Description

This invention relates to apparatus and method for recognizing an individual and/or for verifying an individual's identity. It pertains particularly to such apparatus and method which records for comparison a unique and repeatable electronic identification pattern of an individual's unique oscular structure.

In the current machine-oriented society there is need for a rapid, positive, automatic verification of a person's identification. Prior art methods of verification include photographs, fingerprints, signatures, voice prints, or presentation of an identification number, either by the person or by a magnetic strip on a card.

The first four of these prior methods are not readily adaptable to automatic machine verification as an operator is required to make a subjective comparison. Even if the particular comparison could be made by a machine, it would be time consuming to interpret the data and to make the comparison. Thus, on-the-spot verification would not be feasible.

The use of a number, while capable of automation poses serious security problems since either the number or the card containing it is subject to loss or theft.

US—A—4,109,237 discloses a basic method and apparatus for identifying individuals through their retinal vasculature patterns. The apparatus therein discussed includes a plurality of light sources arranged in dual concentric circles. The light sources are sequentially illuminated and darkened, providing a flying spot light source. Green light is used so that it is substantially absorbed by the dark red blood vessels and substantially reflected by the retinal tissue.

However, it has been found that the use of visible light of sufficient intensity to provide a recognizable output signal often causes discomfort to the individual being identified. It also causes the pupil to constrict, making it more difficult to record the scan due to light attenuation caused by the small pupil size.

According to one aspect of the present invention there is provided an apparatus for recording an identification pattern from the fundus of an eye, characterised by a single light source operable to produce a substantially columnar single source beam of light, beam directing means for directing at least a portion of the source beam into the eye from a plurality angularly divergent positions, the light substantially focusing on the fundus of the eye and being reflected in part out of the eye forming a reflected beam, and the beam directing means being arranged to scan a substantially circular locus of sequential foci at a specific location of the fundus of the eye, detector means for sequentially sensing the amount of light in the reflected beam at each of said angularly divergent positions of the single source beam, and means for recording the amounts of light thus sensed to form an identification pattern.

It is possible by means of the invention to use a single light source of constant intensity, and to project the light from the source into the eye from sequential, angularly divergent positions to scan a circular locus on the fundus of the eye.

The apparatus of the invention has a relatively uncomplicated optical system having a few moving parts. The apparatus preferably uses an infrared light source, which will not affect the pupil dilation during the pattern recording scan, and spatial and spectral filters in the optical path to reduce optical noise.

According to a further aspect of the invention there is provided a method of recording an identification pattern from the fundus of an eye characterised by the steps of operating a single light source to produce a substantially columnar single source beam of light, directing at least a portion of said substantially columnar single source beam of light into the eye from a plurality of sequential angularly divergent positions, the light focusing on the fundus of said eye, scanning a substantially circular locus of sequential foci at a specific location on said fundus, and being reflected in part out of said eye forming a reflected beam, sensing the amount of light in the reflected beam at each angularly divergent position of the source beam, and recording the amounts of light thus sensed to form an identification pattern.

In operation, the person to be identified places his eye in the columnar single source beam of light. The beam is directed into the eye from various angularly divergent positions, the light substantially focusing on the retina, scanning the circular locus and being reflected in part out of the eye. The amounts of light thus reflected are sensed and recorded, forming an individual identification pattern.

Preferred embodiments of the invention will now be described in detail with reference to the accompanying drawings wherein:

Fig. 1 is a fragmentary pictorial perspective view of an individual using the identification apparatus of the present invention,

Fig. 2 is a diagrammatic side perspective view of an eye showing sequential positions of rays entering therein,

Fig. 3 is a diagrammatic plan view of the right eye showing the refraction of rays entering therein,

Fig. 4 is a fragmentary detailed plan view of a portion of the retina which is utilized in the identification,

Fig. 5 is a schematic representation of the electronics of the apparatus of the present invention,

Fig. 6 is a diagrammatic view of a circular scale used in the method of identification of the present invention, superimposed on a representation of the retinal vasculature of an eye.

Fig. 7 is a linear diagrammatic view of the scale of Fig. 6 showing the intercept points of the blood vessels with the scale and a graph of the absorption of light along the path defined by the scale.

Fig. 8 is a top view of a first embodiment of apparatus of the present invention.

Fig. 9 is a front view of the apparatus of Fig. 8, looking in the direction of arrows 9—9 in Fig. 8.

Fig. 10 is a schematic plan view of the optics of the apparatus of Fig. 8.

Fig. 11 is a schematic side view of the optics of Fig. 10 looking in the direction of arrows 11—11 in Fig. 10.

Fig. 12 is a schematic plan view of a second embodiment of the optics.

Fig. 13 is a schematic side view of the optics of Fig. 12 looking in the direction of arrows 13—13 in Fig. 12.

Fig. 14 is a schematic plan view of a third embodiment of the optics.

Fig. 15 is a schematic side view of the optics of Fig. 14 looking in the direction of arrows 15—15 in Fig. 14.

Fig. 16 is a waveform representing the retinal pattern of one individual, the rectangles identifying major maximum and minimum intensity points of the waveform.

Fig. 17 is a waveform representing the retinal pattern of a second individual with the identifying rectangles of Fig. 16 associated therewith to show the mis-match of the waveforms and thus prove the difference between the individuals.

The hereindescribed identification apparatus and method takes advantage of the fact that of all human physiological features, the image of the structure of the fundus of the eye is the best identifying characteristic. This is for the reason that each such retinal image is unique to the individual. It is particularly unique in the number of major retinal blood vessels in the area of the optic disk and the relative angles and branching characteristics of these vessels as they emerge from the optic nerve. Further substantially stable features of the fundus of the eye include the size of the optic disk, pigments or coloring patterns of the retina, and the choroidal vasculature.

The retina of the eye is anatomically and physiologically a part of, and an extension of, the brain which nature has provided with the highest precision biofeedback system for environmental control. This remains intact and effective throughout life, even in the presence of bodily trauma, disease and stress.

It is impossible to counterfeit the retinal image. Further, because the identifying characteristic involves the subject's function of seeing, changing the retinal image is impossible. Still further, because of relatively simple optical access, the retinal image is easy to acquire. Focusing of the eye aids in its acquisition. The eye provide much of the optics required to obtain the image.

Also, retinal images are easily susceptible to automated acquisition. No subjective interpretation of the data need be made. The number of variables is small, making the identification process simple and reliable to a machine.

The method of the present invention broadly comprises digital acquisition of the reflectance pattern of the back inside of the eye for the purpose of providing the data by which a digital computer can identify individuals.

More particularly, the method for obtaining the pattern comprises first causing the person's eye to become fixated and positioned by fixation and positioning means. Preferably the eye is indexed relative to a fixation target and positioned both horizontally and vertically to a precise degree and axially to a less precise degree relative to the cornea of the eye being scanned. This procedure causes a particular section of the eye to be presented in order to obtain a repeatable pattern and assures that the entire scan beam enters the pupil.

