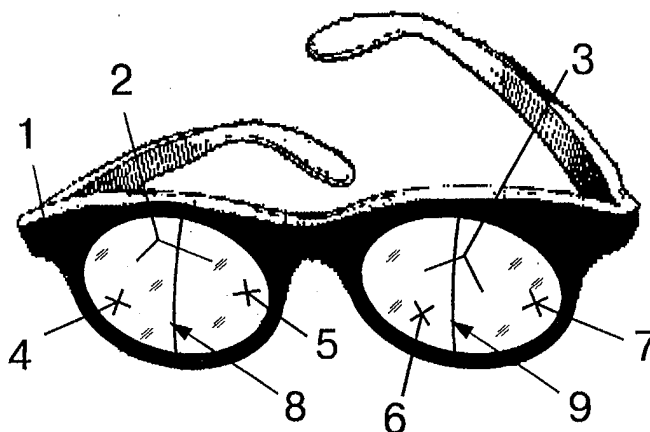


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(54) Title: A SHURKIN-BERSHANSKY DEVICE FOR THE OPTICAL CORRECTION AND EXERCISE OF VISION



(57) Abstract

A device for the optical correction and exercise of vision comprises a frame (1) securely fastened with respect to the human eyes, and optical elements (2 and 3). Said optical elements have transparent zones with different optical characteristics which are interconnected by transition lines and mounted to ensure transition of the visual axis of a corresponding eye at any level from one zone to another on the horizontal. The difference in values of corresponding optical characteristics of the zones lies within the limits between objective sensitivity of the eye and the human's subjective sensitivity to the change in a given optical characteristic. A number of embodiments of the device is proposed in accordance with the invention. A preferred embodiment of the device provides its accomplishment in the form of spectacles. In all cases, image sharpness and fusion are achieved at the expense of a "trimming" of the eye muscles, which in a multiple repetition has an exercising effect on ocular muscles and the eyes as a whole. As a result of using this device with optical elements of a proposed structure, a continuous process of exercising the accommodation-convergent apparatus is carried out, which favors an efficient prophylaxis and treatment of functional visual disorders and makes it possible to use the proposed device as a highly effective means in everyday life of humans having both disturbed and normal vision, irrespective of the type of their activities.

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A SHURKIN-BERSHANSKY DEVICE FOR THE OPTICAL CORRECTION AND EXERCISE OF VISION

FIELD OF THE INVENTION

The present invention relates to medical technology and may be used in ophthalmology for the prophylaxis and treatment of functional visual disorders and may be also employed, for example, in binoculars, microscopes, etc.

BACKGROUND OF THE INVENTION

There have been widely known various devices for the optical correction of vision, in particular spectacles having bifocal lenses which comprise two optically transparent zones with different refractive indices (refraction) and a common frontal line, which results in a substantial reduction in stresses onto the ocular accommodation-convergent apparatus when switching the look from a long to close distance in the process of reading (see, Rozenblyum Yu. Z., Optometry, Moscow, Medicine, 1991, pp. 45-50).

However, bifocal lenses can not be used for exercising the ocular accommodation-convergent apparatus with the purposes of prophylaxis and treatment of functional visual disorders (spasm of accommodation, presbyopia, myopia, abnormalities of binocular vision, etc.), which greatly restricts their functional capabilities.

There is a great number of devices designed for exercising the ocular accommodation-convergent apparatus of both a mechanical type in which a continuous displacement of the watching object along an optic axis or simulation of an object's ranging and approaching takes place (see, FR Patent No. 222075, A61H 5/00, 1974), and a computerized ocular exerciser-type (see, GB Patent No. 2203565, A61H 5/00, 1988; RU Patent No. 2066167, A61H 5/00, A61F 9/00, 1996; RU Patent No. 2045254, A61F 9/00, A61H 5/00, 1995).

Drawbacks with these known devices reside in complexity of their construction, a need for additional time expenditures for the performance of special treatment-and-prophylactic procedures under the supervision of medical personnel, impossibility to combine it with everyday human activities.

Spectacles with an adjustable focal distance for the correction of the human's vision are known (see, RU Patent No. 2046388, G02C 7/08, A61F 9/00, 1995). These spectacles may be used as conventional corrective spectacles for the "work" and for the "expanse", irrespective of a specific situation and type of the human activities, which in the long run increases its fitness to work. However, these spectacles are difficult to manufacture, expensive, inconvenient in utilization and they fail to combine two functions, namely the optical correction and exercise of vision.

The known vision device – an exerciser by Kaverinsky Nikolai Sergeevich (see, RU Patent No. 2062078, A61F 9/00) makes it possible to simultaneously perform both a correction function and a vision exercising function.

