

Vision aid in the form of telescopic spectacles with autofocussing means

Vision aid

The invention relates to a vision aid with the features of the introductory part of claim 1 with an autofocussing means, with a means for changing the focal length and with a means for matching the parallax between the tubes of the vision aid to the respectively set focal length.

One such vision aid (telescopic spectacles) with autofocussing means, with a means for changing the focal length and with a means for matching the parallax between the tubes of the vision aid to the respectively set focal length is known from WO 96/09566 (or US 5 971 540 A with essentially the same contents). The known vision aid is intended for use as telescopic spectacles.

The known telescopic spectacles has an automatic and/or manual focussing means, a device for manually changing the magnification factor and a device for automatic, mechanical parallax equalization which corresponds to the respective focal length. If for example during vascular surgery, due to the location of the different surgical sites, the working distance must be changed, the focal length and the parallax angle are adjusted automatically or manually to the new working distance. In this way optimum adjustment of the vision aid which corresponds to the surgery underway at the time is ensured. Moreover, the user of the vision aid can assume the ergonomic positions which are most advantageous at the time so that it is possible to operate without fatigue. In addition, the known vision aid makes it possible to match the magnification factor to the respective requirement at any chosen working distance. The known vision aid which is worn using a headset allows the user to largely freely select the working distance and the magnification factor used. The control device is a foot-operated switch. To prevent losing the 3-D image when the working distance and the focussing position change, the known

vision aid uses an autofocussing means which by mechanically changing the angle of the tubes of the vision aid to one another matches the parallax angle to the respective focal length. This type of matching of the parallax to the respectively set focal length entails several disadvantages:

(1) The tubes are moved mechanically by motors via gearing; this means relatively high weight and thus low wearing comfort for the user.

(2) Since the tubes of the vision aid must be made movable to one another along the lengthwise axis, the resistivity of the system to mechanical stresses suffers.

(3) For each change of the working distance the parallax equalization means changes the position of the tubes to one another and thus also the angle of the eyepiece planes to the eyes of the user. This can lead to disruptive reflections and to a diminishment of the entrance pupil and thus the field of vision.

(4) In practice it is hardly possible to produce systems independent of the user with this type of parallax equalization, i.e. each system is tailored to a certain user and his distal pupil distance. This necessitates higher investment costs when for example hospitals intend to ensure that all surgeries can be performed with autofocussing telescopic spectacles.

(5) If correction glasses which project beyond the eyepieces are attached to the latter, when the position of the tubes change under certain circumstances they can touch the face of the user and thus distract him.

Furthermore, for users, for example in surgery, it would be of great benefit while using one such vision aid to be able to view additional information such as the vital signs of the patient from the monitoring system, measurement scales or also x-ray,

computer tomography or other data. The telescopic spectacles currently known do not offer this possibility.

Similar telescopic spectacles are known from AT E 99782 B.

US 5 078 469 A discloses telescopic spectacles to which a video camera and a display unit are connected to transmit pictures of the surgical field.

WO 95/25979 A discloses a surgical microscope which has means for producing and displaying three-dimensional video data of the surgical field and for reflecting-in additional information, for example patient data.

US 4 621 283 A describes a device which is worn on the head of the surgeon, with telescopic spectacles and a recording camera and light source, the recording camera and the light source due to a swivelling mirror, regardless of the circumstance that they are worn on the head at a distance, having a viewing direction which is essentially parallel to the directions of viewing through the telescopic spectacles in front of the eyes of the surgeon so that image field seen by the surgeon can be transferred to a screen essentially from the same angle of viewing via the recording means.

US 5 436 948 A shows a device for forming a stereoscopic image with two image-recording systems. These image-recording systems can be television cameras. In the beam path of each of the two television cameras there are two wedge-shaped prisms which each can be turned in opposite directions in order to deflect the light beam as the distance to the object changes in synchronization with focussing of the television cameras. In this way it will be possible to focus the device on the object without having to turn the television cameras themselves.

US 4 779 965 A proposes assigning positive achromatic lenses which are eccentric to binoculars to the objective lenses of the binoculars in order to achieve, by turning these achromatic lenses, the use of the binoculars as a microscope to simultaneously see the images produced by the two optical systems of the binoculars and to obtain a stereoscopic image.

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JP 07152096 A proposes an image recording system with several lenses, one pair of mirrors at a time being pivotally located to the lenses systems in front of their objective lenses so that the parallax angle can be changed without moving the lens pair by swivelling and displacing the mirror of each pair of mirrors.

The object of the invention is to make available a vision aid which is worn on the head and which enables the user to change the working distance and to use different magnification factors which are matched to the respective activity. Furthermore, the 3-D image will be preserved without the position of the two tubes of the vision aid to one another having to be changed, as is the case in the vision aid known from WO 96/09566. Moreover, it is to be possible for the user to view additional information in text or video form which originates from external data sources and to eliminate any poor visibility by the corresponding settings on the eyepieces of the vision aid.

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This object is achieved as claimed in the invention with a vision aid which is characterized in that using adjustable optical elements which are provided in the beam path of the vision aid the angle between the beam paths running out of the tubes toward the object can be changed.

Preferred and advantageous embodiments of the vision aid as claimed in the invention are the subject matter of the dependent claims.

The vision aid as claimed in the invention represents a completely new application or (product) class. It differs on the one hand from telescopic spectacles or surgical microscopes mainly in that the features autofocus, optical parallax equalization and variable zoom enable unprecedented, completely free mobility during use. The vision aid as claimed in the invention differs from a surgical microscope predominantly in that it can be worn by means of a headset on the head of the user.