Once the eye is fixated and positioned, it is scanned with an infrared light source which is arranged in a selected pattern determined efficiently to intercept the major contrasting features. These features are largely comprised of the major vessels and especially the veins contrasted with the surrounding tissue. The reflected portion of the light is detected, filtered, converted to digital form, stored in computer memory and sent to a host computer as reference data or to be matched with reference data acquired earlier.

As shown in Fig. 1, the identification apparatus of the invention, shown generally at 20, is mounted in an easily accessible location at an identification check point, for instance a funds transfer machine or a security entrance, as illustrated at 22. It comprises a case 24, which encloses the hereinafter described optics, and a mounting bracket 26 which supports the apparatus at a convenient position for the user. Preferably a head bracing means such as a light shield or head support 28 is provided to position the user correctly for looking into the instrument. A knob 30 controls the interpupillary distance and another dial or lens turret 32 controls focus. A trigger or button 34 is operable by the user to initiate the identification sequence.

Figs. 2 and 3 shows a diagrammatic representation of an eyeball 36 having beams 38 and 38' entering therein. The anterior portion of the eye includes a cornea 40, and behind the cornea an iris 42 having a pupil 44 as its central opening. A lens 46 is located behind the iris supported by muscles 48 which, by expanding or contracting, may vary the focus of the lens.

The posterior or fundus portion of eyeball 36 includes a retina 50, which is the light sensitive tissue of the eye, and other supporting structures. The most light sensitive portion of the retina is the fovea 52 which is directly on the axis of the eye and is very densely packed with the light receptor structures, i.e. the rods and cones (not shown).

The nerves from retina 50 exit eyeball 36 through an optic nerve 54 which is approximately 15.5 degrees off axis toward the inside, or nasal side of the eye. The area of the retina where the optic nerve attaches, i.e. the optic disk 56, is substantially void of light receptor structures, thus forming the "blind spot" of the eye. In the central portion of the optic disk is a slight depression or cup 58.

A pair of blood vessels 60 centrally located in optic nerve 54 supply blood to and drain blood from retina 50. As best shown in Fig. 6, these vessels branch in the retina to form a vascular network 62. This vasculature is visible upon looking into the eye and appears as dark or non-reflective lines on an otherwise more reflective retina.

The central blood vessels 60 need not enter at exactly the center of optic disk 56, as is evident in Fig. 6. However, upon entry the blood vessels rapidly branch into a plurality of smaller vessels which extend somewhat randomly throughout the retina. Generally, no large blood vessels are found in the area of fovea 52 which is off the left side of the drawing of Fig. 6. This retinal vasculature is a very stable congenital structure and is unique to each individual, providing a definitive identification pattern.

Other structures (not shown), for example pigmentation, variations in the density of rods and cones, and the vasculature of the choroid, may also be observable in the use of the present invention. They also are substantially stable and contribute to a unique identification pattern. For purposes of simplifying terminology, however, all such structures will herein be referred to as the retinal vasculature, ocular vasculature, or as tending to vary the reflectance of the fundus of the eye.

Figs. 2 and 3 show a columnated beam of light 38 directed into the eye. The eye is focused on infinity, and thus all rays in the column are focused to a small spot on retina 50. The entering beam is operable to move in a cone having its apex at the lens of the eye, and thus enters the eye from a circle of sequential angularly divergent positions such as is shown at 38'. Thus a locus of points is illuminated on the retina, as is illustrated by the dashed circle 64.

Fig. 4 is an enlarged view of retina 50 showing a segment of the locus 64. One of the blood vessels 62' extends across this area of the retina and is intersected by the locus of sequentially illuminated points. As shown by the arrows, light striking the retina is reflected, while light striking the darker blood vessel is substantially absorbed.

Now referring to Figs. 6 and 7, a circular scale, shown at 66, is used in the practice of the invention. The circular scale is graduated in 256 divisions, each representing a location where the intensity of light reflected back from the fundus of the eye is measured. Locus 64 conforms to the dashed circle, and in Fig. 7 a dark bar 68 is shown where the reflected intensity is low due to absorption of the light by a blood vessel. A graph 70 illustrates the absorption as smoothed over the 256 points. Some background noise is evident in the measured intensities. However, major changes in the reflected intensity are a result of readily observable structures in the eye.

The apparatus of the present invention is shown in a first embodiment in Figs. 8 and 9. While the scanning of a single eye is adequate for purposes of obtaining a unique identification pattern, the apparatus is preferably binocular, as illustrated. This aids particularly in repeatably stabilizing the orientation and fixation of the eyes, as well as allowing use by individuals who can see only in one eye.

Fig. 8 shows a top view of the apparatus, including two halves which are essentially inverse duplicates of each other. The apparatus is mounted on a center pedestal 72 attached to mounting bracket 26 and through which extends an interpupillary adjustment screw 74 and a pair of guide pins 76. Adjustment knobs 30 are attached to the ends of the adjustment screw.

Screw blocks 80 are threaded on the adjustment screw, one with a right hand thread and one with a left hand thread so that they will move inwardly or outwardly together as the adjustment screw is turned. Each screw block is fixed to a plate 82 which in turn mounts the hereinafter described optics. Interpupillary adjustment screw 74 thus provides a means operable to adjust the distance between the beams to accommodate various users.

The fixation optics includes, for each eye, a fixation reticle 84, illuminating means for illuminating the fixation recticle, preferably a light emitting diode 86, and a columnating means 88 for columnating the light from the light-emitting diode.

The fixation reticles each include a pattern. Although the reticles may have an identical appearance, preferably a complete crosshair pattern, the patterns illustrated in Fig. 9 are complementary, wherein one reticles pattern is one half of a crosshair pattern 84' and the other recticle pattern is the other half of the crosshair pattern 84'.

Drive current to the fixation light-emitting diodes is alternated so that both are not on at the same time. The reason for this is to prevent one eye's perception from dominating the other, especially when the discs do not fuse. When the interpupillary distance is correct and the head is positioned properly the reticle images will fuse and the crosshair will be centered in the illuminator beam.

Each eye 36 can focus straight ahead on the images 84' of the fixation reticles. Because the light is columnated, the images appear at infinity, and because the beams are parallel the eyes assume a naturally relaxed position.

As shown best in Fig. 9, a pair of lens turrets 32 is mounted on the front of the identification apparatus for individual adjustment by each user. Each lens turret houses a plurality of refraction correction lenses 92. Each lens in each turret has a different refractive power so a wide range of corrections is available. As best shown in Fig. 8, the turrets are mounted at an angle with respect to the fixation axis, the purpose of which will be discussed hereinafter.

Figs. 8 and 9 also illustrate, in each half of the apparatus, a motor 94 which drives a belt 96 which in turn rotates a prism journal 98. An encoder 100 is attached to the motor for deter-

mining its rotational position and consequently the rotational position of the prism journal.