Combining two functions in this vision device is ensured by the fact that a device comprising optical elements encased in a frame securely fastened with respect to the human eyes is provided with mirror surfaces permitting to extend a vision zone and to exercise eyesight. However, this device is insufficiently effective, since it can not be used in the process of everyday human activities, especially when performing visually-intense activities (reading, computing, carrying out assembly works, etc.), since the exercising ideology with this device is based on the switch of the look from an object being in front of the human being to another object which is found in the other point of environment and reflected by the mirror surface.

Apart from the above listed devices, currently there are many various methods and devices for the prophylaxis and treatment of vision, some of them being very efficient. But all of them are characterized by a common disadvantage consisting in that they are all of a "session" type, that is to say, they only affect the human eye when performing treatment-and-prophylactic procedures. As to the remaining time, conditions of the eye work are not essentially changeable, which inevitably results in the regeneration of visual disorders and a need for aftertreatment.

SUMMARY OF THE INVENTION

The technical object of the present invention is to agree the eye's operating conditions with the nature of a present-day visual load by providing a continuous process for the vision exercise at the expense of involuntary eye movements without turning the head, when watching objects being directly in front of

the human being within the limits of the physiological visual angle, to improve the efficiency of treatment and prophylaxis of functional visual disorders.

It is known that the process of watching various objects by the human being takes place mainly when the look moves on the horizontal within the limits of the physiological visual angle without turning the head (see, Rozenblyum Yu. Z., Optometry, Moscow, Medicine, 1991, p. 3b).

It is also known that sensitivity of the human being to the shift of the object image (subjective sensitivity) is significantly lower than the physiological (objective) sensitivity of the eye to this shift (see, Vatchenko A. A., Spasm of Accommodation and Shortsightedness, Kiev, Health, 1977, pp. 55-60).

These and other objects are solved in accordance with the present invention by means of a device for the optical correction and exercise of vision comprising optical elements encased in a frame securely fastened with respect to the human eyes, said optical elements have zones with different optical characteristics which are interconnected by transition lines and mounted in said frame to ensure transition of the visual axis of a corresponding eye from one zone to another of the optical element at any level on the horizontal, the difference in values of optical characteristics of the zones of each optical element lies within the limits between objective sensitivity of the eye and the human's subjective sensitivity to the change in a given optical characteristic.

A further embodiment of the present invention provides a device for the optical correction and exercise of vision comprising optical elements having zones with different optical characteristics, wherein the technical object is solved by the fact that the zones are formed by lenses, or prisms, or light filters, or any combination thereof. In so doing, optical centers and/or optic symmetry axes of corresponding zones of the optical elements may be located in the same horizontal plane, or in parallel planes, or in intercrossing planes, a transition line of optical characteristics from one zone to another of the optical element may be made to the shape of a straight line or a line of arbitrary form which differs from the straight line, transition lines of characteristics of the zones of the optical elements may be located symmetric or asymmetric about each other.

Another embodiment of the present invention provides a device for the optical correction and exercise of vision comprising optical elements having zones

with different optical characteristics, said zones are formed by lenses, a mean value of focal power of the zones of the optical element formed by the lenses corresponds to the amount of refraction of the human eye, the difference in focal powers of the zones is smaller than the human's subjective sensitivity to the refraction change.

Still another embodiment of the present invention provides a device in which optical elements may be shaped as perforated plates with their optical zones being formed by stop apertures having a varying cross-section.

Still further embodiment of the present invention provides a device in which optical elements having zones with different optical characteristics may be mounted in a spectacle frame or a removable binocular or monocular extension piece on spectacles.

BRIEF DESCRIPTION OF THE DRAWINGS

The various objects, advantages and novel features of the present invention will be more readily apparent from the following detailed description when read in conjunction with the appended drawings, in which:

FIGURE 1 illustrates a device for the optical correction and exercise of vision made in the form of spectacles in accordance with the present invention;

FIGURE 2 is a graph illustrating the change in characteristics of the optical element as a function of a turning angle of the optic axis of the eyes in a device designed mainly for curative purposes in accordance with the present invention;

FIGURE 3 is a graph illustrating the change in characteristics of the optical element as a function of a turning angle of the optic axis of the eyes in a device designed mainly for the prophylaxis of visual disorders in accordance with the present invention;

FIGURE 4 is a schematic view showing a device with different embodiments of the form and interposition of transition lines of the optical element characteristics in accordance with the present invention;

FIGURE 5 is a schematic view showing a device with the optimal disposition of optical centers and optic symmetry axes of the zones in accordance with the present invention;

FIGURES 6 and 7 schematically illustrate a device with different embodiments of interposition of optic symmetry axes of the zones of optical elements formed by lenses in accordance with the present invention;