The beam directing optics of the present invention for driving beam 38 in a substantially circular or conical pattern, as discussed above, are best shown in a first embodiment in Figs. 10 and 11.

Fig. 11 shows the beam rotating components of the system. A light source, preferably an incandescent tungsten filament 102, produces a broad spectrum of light, part of which is in the near infrared range from 7500 to 9500 Angstrom units of wavelength. An infrared filter 104 allows only this infrared radiation to pass further into the system. A lens 106 then focuses the light through a source pinhole 108 which intercepts all unwanted rays and leaves only a clearly defined spot to be transmitted into a columnating lens 110. The resultant column of light is then reflected off of a partially silvered mirror 112 and through a rotating prism 114 mounted in prism journal 98. The beam is then reflected by mirror 116 through one of lenses 92 in lens turret 32 and into the user's eyeball 36.

As the beam passes through rotating prism 114 it is deflected a small amount, preferably about 4.5 degrees. Thus, as the prism rotates, the resultant beam describes an outwardly divergent cone. However, the diverging beams coincide for some distance and form an inner cone having its apex spaced apart from the prism. The rays passing through this apex come through a single spot on the outside edge of the prism. As the prism is rotated, so also is this spot.

As shown, the eyeball 36 of the user is presented in this inner cone of coincident beams at such a point that the size of a section of the cone substantially coincides with the size of pupil 44. Thus, a single spot on the perimeter of the prism is responsible for refracting light into the eye from a plurality of sequential, angularly divergent positions. The remainder of the rotating prism may be blackened to eliminate the peripheral light which would be directed onto the white of the eyeball and the face of the user if the prism were all transparent. The diverging rays in the beams are illustrated for purposes of explanation only.

Before passing through lens 92 the beams of light are columnar. However, since some users are not able to focus their eyes at infinity, a means for correcting the user's vision, such as refraction lens 92, is required. Preferably the user does not wear spectacles when using this apparatus since they would induce refractive variation as a result of variation in spectacle/corneal orientation, and would tend to cause unwanted reflections. However, similar restrictions do not apply to contact lenses since they mold to cornea 40. Lens 92 varies the beam from columnar a slight amount so that the beam will be focused on the retina and thus provide vision correction.

At any one time the small spot on retina 50 upon which the light strikes then reflects a portion of the light randomly back into the interior of eyeball 36. The reflected intensity depends on the type of structure encountered. The rods and cones tend to be quite reflective, while blood vessels 62 absorb much of the incident light.

Part of the reflected light is directed toward lens 46 of the eye. This light then follows the reverse path of incoming source 38. It is columnated by the lens of the eye to form a reflected beam coincident with the source beam and then travels through corrector lens 92, reflects off mirror 116, and is bent slightly back to a parallel optical axis as it passes through prism 114. A portion of the reflected beam is transmitted through partially silvered mirror 112 and is thus separated from the source beam.

The separated portion of the reflected beam is then focused by a focusing lens 118, reflected by a mirror 120 and directed through a receiver pinhole 122. The pinhole blocks stray light which might originate from reflections from surfaces other than the illuminated spot in the eye. Thereafter, the light is refocused by a lens 124 onto a detector 126. The detector senses the amount or intensity of light in the reflected beam.

Fig. 10 illustrates the relationship between the main or scanner optical axis and the fixation optical axis. The fixation optics are mounted at between 14 and 17 degrees, and preferably at approximately 15.5 degrees from the scanner optical axis or the axis around which the source beam is angularly divergent. Eyeball 36 is oriented so that the image of fixation reticle 84 is focused at fovea 52. Thus, the source beam enters the eye obliquely with the scanner axis intersecting the center of optic disk 56. Lens 92 is oriented to bisect the angle between the fixation axis and the scanner axis so that both beams encounter similar refraction in the lens and reflections from the surfaces of the lens do not create unwanted optical noise.

Figs. 12 and 13 illustrate a second embodiment of the optics of the present invention. The components of the system are substantially the same, with the exception of the apparatus and manner of compensating for refraction correction for various users. This correction is accomplished without the need for a refraction lens 92 as previously described.

The fixation beam is reflected by a prism 128 so that the initial fixation axis is parallel to the scanner axis. The fixation reticle 84 and source 86, as well as scanner source 102, filter 104, lens 106 and pinhole 108, and the detector 126, lens 124, and pinhole 122 are all mounted on a carriage 130. The carriage is operable to move back and forth parallel to the optical axes.

It should be noted that the distance between reticle 84 and lens 88 is the same as the distance between pinhole 122 and lens 118, and pinhole 108 and lens 110. Thus, when the carriage is positioned at other than the focal length of the lenses the resultant beam is not columnated, but varies slightly from columnar at the right amount to correct the vision of the user. Further, as the user fixates on the fixation pattern, adjusting the carriage so that the pattern is in focus also focuses the scanner optics.

Figs. 14 and 15 illustrate a third embodiment of the optics of the present invention. In this embodiment the beam directing means comprises a rotating mirror 132 mounted in the light path in place of rotating prism 114. The mirror is mounted on a shaft 134 and rotated by motor 94'. The mirror is not normal to the shaft, rather it is preferably tilted approximately 2.25 degrees from normal. This will cause the light to be reflected in an outwardly diverging cone as the mirror is rotated.

Similar to the embodiment having the prism, the diverging reflected beams coincide for some distance forming an inner cone having its apex spaced apart from the rotating mirror. And, as with the prism, only a single spot on the mirror is utilized in reflecting the source beam 38 into the eye. The remainder of the mirror may be blackened to prevent unwanted reflections. A shaft encoder 100' is attached to motor 94' to determine the rotational position of the motor and thus the direction of the beam of light 38 reflected from the mirror.

The use of rotating mirror 132 in fact does not produce an exact circle of reflected beams. Because it is at an angle with respect to the incident beam, it rather produces an oval pattern. However, this pattern is constant or reproducible from use to use, so no error is introduced by it.

Fig. 5 illustrates, in schematic form, the electronics of the present invention. Detector/amplifier 126 produces an electric analog signal S_1 corresponding to the intensity of light striking the detector. An analog to digital converter 136 receives this signal and produces a digital output data signal S_2 corresponding to the analog input signal. Signals S_3 and S_4 are produced by encoder 100. Signal S_3 is a strobe signal, pulsing once for each of the 256 positions shown by scale 66. Signal S_4 is a start strobe, pulsing once at a point corresponding to the zero point on the scale.

A digital computer 138 receives the signals S_2 from the converter 136, and S_4 from the encoder 100. A return start or "on" signal S_5 is produced by the computer and is directed to the converter. Also, the computer produces an on/off signal S_6 to control light sources 86 and 102 and motor 94. The final output is electric signal S_7.

Operation

The individual user wishing, for example, to gain access to a particular security area presses the start button 34 of the identification apparatus to activate the scanner motor and scanner lamp. The user now adjusts focus for each eye by manipulating lens turrets 32.

When the user first uses the apparatus, the corrector setting for each eye is accomplished in the following manner: He sets one turret to occlude the fixation target for its corresponding eye and sets the other turret for its most far sighted (positive diopter) correction. If the fixation target presented to the non-occluded eye is out of focus, he starts to step the turret for that eye toward the most near sighted position (most negative diopter). When the target first comes into focus, he stops stepping the turret and notes the number appearing on the turret for that eye. He then repeats this procedure for the other eye.

The user now adjusts the interpupillary distance by manipulating knob 30 to achieve the appropriate distance between the two fixation optics axes. The user adjusts the distance between the device eyepieces to match his interpupillary distance. When the user first uses the apparatus, this adjustment is made in the following manner: The user peers into the device and adjusts the interpupillary knob 30 until the two defocused images are intersected by the vertical line of the recticles 84. The user notes the calibration number appearing on the knob 30 and thereafter simply sets the appropriate pupil-distance number before peering into the apparatus.

The user tilts his head until the defocused red half discs are adjacent, forming what appears to be single defocused disc illuminating the crosshair reticle image.

The user now initiates the scan sequence by pressing scan button 34. Digital computer 138, by signal S_6 turns on motor 94 and scanner light source 102. The motor is given adequate time to achieve the proper speed, then the scan sequence is initiated.

The encoder start or zero signal S_4 pulses once per complete revolution of scanning beam 38. Preferably the start signal is coordinated with the beam focusing on the side of the scan locus closest to fovea 52. This area is the least likely to have major blood vessels and consequently the encounters with most of the light-absorbing structures will be centrally located in the scan sequence.

The computer 138, upon receiving the start signal S_4 from encoder 100, produces a start or "on" signal S_5 which instructs converter 136 to begin sending digital data S_2 to the computer. The encoder generates a strobe signal S_3, pulsing once for each data point to be sampled. On each pulse the converter converts the instantaneous analog voltage S_1 to a digital equivalent and sends it to the computer. This occurs in rapid succession for each of the 256 points. Then the encoder pulses signal S_4 again, terminating the data stream. In the binocular version of the apparatus a similar procedure is either simultaneously or sequentially carried out for the other eye, and the two patterns thus obtained are combined into a single identification pattern.

It should be remembered that the data are originally obtained from the reflectance from a plurality of sequentially divergent positions from the fundus of the eye. Consequently, by repeating the scanning cycle, optical and electrical noise may be filtered out while enforcing the good signal which is the varied reflectance. Computer 138, having recorded the data, is thus able to analyze it and determine if repeating the scan would significantly increase reliability. If so, another scan is taken. This entire process occurs so quickly that the user is unaware of the complex operations being performed.

Of course, in the most basic form of the invention, any means to record the various initial intensities of the scan is all that is required. However, the use of modern digital computers for controlling the process increases the speed and reliability of the system.

After the scan is completed, computer 138, via on/off signal S_6, turns off motor 94 and light sources 86 and 102. The identification pattern thus recorded is output via signal S_7.

Thereafter the user's identification pattern may be compared with a reference pattern or a plurality of reference patterns to determine or verify the identity of the user. This comparison process may best be performed by programmed general purpose digital computers having mass storage containing the recorded identification patterns of many users.

Initially, for the identification system to be used, the ocular vasculature patterns of all individuals of known identity authorized to use the system need to be entered into the data storage area. This involves an initial registration of each user in which the pattern is merely recorded, becoming the reference pattern for later recall and use.

Fig. 16 illustrates the waveform 140 representing the retinal pattern of an eye of one individual, with the rectangles 142 identifying ten major maximum and minimum intensity points of the waveform. These rectangles are also shown in Fig. 17 in association with the waveform 144 representing the retinal pattern of an eye of a different individual. It is to be noted that the rectangles 142 do not register with any major maximum or minimum intensity points of the waveform 144. Accordingly, it is apparent that the waveforms 140 and 144 represent the retinal patterns of totally different eyes.

The individuality of the ocular vasculature is such that it is possible, using the present invention, to distinguish each and every sighted person on the earth.

Claims

1. Apparatus for recording an identification pattern from the fundus of an eye, characterised by a single light source (102—110) operable to produce a substantially columnar single source beam of light, beam directing means (112, 114 or 132) for directing at least a portion of the source beam into the eye from a plurality of sequential angularly divergent positions, the light substantially focusing on the fundus of the eye and being reflected in part out of the eye forming a reflected beam, and the beam directing means being arranged to scan a substantially circular locus of sequential foci (64) at a specific location on the fundus of the eye, detector means (126) for sequentially sensing the amount of light in the reflected beam at each of said angularly divergent positions of the single source beam, and means (138) for recording the amounts of light thus sensed to form an identification pattern.

2. Apparatus according to claim 1, characterised in that the light from the light source consists essentially of infrared radiation.

3. Apparatus according to claim 2, characterised by a light filter (104) disposed in the single source beam of light operable to pass substantially only infrared radiation.

4. Apparatus according to claim 1, 2 or 3, characterised in that the beam directing means comprises a prism (114) disposed in the single source beam operable to deflect at least a portion of the source beam to direct it into the eye, and motive means (94, 96, 98) operable to rotate the prism so that the portion of the source beam entering the eye comes from various angularly divergent positions to scan the said substantially circular locus as the prism is rotated.

5. Apparatus according to claim 4, characterised by an encoder (110) attached to the motive means for determining the rotational position of the prism, and electrical means for associating the instantaneous rotational position of the prism and the instantaneous amount of light in the reflected beam.

6. Apparatus according to claim 1, 2 or 3 characterised in that the beam directed means comprises a mirror (132) disposed in the source beam operable to direct a portion of the source beam into the eye, and a motor (94') having its shaft (134) attached to the mirror in non-perpendicular relation and operable to rotate the mirror so that the portion of the source beam entering the eye comes from various angularly divergent positions to scan the said substantially circular locus as the mirror is rotated.

7. Apparatus according to claim 6, characterised by an encoder (100') attached to the shaft of the motor for determining the rotational position of the mirror, and electrical means for associating the instantaneous rotational position of the mirror and the instantaneous amount of light in the reflected beam.

8. Apparatus according to any preceding claim, characterised by a beam splitter (112) located in the paths of the source and reflected beams allowing a part of one beam to pass therethrough and allowing a part of the other beam to be reflected therefrom, thereby providing for coincident beams entering and exiting the eye.

9. Apparatus according to any preceding claim, characterised by vision correction means (92) to slightly vary the columnar nature of the source and reflected beams to provide for vision correction for each of various users.

10. Apparatus according to claim 9, characterised by refraction means (92) in the source and reflected beams to refract the light to provide for vision correction for the user.

11. Apparatus according to any preceding claim, characterised by alignment means (86, 84, 88) for aligning the eye so that the locus of foci on the fundus of the eye is substantially centered on the optic disc.