FIGURE 8 schematically illustrates a device with different embodiments of interposition of optic symmetry axes of the zones of optical elements formed by prisms in accordance with the present invention;

FIGURE 9 is a schematic view showing a device in which optical elements are shaped as perforated plates in accordance with the present invention;

FIGURE 10 shows a diagram explaining the principle of operation of a device with optical elements formed by lenses in accordance with the present invention;

FIGURE 11 shows a diagram explaining the principle of operation of a device with optical elements formed by prisms in accordance with the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the drawings, in which there is shown in FIGURE 1 a device comprising a spectacle frame 1 with optical elements 2 and 3. Each optical element is made monolithic and has two optically transparent zones: the left 4 and 6 and the right 5 and 7, respectively, which are interconnected in corresponding transition lines 8 and 9.

As illustrated in FIGURES 2 and 3, zones of the optical elements are made such that the difference in values of their optical characteristics, P_x , lies within the limits between objective sensitivity of the eye (O_u) and the human's subjective sensitivity (C_u) to the amount of the change in a given optical characteristic (X_o).

Depending on the purpose it is designed, a device for the optical correction and exercise of vision is fabricated by forming zones of optical elements from lenses only, or from prisms only, or from light filters only, or from any combination thereof. Moreover, optical elements of the device may be fabricated from perforated plates. In all the cases mentioned above, there are various embodiments as to the form and mutual arrangement of transition lines and mutual arrangement of the optical centers and optic symmetry axes of corresponding elements and zones.

Thus, in case where the zones of optical elements are made of lenses, the difference in their focal powers is chosen to be within $P_x = (0.1 - 0.5)$ diopters and

used basically for the prophylaxis and treatment of disturbances of accommodation ability. In so doing, smaller values (up to 0.3) are used in the devices designed mostly for continuous wear, while larger values (over 0.3) are used in those devices which are employed mainly for sessions of medical exercises.

In case where the optical zones are fabricated from prisms, the difference in their focal powers is chosen to be within $P_x = (1 - 4)$ centiradian and employed basically for the prophylaxis and treatment of abnormalities of binocular vision, while using smaller values (up to 2) in the devices designed for continuous wear and larger values (over 2) in those devices which are employed for medical exercises.

Characteristics of optical zones made of light filters are chosen in much the same way, with the formation of the zones 4 and 5, 6 and 7 (FIGURE 5) of a required density and color. A device comprising optical elements formed by light filters is used for the prophylaxis and treatment of color vision.

When using perforated plates as optical elements, their optical zones are formed by stop apertures of a varying cross-section (FIGURE 9). For instance, one zone is made with circular apertures 1 mm in diameter, another – with apertures 1.2 – 1.5 mm in diameter, which corresponds to $P_x = (0.2 - 0.5)$ mm. This favors the exercise of accommodation at the expense of changing a depth of focus when a line of the eyesight goes from one of the optical elements to another.

Absolute values of characteristics of the optical zones are selected depending on a type of visual disorder.

In the treatment of shortsightedness (myopia), the zones are formed such that the focal power of one of the zones in the optical element is in accord with the human's eye refraction (section H in the graph of FIGURE 2), while that of the other zone is greater by the value P_x (section B), which favors relaxation of the Bowman's muscle of the eye's accommodation apparatus.

In the treatment of long-sightedness (hypermetropia, or presbyopia), focal power of one of the zones in the optical element must be in accord with the human's eye refraction (section B in the graph of FIGURE 2), while that of the other zone must be smaller by the value P_x (section H), which favors strengthening of the Bowman's muscle.

With normal vision (emmetropia), there are used optical elements with a total optical characteristic equal to 0, wherein one of the zones is provided with the characteristic of plus $P_x/2$ (section B in FIGURE 3), the other with the characteristic of minus $P_x/2$ (section H in FIGURE 3). A device having such characteristics exerts an exercising effect on the ocular muscle apparatus and is used mainly for the active prophylaxis of visual disturbances.

According to the nature of transition of optical characteristics from one zone to another (FIGURES 2 and 3), optical elements may be made with both a jump-type transition and a smooth transition (shown by dotted lines).

With a jump-type characteristic of transition, a line separating zones of the optical element is visible on the surface thereof, but this line does not cause discomfort, since the human being quickly gets used to it and "ignores" the line. Such a transition exerts the greatest exercising effect, however, due to the possibility of the occurrence of a perceptible "image jump", it is basically used in the case of low P_x values in the devices to be employed in continuous wear.

With a smooth characteristic, a transition line on the optical element surface may be invisible, which offers a considerable comfort improvement when using a device. Since in the case of a smooth variation of the characteristic, an "image jump" perception decreases, it provides the possibility for enhancement of an exercising action at the expense of the formation of zones with the difference in characteristics which corresponds to a maximum P_x value. Such a phenomenon is employed in the devices intended to perform sessions of medical vision exercises.