12. Apparatus according to any preceding claim, characterised by vision fixation means (84) providing a fixation point, illumination means (86)

(14)

Of course, in the most basic form of the invention, any means to record the various initial intensities of the scan is all that is required. However, the use of modern digital computers for controlling the process increases the speed and reliability of the system.

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The individuality of the ocular vasculature is such that it is possible, using the present invention, to distinguish each and every sighted person on the earth.

Claims

1. Apparatus for recording an identification pattern from the fundus of an eye, characterised by a single light source (102—110) operable to produce a substantially columnar single source beam of light, beam directing means (112, 114 or 132) for directing at least a portion of the source beam into the eye from a plurality of sequential angularly divergent positions, the light substantially focusing on the fundus of the eye and being reflected in part out of the eye forming a reflected beam, and the beam directing means being arranged to scan a substantially circular locus of sequential foci (64) at a specific location on the fundus of the eye, detector means (126) for sequentially sensing the amount of light in the reflected beam at each of said angularly divergent positions of the single source beam, and means (138) for recording the amounts of light thus sensed to form an identification pattern.

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4. Apparatus according to claim 1, 2 or 3, characterised in that the beam directing means comprises a prism (114) disposed in the single source beam operable to deflect at least a portion of the source beam to direct it into the eye, and motive means (94, 96, 98) operable to rotate the prism so that the portion of the source beam entering the eye comes from various angularly divergent positions to scan the said substantially circular locus as the prism is rotated.

5. Apparatus according to claim 4, characterised by an encoder (110) attached to the motive means for determining the rotational position of the prism, and electrical means for associating the instantaneous rotational position of the prism and the instantaneous amount of light in the reflected beam.

6. Apparatus according to claim 1, 2 or 3 characterised in that the beam directed means comprises a mirror (132) disposed in the source beam operable to direct a portion of the source beam into the eye, and a motor (94') having its shaft (134) attached to the mirror in non-perpendicular relation and operable to rotate the mirror so that the portion of the source beam entering the eye comes from various angularly divergent positions to scan the said substantially circular locus as the mirror is rotated.

7. Apparatus according to claim 6, characterised by an encoder (100') attached to the shaft of the motor for determining the rotational position of the mirror, and electrical means for associating the instantaneous rotational position of the mirror and the instantaneous amount of light in the reflected beam.

8. Apparatus according to any preceding claim, characterised by a beam splitter (112) located in the paths of the source and reflected beams allowing a part of one beam to pass therethrough and allowing a part of the other beam to be reflected therefrom, thereby providing for coincident beams entering and exiting the eye.

9. Apparatus according to any preceding claim, characterised by vision correction means (92) to slightly vary the columnar nature of the source and reflected beams to provide for vision correction for each of various users.

10. Apparatus according to claim 9, characterised by refraction means (92) in the source and reflected beams to refract the light to provide for vision correction for the user.

11. Apparatus according to any preceding claim, characterised by alignment means (86, 84, 88) for aligning the eye so that the locus of foci on the fundus of the eye is substantially centered on the optic disc.

12. Apparatus according to any preceding claim, characterised by vision fixation means (84) providing a fixation point, illumination means (86)

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for illuminating the fixation point, and collimating means (88) for collimating the light from the fixation point whereby the fixation point is caused to appear at infinity, the fixation point being observable when the eye is positioned in the source beam of light.

13. Apparatus according to claim 12, characterised in that the column of light from the fixation point is arranged to intersect an axis around which the source beam is angularly divergent, at an angle of between 14 and 17 degrees.

14. Apparatus for recording an identification pattern from both eyes, characterised by a dual set of the apparatus according to any preceding claim, the source beam from one apparatus being directed into one eye and the source beam from the other apparatus being directed into the other eye, and means for combining the two identification patterns thus recorded into a single identification pattern.

15. Apparatus according to claim 14, including means for repeatably stabilizing the orientation and fixation of the human eyes, characterised by first and second fixation reticles (84) providing first and second fixation points, single beam illuminating means (86) for illuminating the fixation reticles, collimating means (88) for collimating the single light beam from the fixation reticles whereby the fixation points are caused to appear at infinity, the columns of light being substantially parallel and spaced apart substantially an interpupillary distance.

16. Apparatus according to claim 15, characterised by bracing means (28) for bracing the head of the user to prevent movement thereof.

17. Apparatus according to claim 15 or claim 16, characterised in that the reticles (84) have an identical appearance.

18. Apparatus according to any one of claims 15 to 17, characterised in that the reticles comprise crosshair patterns (84').

19. Apparatus according to claim 18, characterised in that the pattern of one reticle is one half of a crosshair pattern and the pattern of the other reticle is the other half of the crosshair pattern.

20. Apparatus according to any one of claims 15 to 19, characterised by refraction means (92) in the columns of light to refract the light to provide for vision correction for the user.

21. Apparatus according to any one of claims 15 to 20, characterised by interpupillary distance varying means (30, 74) to vary the distance between the columns of light to accommodate various users.

22. A method of recording an identification pattern from the fundus of an eye characterised by the steps of operating a single light source (102) to produce a substantially columnar signal source beam of light, directing at least a portion of said substantially columnar single source beam of light (38) into the eye (36) from a plurality of sequential angularly divergent positions, the light focusing on the fundus of said eye, scanning a substantially circular locus of sequential focus at a specific location on said fundus, and being reflected in part out of said eye forming a reflected beam, sensing the amount of light in the reflected beam at each angular divergent position of the source beam, and recording the amounts of light thus sensed to form an identification pattern.

23. The method according to claim 22, characterised by the step of aligning the eye so that the locus of foci on the fundus of the eye is substantially centered on the optic disc (56).

24. A method according to claim 22 or claim 23, characterised by the step of bracing the head of the user to prevent movement thereof.

25. A method according to any one of claims 22 to 24, characterised by the step of refracting the beams to provide for vision correction for the user.

26. A method for recording an identification pattern from both eyes comprising repeating the steps of any one of claims 22 to 25 for each eye and combining the two identification patterns thus obtained into a single identification pattern.

27. A method according to claim 26 wherein the orientation and fixation of the human eyes are stabilized by the steps of bracing the head of the user to prevent movement thereof, providing the appearance of a first reticle (84) at infinity to one of the eyes (36), providing the appearance of a second reticle (84) at infinity to the other of the eyes, the images of the reticles being visible when both eyes are looking in a substantially parallel direction, orienting the eyes to align the images of the reticles, and fixation on the reticle images.

Patentansprüche

1. Gerät zur Prüfung eines Identitätsmusters vom Hintergrund eines Auges, gekennzeichnet durch eine einzige Lichtquelle (102—110) zum Erzeugen eines im wesentlichen säulenförmigen Einquellenlichtstrahles, durch Ausrichtmittel (112, 114 oder 132) zum Richten wenigstens eines Teils des Strahles in das Auge von einer Vielzahl aufeinanderfolgender, winklig divergenter Stellen, wobei das Licht, das im wesentlichen auf den Augenhintergrund fokussiert und teilweise aus dem Auge herausreflektiert wird, einen Reflexionsstrahl bildet und wobei die Ausrichtmittel zum Abtasten eines im wesentlichen kreisförmigen Ortes aufeinanderfolgender Brennpunkte (64) an einer bestimmten Stelle auf dem Augenhintergrund ausgebildet sind, durch Detektionsmittel (126) zum aufeinanderfolgenden Feststellen des Lichtbetrages in dem Reflexionsstrahl an jeder winklig divergenten Stelle des Einquellenlichtstrahles und durch Mittel (138) zum Prüfen des so abgetasteten Lichtbetrages zwecks Bildung des Identitätsmusters.

2. Gerät nach Anspruch 1, dadurch gekennzeichnet, daß das Licht der Lichtquelle im wesentlichen aus Infrarotstrahlung besteht.

3. Gerät nach Anspruch 2 gekennzeichnet durch einen im Strahlengang des Einquellenstrahls angeordneten Lichtfilter (104) zum Durchlassen von im wesentlichen Infrarotstrahlung.

4. Gerät nach Anspruch 1, 2 oder 3, dadurch ge-

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kennzeichnet, daß die Ausrichtmittel ein im Strahlengang des Einquellenstrahls angeordnetes Prisma (114), das zum Ablenken wenigstens eines Teils des Strahles bedienbar ist, um Licht in das Auge zu richten, und Antriebsmittel (94, 96, 98) umfassen, die das Prisma derart drehen, daß der in das Auge eintretende Teil des Lichtstrahles von verschiedenen, winklig divergenten Stellen kommt, um den im wesentlichen kreisförmigen Ort bei Drehung des Prismas abzutasten.

5. Gerät nach Anspruch 4 gekennzeichnet durch einen an den Antriebsmitteln angebauten Kodierer (100) zum Bestimmen der Rotationsstellung des Prismas und durch elektrische Mittel zu Zuordnen der augenblicklichen Rotationsstellung des Prismas und des augenblicklichen Lichtbetrages des Reflexionsstrahles.

6. Gerät nach Anspruch 1, 2 oder 3, dadurch gekennzeichnet, daß die Strahlausrichtmittel einen im Strahlengang des Lichtquellenstrahls angeordneten Spiegel (132) zum Richten eines Teiles des Lichtquellenstrahles in das Auge und einen Motor (94') umfassen, dessen Welle (134) in einer nichtrecktwinkligen Beziehung an dem Spiegel befestigt ist, um den Spiegel so zu drehen, daß der in das Auge eintretende Lichtquellenstrahl von verschiedenen, winklig divergenten Stellen kommt, um den im wesentlichen kreisförmigen Ort bei Drehung des Spiegels abzutasten.

7. Gerät nach Anspruch 6, gekennzeichnet durch einen an der Welle des Motors befestigten Kodierer (100') zum Bestimmen der Rotationsstellung des Spiegels und durch elektrische Mittel zum Zuordnen der augenblicklichen Rotationsstellung des Spiegels zum augenblicklichen Lichtbetrag in dem Reflexionsstrahl.

8. Gerät nach einem vorangehenden Anspruch, gekennzeichnet durch einen in den Wegen des von der Lichtquelle kommenden und des reflektierten Strahles angeordneten Strahlenteilers (112), der es einem Teil des einen Strahls erlaubt, ihn zu passieren, und es einem Teil des anderen Strahls erlaubt, von ihm reflektiert zu werden, wodurch zusammentreffende Strahlen zum Eintreten und Beleuchten des Auges vorgesehen sind.

9. Gerät nach einem vorangehenden Anspruch, gekennzeichnet Sehkorrekturmittel (92), um die säulenförmige Natur des von der Lichtquelle kommenden und des reflektierten Strahles geringfügig zu verändern, um eine Sehkorrektur für jeden der verschiedenen Benutzer vorzusehen.

10. Gerät nach Anspruch 9, gekennzeichnet durch Refraktionsmittel (92) im Strahlengang des von der Lichtquelle kommenden und des reflektierten Strahles, um das Licht zwecks Vorsehens einer Sehkorrektur für den Benutzer zu brechen.

11. Gerät nach einem vorangehenden Ansprüch, gekennzeichnet, durch Ausrichtungsmittel (86, 84, 88) zum Ausrichten des Auges derart, daß der Ort der Brennpunkte auf dem Augenhintergrund im wesentlichen zur optischen Kreisfläche ausgerichtet ist.

12. Gerät nach einem vorangehenden Anspruch, gekennzeichnet durch Fixationsmittels (84) zum Vorsehen eines Fixationspunktes, durch Beleuchtungsmittel (86) zum Beleuchten des Fixationspunktes und durch Kollimationsmittel (88) zum Kollimieren des Lichtes vom Fixationspunkt, wodurch der Fixationspunkt veranlaßt, wird, in der Unendlichkeit zu erschienen, wobei der Fixationspunkt zu beobachten ist, wenn das Auge in dem Lichtquellenstrahl positioniert ist.

13. Gerät nach Anspruch 12, dadurch gekennzeichnet, daß die Lichtsäule von Fixationspunkt angeordnet ist, eine Achse zu schneiden, um welche der Lichtquellenstrahl winklig divergent verläuft, und zwar mit einem Winkel zwischen 14 und 17 Grad.

14. Gerät zum Prüfen eines Identitätsmusters von beiden Augen, gekennzeichnet durch eine dualen Satz des Gerätes nach einem der vorangehenden Ansprüche, wobei der Lichtquellenstrahl des einen Gerätes in das einen Auge und der Lichtquellenstrahl des anderen Gerätes in das andere Auge gerichtet wird, und durch Mittel zum Kombinieren der beiden so aufgenommenen Identitätsmuster zu einem einzigen Identitätsmuster.

15. Gerät nach Anspruch 14 und Mitteln zum wiederholbaren Stabilisieren der Ausrichtung und Fixation der menschlichen Augen, gekennzeichnet durch erste und zweite Fixationsleuchtkreise (84) zum Vorsehen von ersten und zweiten Fixationspunkten, durch Einzelstrahlbeleuchtungsmittel (86) zum Beleuchten der Fixationsleuchtkreise, Kollimationsmittel (88) zum Kollimieren des Einzellichtsstrahles von den Fixationsleuchtkreisen, wodurch die Fixationspunkte veranlaßt, werden, in der Unendlichkeit zu erscheinen, wobei die Lichtsäulen im wesentlichen parallel und durch den Augenabstand im wesentlichen voneinander beabstandet sind.

16. Gerät nach Anspruch 15, gekennzeichnet durch Abstützmittel (28) zum Abstützen des Kopfes des Benutzers, um dessen Bewegung zu vermeiden.

16. Gerät nach Anspruch 15 oder 16, dadurch gekennzeichnet, daß die Leuchtkreise (84) ein identisches Aussehen haben.

18. Gerät nach einem der Ansprüche 15 bis 17, dadurch gekennzeichnet, daß die Leuchtkreise ein Fadenkreuzmuster (84') umfassen.