Depending on the purpose a device is designed, a transition line 8 and/or 9 may have a varying form. In those devices intended to perform curative exercises, the zones are formed basically with a transition line taking the form of a straight vertical line (FIGURE 4; lines 8a and 9b), since such exercises are performed with practically a constant distance from the eyes to watching objects, that is to say, at a constant angle of ocular convergence.

In the devices intended for continuous wear, in order to match the location of points in a frontal line with an angle of ocular convergence when the eye is bound by a proximal and a distant limit (for instance, in the process of reading), said frontal line has an arbitrary form which differs from that of the straight line (FIGURE 4; line 8b or 8c).

In case of need for the application of bifocal spectacles to achieve a similar effect, their optical elements may be divided into zones either separately in the upper (for the distance) or the lower (for the proximity) part, or simultaneously in the both parts.

To perform exercises in the case of binocular vision, transition lines of the zones of optical elements are made specularly reflected, with said elements being located symmetric about the vertical axis (for instance, lines 8a and 9b, or 8b and 9a in FIGURE 4).

Given some abnormalities of binocular vision, depending on the curative objective to be achieved (for instance, as the need arises to ensure a simultaneous transition from one zone to another when the eye's visual axes make a turn), a shape of the transition line on the optical elements and their mutual arrangement may be varying. For instance, in those devices intended for the treatment of squint a transition line on one of the elements takes the form of a straight vertical line (FIGURE 4; line 8a), whereas a transition line on the second element is made in the form which differs from the straight line and located as shown in FIGURE 4 (line 9a – in the case of convergent squint; line 9c – in the case of divergent squint).

In another embodiment of the present invention in which zones of the optical elements are fabricated from lenses, in order to diminish an "image jump" during the transition from one zone to another, optical centers of the zones of one element are aligned and arranged in the transition line, with the optical elements being set up such that their optical centers are in the same horizontal plane (line Π in FIGURE 5).

In still another embodiment of the present invention in which said zones are fabricated from prisms, and in case of need for excluding vertical shifts, optic symmetry centers of corresponding zones of optical elements are located in the same horizontal plane (line Π in FIGURE 5).

To exercise vision of humans suffering from astigmatism, zones of optical elements are fabricated from astigmatic lenses. For the same purpose, a device may be employed with optical elements being fabricated from lenses, which affords a predetermined compensating distortion of the space at the expense of shifting the optical centers of zones of optical elements (FIGURES 6 and 7). In so doing, according to required distortion parameters, center lines of corresponding

optical zones may be parallel (lines Π_{5-6} and Π_{4-7} in FIGURE 6) or intersected (lines Π_{5-6} and Π_{4-7} in FIGURE 7).

As the need arises that oblique muscles be included in the process of exercising (for instance, with abnormalities of vertical fusion), a device is used in which optical elements afford a vertical image shift, by shaping optical zones as prisms with optic symmetry axes of corresponding optical zones being located at angle with respect to the horizontal, wherein said optic symmetry axes may be located in parallel planes (lines Π_4 and $\Pi_{7'}$ in FIGURE 8) or in intercrossing planes (lines Π_4 and $\Pi_{7''}$ in FIGURE 8).

In all cases, if it is necessary that an exercising influence on one of the eyes be reduced, a corresponding optical element is provided with a smaller difference in characteristics of optical zones than that of another (in a particular case, optical zones may be only present in one of the optical elements).

In another particular case, optical elements of the device may be provided with a great number of zones (for example, with three zones, the middle one being corrective, the terminals being corrective-exercising).

In order to reduce a range of optical elements used, a device may be fabricated in the form of removable extension pieces on spectacles.

The principle of operation of a device in accordance with the present invention consists in the fact that, when the human being watches objects in the space by shifting optic axes of the eyes in the horizontal within the limits of the physiological visual angle (without turning the head), there are apparent space-shifts of objects that force corresponding ocular muscles to "trim" every time to novel conditions of vision, thereby helping the muscles to perform a continuous operation, that is to say exercise. However, with the selected characteristics of the device, said object shifts do not go beyond the limits of the human's subjective sensitivity to that shift. The human being therefore does not essentially perceive the process of exercising, which provides the possibility for using the device in everyday life while combining a required visual correction with the treatment and prophylaxis of vision.

FIGURES 10 and 11 show diagrams illustrating the principle of operation of devices provided with optical elements which are fabricated from lenses and prisms, respectively (physical phenomena occurring in the process of watching

various objects through lenses or prisms are generally known, and they are not discussed in this description).