19. Gerät nach Anspruch 18, dadurch gekennzeichnet, daß das Muster des einen Leuchtkreises die eine Hälfte eines Fadenkreuzmusters und das Muster des anderen Leuchtkreises die andere Hälfte eines Fadenkreuzmusters ist.

20. Gerät nach einem der Ansprüche 15 bis 19, gekennzeichnet durch Refraktionsmittel (92) in den Lichtsäulen zwecks Lichtbrechung, um eine Sehkorrektur für den Benutzer vorzusehen.

21. Gerät nach einem der Ansprüche 15 bis 20, gekennzeichnet durch Mittel (30, 74) zur Veränderung des interpupillaren Abstandes, um den Abstand zwischen den Lichtsäulen in Anpassung an verschiedene Benutzer zu verändern.

22. Verfahren zum Prüfen eine Identitätsmusters vom Hintergrund eines Auges, gekennzeichnet durch den Schritt des Bedieners einer

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einzigen Lichtquelle (102), um einen im wesentlichen säulenförmigen Einquellenlichtstrahl zu erzeugen, durch den Schritt des Richtens wenigstens eines Teiles des im wesentlichen säulenförmigen Einquellenlichtstrahles (38) in das Auge (36) von einer Vielzahl aufeinanderfolgender, winklig divergenter Stellen, durch den Schritt des Fokussierens von Licht auf den Hintergrund des Auges, durch den Schritt des Abtastens eines im wesentlichen kreisförmigen Ortes von aufeinanderfolgenden Brennpunkten an einer bestimmten Stelle auf dem Augenhintergrund, durch den Schritt des Reflektierens eines Teils des Lichtes aus dem Auge unter Bildung eines Reflexionsstrahles, durch den Schritt des Feststellens des Lichtbetrages in dem Reflexionsstrahl an jeder winklig divergenten Stelle des Lichtquellenstrahles und durch den Schritt des Aufnehmens des so festgestellten Lichtbetrages, um ein Identitätsmuster zu bilden.

23. Verfahren nach Anspruch 22, gekennzeichnet durch den Schritt des Ausrichtens des Auges derart, daß der Ort der Brennpunkte auf dem Hintergrund des Auges im wesentlichen auf der optischen Kreisfläche (56) zentriert ist.

24. Verfahren nach Anspruch 22 oder 23, gekennzeichnet durch den Schritt des Abstützens des Kopfes des Benutzers, um dessen Bewegung zu vermeiden.

25. Verfahren nach einem der Ansprüche 22 bis 24, gekennzeichnet durch den Schritt des Brechens der Strahlen, um eine Sehkorrektur für den Benutzer vorzusehen.

26. Verfahren zum Prüfen eines Identitätsmusters von beiden Augen, das das Wiederholen der Schritte nach einem der Ansprüche 22 bis 25 für jedes Auge umfaßt und bei dem die beiden so erhaltenen Identitätsmuster zu einem einzigen Identitätsmuster kombiniert werden.

27. Verfahren nach Anspruch 26, bei dem die Ausrichtung und Fixation der menschlichen Augen durch die Schritte des Abstützens des Kopfes des Benutzers stabilisiert werden, um die Kopfbewegung zu vermeiden, bei dem das Erscheinen eines ersten Leuchtkreises (84) in der Unendlichkeit bei dem einen Auge vorgesehen wird, bei dem das Erscheinen eines zweiten Leuchtkreises in der Unendlichkeit bei dem anderen Auge vorgesehen wird, bei dem die Bilder der Leuchtkreise sichtbar sind, wenn beide Augen in eine im wesentlichen parallele Richtung blicken und bei dem die Augen zwecks Ausrichtung der Bilder der Leuchtkreise ausgerichtet und auf die Leuchtkreise fixiert werden.

Revendcations

1. Appareil pour l'enregistrement d'un schéma d'identification du fond d'un oeil, caractérisé par le fait qu'il comprend une source lumineuse unique (102—110) pouvant être manipulée afin de produire un faisceau unique sensiblement rectiligne de ladite source lumineuse, d'un moyen d'orientation dudit faisceau (112, 114 ou 132) destiné à diriger au moins une partie du faisceau de la source dans l'oeil à partir d'une pluralité de positions séquentielles angulairement divergentes, la lumière se focalisant sensiblement sur le fond de l'oeil et étant réfléchie partiellement à l'extérieur de l'oeil en formant un faisceau réfléchi, et le moyen d'orientation du faisceau étant disposé de manière à balayer un espace sensiblement circulaire de foyers séquentiels (64) en un point spécifique du fond de l'oeil, un moyen de détection (126) pour détecteur séquentiellement la quantité de lumière présente dans le faisceau réfléchi en chacune desdites positions angulairement divergentes du faisceau unique de la source lumineuse, et un moyen (138) pour enregistrer les quantités de lumière ainsi détectée afin de forme un schéma d'identification.

2. Appareil selon la revendication 1, caractérisé par le fait que la lumière venant de la source lumineuse est essentiellement constituée par un rayonnement infra-rouge.

3. Appareil selon la revendication 2, caractérisé par le fait qu'un filtre à lumière (104) disposé sur le faisceau lumineux provenant de la source unique et pouvant être manipulé de manière à ne laisser passer pratiquement que des faisceaux infra-rouges.

4. Appareil selon la revendication 1, 2 ou 3, caractérisé par le fait que le moyen d'orientation du faisceau comprend un prisme (114) disposé sur le faisceau de la source lumineuse unique et pouvant être manipulé de manière à faire dévier au moins une portion du faisceau de la source et le diriger à l'intérieur de l'oeil et un moyen de mobilisation (94, 96, 98) pouvant être manipulé de manière à faire tourner le prisme pour qu'une portion du faisceau de source entrant dans l'oeil provienne de différentes positions angulairement divergentes afin de balayer ledit espace sensiblement circulaire pendant la rotation du prisme.

5. Appareil selon la revendication 4, caractérisé par le fait qu'il comprend un codeur (100) fixé au moyen de mobilisation destiné à déterminer la position de rotation du prisme et un moyen électrique destiné à associer la position momentanée de rotation du prisme et la quantité momentanée de lumière dans le faisceau réfléchi.

6. Appareil selon la revendication 1, 2 ou 3, caractérisé par le fait que le moyen d'orientation du faisceau comprend un miroir (132) disposé sur le faisceau de source, pouvant être manipulé de manière à diriger une portion du faisceau de source à l'intérieur de l'oeil et un moteur (94') dont l'arbre (134) est fixé sur le miroir en une relation non perpendiculaire et pouvant être manipulé de manière à faire tourner le miroir afin que la portion du faisceau de source entrant dans l'oeil provienne de différentes positions angulairement divergentes afin de balayer ledit espace sensiblement circulaire pendant la rotation du miroir.

7. Appareil selon la revendication 6, caractérisé par le fait qu'il comprend un codeur (100') fixé à l'arbre du moteur, destiné à déterminer la position de rotation du miroir et un moyen électrique destiné à associer la position de rotation momen-

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tanée du miroir et la quantité momentanée de lumière dans le faisceau réfléchi.

8. Appareil selon l'une quelconque des revendications précédentes, caractérisé par le fait qu'il comprend un diviseur de faisceau (112) placé sur les trajets du faisceau de la source lumineuse d'une part, et du faisceau réfléchi d'autre part, permettant à une partie du faisceau de passer à travers celui-ci et permettant à une partie de l'autre faisceau d'être réfléchie à partir de celui-ci, assurant ainsi que les faisceaux coïncidant entrent et sortent de l'oeil.

9. Appareil selon l'une quelconque des revendications précédentes, caractérisé par le fait qu'il comprend un moyen de correction visuelle (92) destiné à modifier légèrement la nature rectiligne des faisceaux de source et des faisceaux réfléchis afin de permettre une correction de la vision de chacun des différents usagers.

10. Appareil selon la revendication 9, caractérisé par le fait qu'il comprend un moyen de réfraction (92) dans le faisceau de source et les faisceaux réfléchis afin de réfracter la lumière dans le but d'assurer la correction de la vision de l'usager.

11. Appareil selon l'une quelconque des revendications précédentes, caractérisé par le fait qu'il comprend un moyen d'alignement (86, 84, 88) destiné à aligner l'oeil de telle manière que l'espace des foyers sur le fond de l'oeil soit sensiblement centré sur la disque optique.

12. Appareil selon l'une quelconque des revendications précédentes, caractérisé par le fait qu'il comprend un moyen de fixation de la vision (84) assurant un point de fixation, un moyen d'éclairage (86) pour éclairer ledit point de fixation et un moyen de collimation (88) destiné à collimater la lumière venant du point de fixation, ce qui a pour effet de faire apparaître le point de fixation à l'infini, le point de fixation pouvant être observé lorsque l'oeil est placé dans le trajet du faisceau lumineux de la source.

13. Appareil selon la revendication 12, caractérisé par le fait que la colonne de lumière venant du point de fixation est disposée de manière à couper un axe autour duquel le faisceau de source diverge angulairement en une angulation comprise entre 14 et 17 degrés.

14. Appareil pour l'enregistrement d'un schéma d'identification venant des deux yeux, caractérisé par le fait qu'il comprend deux exemplaires de l'appareil conforme à l'une quelconque des revendications précédentes, le faisceau de source venant de l'un des appareils étant dirigé dans un oeil et le faisceau de source venant de l'autre appareil étant dirigé dans l'autre oeil, et un moyen pour combiner les deux schémas d'identification ainsi enregistrés en un seul schéma d'identification.

15. Appareil selon la revendication 14, comprenant un moyen pour stabilisier de manière répétée l'orientation et la fixation des yeux humains, caractérisé par le fait qu'il comprend un premier et un deuxième réticule de fixation (84) assurant un premier et un deuxième point de fixation, un moyen d'éclairage à faisceau unique (86) destiné à éclairer les réticules de fixation, des moyens de collimation (88) destinés à collimater le faisceau lumineux unique venant des réticules de fixation ayant pour effet de faire apparaître les points de fixation à l'infini, les colonnes de lumière étant sensiblement parallèles et réciproquement espacées à un distance sensiblement égale à la distance inter-pupillaire.

16. Appareil selon la revendication 15, caractérisé par le fait qu'il comprend un moyen d'attache (28) destiné à attacher la tête de l'usager afin d'empêcher tout mouvement de celle-ci.

17. Appareil selon la revendication 15 ou 16, caractérisé par le fait que les réticules (84) ont une apparence identique.

18. Appareil selon l'une des revendication 15 à 16, caractérisé par le fait que les réticules comprennent des systèmes à fils entrecroisés (84').

19. Appareil selon la revendication 18, caractérisé par le fait que le système d'un réticule est une moitié d'un système à fils entrecroisés et que le système de l'autre réticule est l'autre moitié dudit système à fils entrecroisés.

20. Appareil selon l'une quelconque des revendications 15 à 19, caractérisé par le fait qu'il comprend un moyen de réfraction (92) dans les colonnes de lumière, destiné à réfracter la lumière afin de fournir une correction visuelle à l'usager.

21. Appareil selon l'une quelconque des revendications 15 à 20, caractérisé par le fait qu'il comprend un moyen de variation de la distance interpupillaire (30, 74), destiné à modifier la distance entre les colonnes de lumière pour le adapter à différents usagers.

22. Un procédé d'enregistrement d'un schéma d'identification du fond d'un oeil, caractérisé par le fait qu'il comprend les différentes étapes de manipulation d'une source lumineuse unique (102) afin de produire un faisceau unique de source lumineuse sensiblement rectiligne, en dirigeant au moins une portion dudit faisceau unique (38) sensiblement rectiligne dans l'oeil (36) à partir d'une pluralité de positions séquentielles angulairement divergentes, la lumière se focalisant sur le fond dudit oeil en balayant un espace sensiblement circulaire de foyers séquentiels en un point spécifique dudit fond d'oeil et étant réfléchi partiellement à l'extérieur dudit oeil en formant un faisceau réfléchi, en orientant la quantité de lumière présente dans le faisceau réfléchi en chaque position angulairement divergente du faisceau de source et en enregistrant les quantités de lumière ainsi dirigée afin de former un schéma d'identification.

23. Procédé selon la revendication 22, caractérisé par le fait qu'il comprend l'opération d'alignement de l'oeil, de telle manière que l'espace des foyers sur le fond de l'oeil soit sensiblement centré sur le disque optique (56).

24. Procédé selon la revendication 22 ou 23, caractérisé par le fait qu'il comprend l'opération consistant à attacher la tête de l'usager afin d'empêcher tout mouvement de celle-ci.

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25. Procédé selon l'une quelconque des revendications 22 à 24, caractérisée par le fait qu'il comprend l'opération de réfraction des faisceaux afin d'assurer la correction de la vision de l'usager.

26. Procédé pour enregistrer un schéma d'identification à partir des deux yeux, comprenant la répétition des étapes, de l'une quelconque des revendications 22 à 25 pour chaque oeil et combinant les deux schémas d'identification ainsi obtenus en un schéma d'identification unique.

27. Procédé selon la revendication 26 dans lequel l'orientation et la fixation des yeux se trouvent stabilisées par les étapes consistant à attacher la tête de l'usager afin d'empêcher tout mouvement de celle-ci, en assurant l'apparition à l'infini d'un premier réticule (84) pour l'un des yeux (36), assurant l'apparition à l'infini d'un deuxième réticule (84) pour l'autre oeil, les images desdits réticules étant visibles lorsque les deux yeux regardent dans une direction sensiblement parallèle, orientant les yeux afin d'aligner les images des réticules et assurer la fixation sur les images des réticules.

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