In an alternate watching (without turning the head) of the objects A and B, optic axes of the eyes pass, respectively, either through the zones 4 and 6 (when watching the object A), or the zones 5 and 7 (when watching the object B) of the optical elements 2 and 3. If the zones 4 and 6 are positive lenses and the zones 5 and 7 are negative lenses (FIGURE 10), then an image of the object A shifts in a line of vision of each eye (points A1 and A2), and the human being sees a sharp picture of the object at the point A_0 . The same occurs when watching the object B, the only difference consisting in that the human being sees a sharp picture of the object at the point B_0 .

When watching the objects through prisms (FIGURE 11, where the zones 4 and 6 are prisms with their bases facing the "nose", while the zones 5 and 7 are prisms with their bases facing the "temples"), there is a shift of images in the lines perpendicular to the lines of vision, which results in the image bifurcation (points A1 and A2 for the object A and points B1 and B2 for the object B) followed by their "fusion" (points A_0 and B_0 , respectively).

In all cases, sharpness and "fusion" of images are achieved by the "trimming" of the eye muscles, which in a multiple repetition has an exercising effect on ocular muscles and the eyes as a whole.

All the embodiments in accordance with the present invention take account of the eye's structural features, and they are made such that with each horizontal displacement of optic axes of the eyes within the limits of the physiological visual angle (without turning the head), zones with different optical characteristics fall within the visual field. As a consequence, there occurs a "trimming" of the eyes to specific conditions of vision which is essentially imperceptible by the human being. In other words, there occurs a "trimming" of the accommodation-convergent apparatus that ensures a sharp image on the retina, but the human being does not perceive an "image jump", since his subjective sensitivity to the image shift is considerably lower than physiological sensitivity.

In a long-lasting work of the eyes under such conditions, developments of stagnation giving rise to the growth of functional visual disorders are excluded. In

so doing, the ocular muscle tension is maintained and uninterruptedly developed while ensuring a high working capacity of the eyes.

As a result, when using this device with optical elements of a proposed structure, a continuous process of exercising the accommodation-convergent apparatus is performed, which favors an efficient prophylaxis and treatment of functional visual disorders.

INDUSTRIAL APPLICABILITY

This device, while possessing all advantages of conventional vision correction devices, affords a continuous, imperceptible for the human being, exercise of ocular muscles, which favors normalization of functions of the visual apparatus, recovery of vision and essentially rules out the occurrence of functional visual disorders.

Clinical studies of experimental prototypes of a device for the correction and exercise of vision have shown that the device is very effective in the treatment of such visual disorders as shortsightedness (spasm of accommodation), long-sightedness, asthenopia, presbyopia, nystagmus, squint. However, its major advantage resides in the prophylaxis of visual disorders.

The point is that, historically the human eye has failed to adopt itself to a long-lasting watching of various objects which are situated relatively near to the person, but the progress of mankind forces the eye to act so.

The present invention enables one to alter operating conditions of the eye thereby causing it to uninterruptedly and, what is very important, essentially imperceptibly for the human being, perform physiological micromassage of ocular muscles. This results in vasodilatation, intensification of metabolic processes, recovery of normal biologic cycles, thus ensuring a high performance capability of the eyes.

In practice, the principle of visual exercise embodied in this device which is intended to attach an eye's mode of operation to the conditions of a present-day visual load, provides the possibility for using thereof as a highly effective means in everyday life of humans having both disturbed and normal vision, irrespective of the type of their activities.

Although the present invention has been described with reference to preferred embodiments, the invention is not limited to the details thereof, and various changes and modifications obvious to one skilled in the art to which the invention pertains are deemed to be within the spirit, scope and contemplation of the invention as further defined in the appended claims.

WHAT IS CLAIMED IS:

1. A device for the optical correction and exercise of vision comprising optical elements encased in a frame securely fastened with respect to the human eyes, characterized in that said optical elements have zones with different optical characteristics which are interconnected by transition lines and mounted to ensure transition of the visual axis from one zone to another at any level on the horizontal, the difference in values of corresponding optical characteristics of the zones of each optical element lies within the limits between objective sensitivity of the eye and subjective sensitivity of the human being to the change in a given optical characteristic.

2. The device as claimed in claim 1, characterized in that the optical zones are formed by lenses, or prisms, or light filters, or any combination thereof.

3. The device as claimed in claim 1, characterized in that the optical elements are shaped as perforated plates with their zones being formed by stop apertures having a varying cross-section.

4. The device as claimed in claim 2, characterized in that a mean value of focal power of the zones of an optical element formed by the lenses corresponds to the value of refraction of the human eye, the difference in focal powers of the zones is smaller than the human's subjective sensitivity to the refraction change.

5. The device as claimed in claim 2, characterized in that the optical centers and/or optic symmetry axes of the corresponding zones are located in the same plane.

6. The device as claimed in claim 2, characterized in that the optical centers and/or optic symmetry axes of the corresponding zones are located in parallel planes.

7. The device as claimed in claim 2, characterized in that the optical centers and/or optic symmetry axes of the corresponding zones are located in intercrossing planes.

8. The device as claimed in claim 1, characterized in that a transition line of the optical characteristics from one zone to another of the optical element is

made in the form of a straight line or a line of arbitrary form which differs from the straight line.

9. The device as claimed in claim 1, characterized in that the transition lines of the optical elements are located symmetric or asymmetric about each other.

10. The device as claimed in claim 1, characterized in that the optical elements having zones with different optical characteristics are mounted in a spectacle frame or a removable extension piece on spectacles.

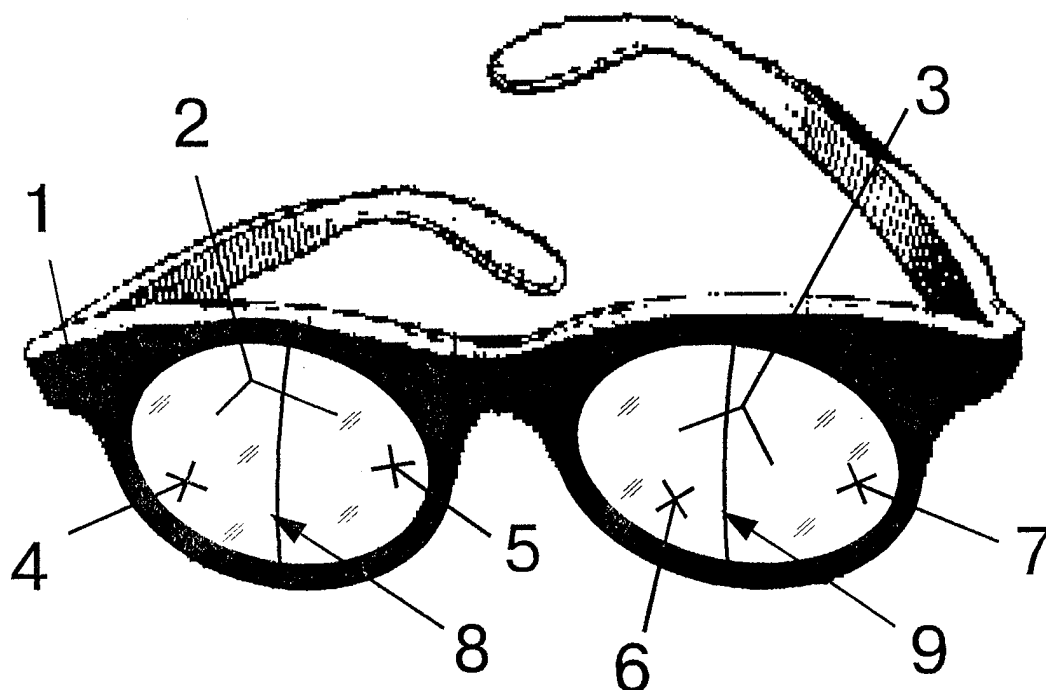


Fig .1

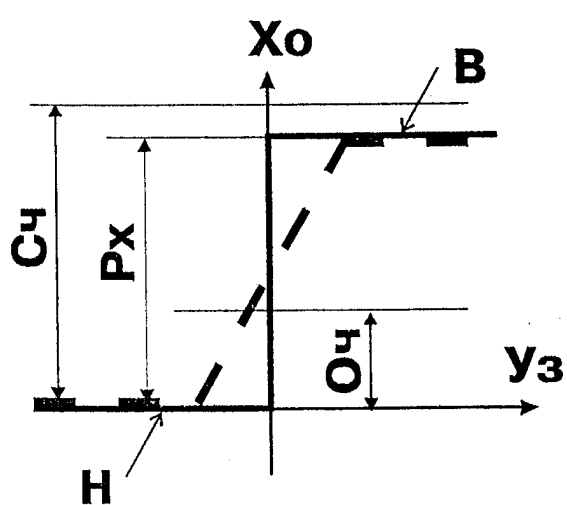


Fig .2

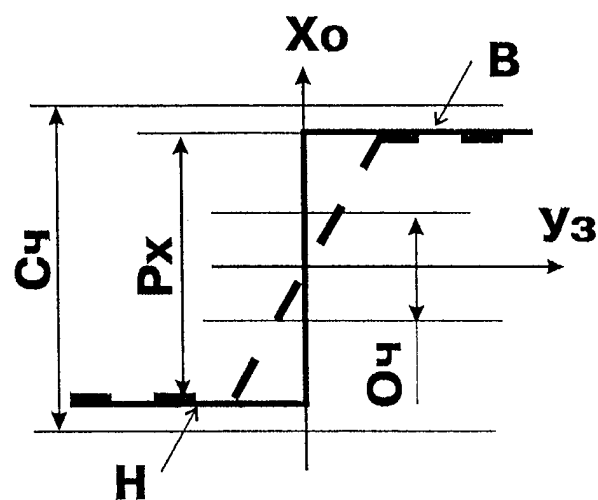


Fig .3

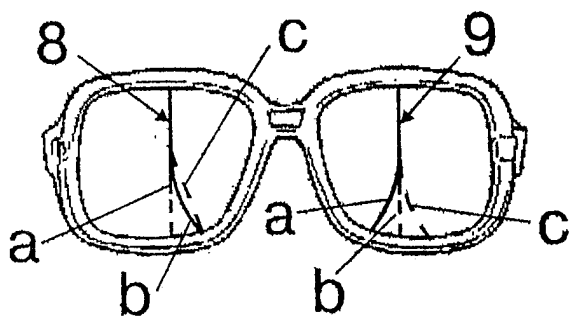


Fig. 4

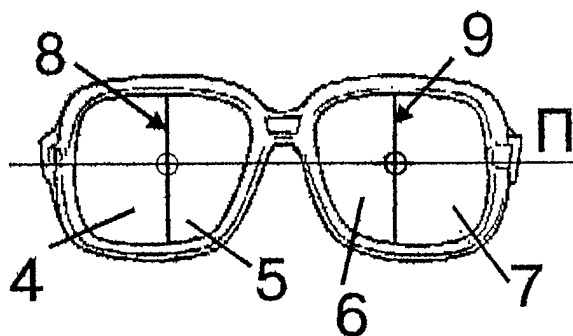


Fig. 5

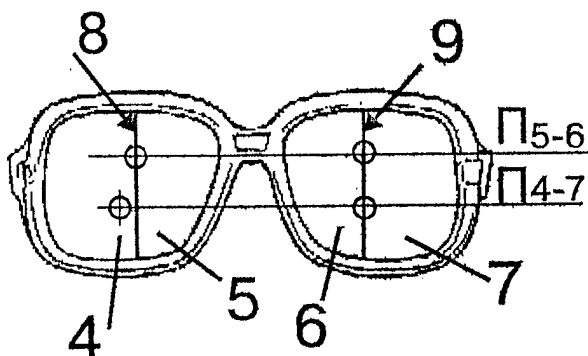


Fig. 6

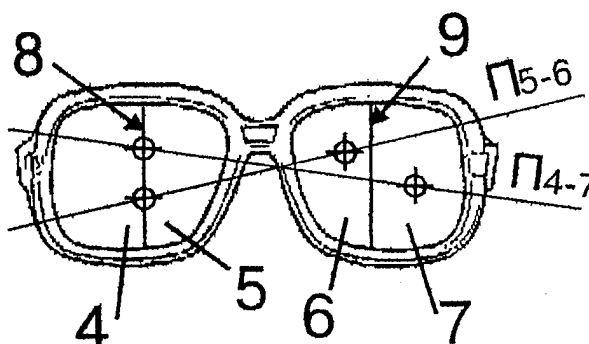


Fig. 7

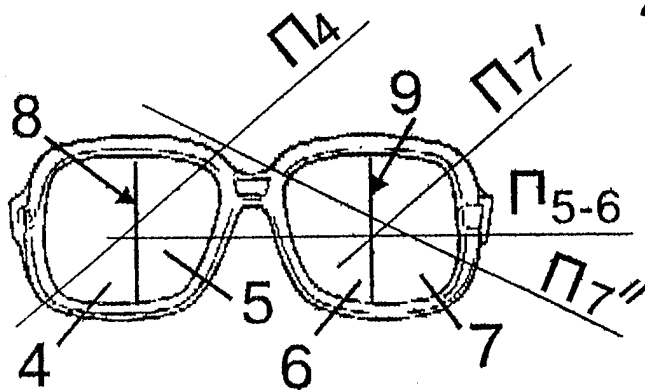


Fig. 8

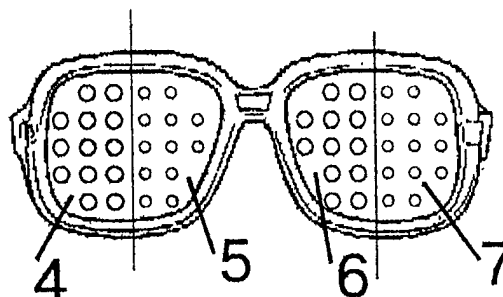


Fig. 9

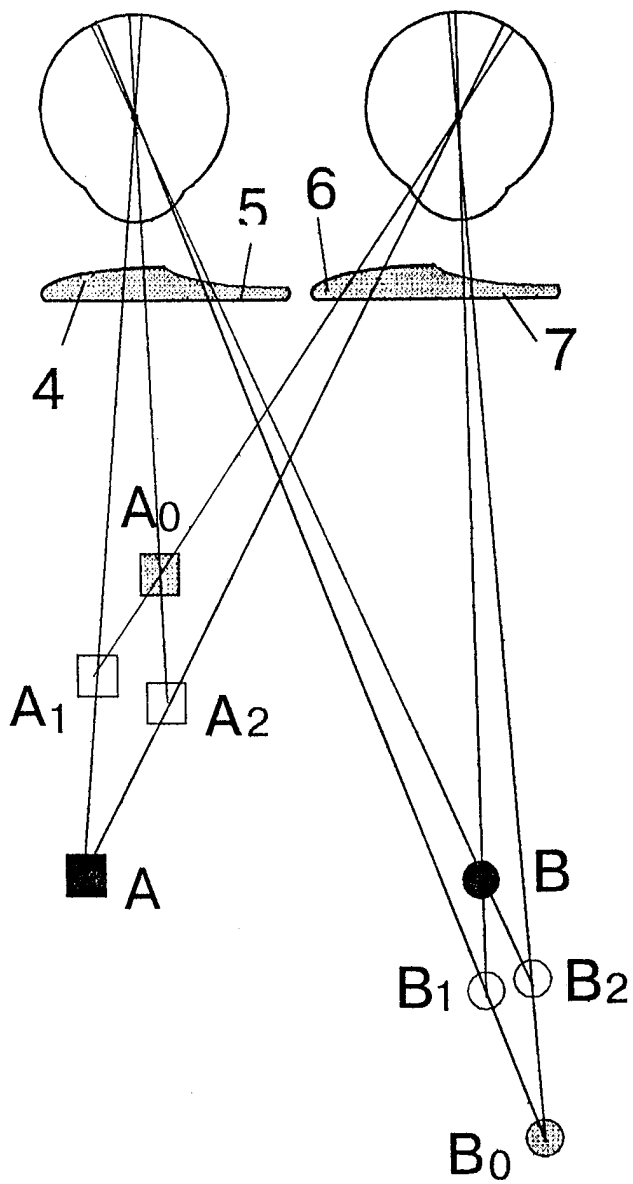


Fig. 10

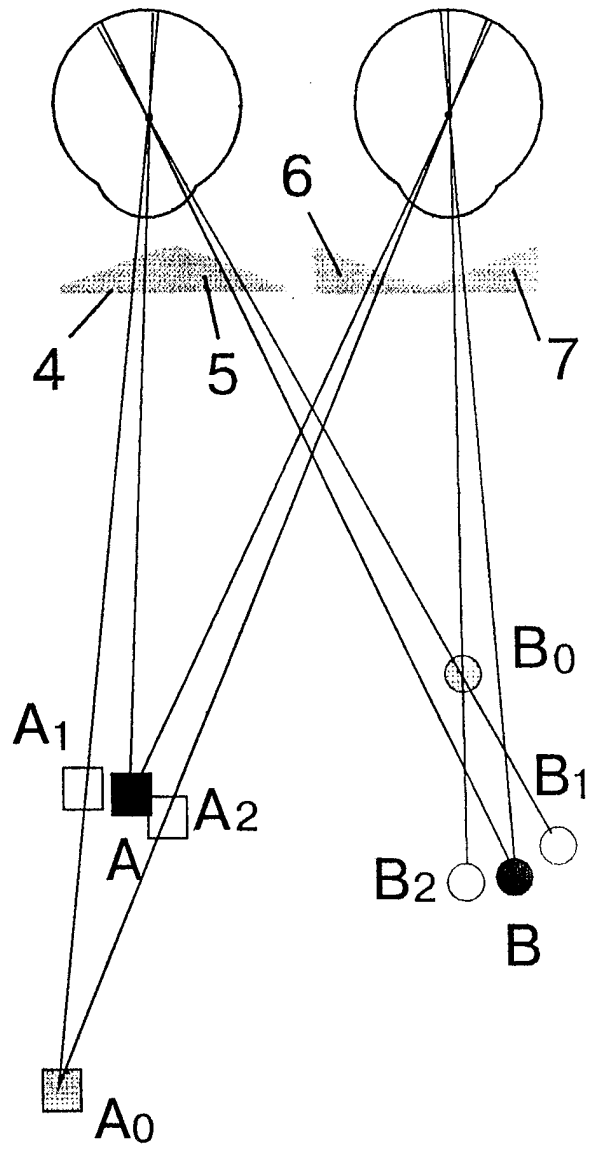


Fig. 11