The vision aid as claimed in the invention can be used not only in operations on human or animal bodies, but wherever the user is to see the working field magnified.

The invention represents a light, stable and comfortable stereoscopic vision aid with variable magnification factor, autofocus and automatic parallax equalization and with the possibility of compensating poor visibility, the angle of the tubes of the vision aid to one another not needing to be

changed. This features also allows a structural form of the vision aid such that the two beam paths can be accommodated in a single, preferably oval tube. Furthermore, additional visual information can be offered to the user.

In preferred embodiments the vision aid as claimed in the invention offers at least one of the following possibilities.

When the vision aid as claimed in the invention is being used in surgery, the working distance of the surgeon using the vision aid of the invention can be changed - for example to enable an assistant a better view into the surgical area - without changing the magnification factor.

Furthermore, objects, such as for example a tumor, can be subjected to accurate, quantitative determination without the need to adapt the magnification factor.

During surgery the beam path often intersects briefly between the objective lens and the surgical field; this leads to undesirable adaptation of the focal length to the intersecting article with its subsequent readaptation to the original visual field by the autofocussing means in the known telescopic spectacles. In the invention this can be prevented by automatic changing of the focal length being provided with a delay switch and therefore a change of the working distance only after an adjustable time and/or with an optional speed leading to a focal length which is optimized to the new working distance. The reaction time of the autofocussing part can therefore be matched to a certain situation or a personal style of working.

Especially in surgical training does one embodiment of the invention allow students observing the operation to follow the surgery in exactly that perspective also offered to the surgeon.

Especially in surgery within body cavities does the problem of optimum illumination often arise; the ceiling light can rarely be moved into a suitable position; a light source mounted in the

headset necessarily has a parallax angle to the optical beam path between the objective lens and the visual field; this leads to unwanted cast shadow formation, especially in body cavities with a small diameter. It can also be advantageous for the assisting physicians to recognize the exact visual field of the surgeon in order to direct their attention to it.

Applications of the invention are also conceivable in which the autofluorescent properties of tissues are used. To do this, with or without using various filter and frequency conversion systems, a UV/IR or laser light source combined with the vision aid as claimed in the invention can be used.

There are also application situations in which an amplified 3-D impression becomes advantageous. The invention does this in one version by a device for increasing the distance of the objective lenses from one another.

Often the user of the vision aid as claimed in the invention, for example to conventionally orient himself during an operation, looks past the telescopic spectacles mounted in front of his eyes. When there is poor visibility it is only practicable if correction glasses are attached to the eyepieces of the telescopic spectacles. These correction glasses carry out parallax adaptation when the focal length of the telescopic spectacles changes in one embodiment of the invention in order to prevent a reduction of the optical quality when the parallax angle changes.

Poor visibility which cannot be corrected by diopter equalization mounted on the eyepiece is a problem when using the vision aid known from WO 96/09566 and is eliminated in one embodiment of this invention by correction glasses mounted on the eyepieces.

Absorbing, reflecting or filtering protective glasses which are easy to clean and which are preferably provided as claimed in the invention and reflection of information, for example surgery

parameters, into or near the immediate visual field are advantageous in several conceivable possible applications.

For accurate quantitative determination of objects, in the invention a measurement scale which can be made as a liquid crystal display, LED vacuum fluorescent display or gas discharge display or also in another form can be inserted in an intermediate image plane.

Furthermore, in one embodiment, by reflecting a part of the beam path out onto a CAD camera module, it becomes possible to observe the course of the surgery on a monitor which is desirable for example in surgical training.

One preferred light source which is made as a fiber bunch with a variable aperture and which is integrated into the optical system greatly improves the illumination properties when using this embodiment of the vision aid of the invention compared to known vision aids. The light is coupled preferably by a beam splitter or into the prism surface of a prism reversal system. The light source can emit UV/IR or laser light for observation. The light reflected by the object can be absorbed or reflected by a filter in the eyepieces. The use of infrared light, ultraviolet light or laser light can be of great diagnostic value.

Parallax equalization when the focal length changes without changing the tube or eyepiece distances can be achieved in the invention by for example an electric motor mounted in the middle part of the vision aid simultaneously laterally and/or axially moving and optionally tilting the respective objective lens or part of it (front member) via the corresponding sheathed cables or gearing, cam-controlled. Using axial displacement focussing (changing of the focal length) to different distances can take place. In the base setting of the vision aid (the optical axis of the movable objective lens or lens part lies in the optical axis of the zoom extension) the distance setting and convergence angle are set preferably to a middle working distance so that

the optical axes of the eyepieces run through the optical center points of the eyes. When the working distance changes, the objective lens or with internal focussing the corresponding objective lens parts can be axially moved such that the object-side system focal points lie in the object plane. At the same time, in the invention lateral motion controlled via cams can take place with the type that the focal points of the two objective lenses are guided exactly along the plane of symmetry of the vision aid. For parallax equalization then neither an angle change nor distance change is necessary with respect to the optical axes of the eyepiece.

Furthermore, at the same time, by tilting the objective lenses or parts of them, correction of the image errors which occur due to lateral offset (for example, astigmatism, tilting of the image plane) can be done. The aforementioned movements of the objective lenses or the objective lens parts can also be caused by electrical or pneumatically actuated linear drives of actuators.

The relationships between the

- a) focussing of the lens systems by changing the focal length and
- b) the change of the magnification factor of the lens system can be explained as follows.

In order to obtain a sharp image at a given distance between a lens system and an article/object field, the focal length of the lens system must be changed according to the distance between the article/object field, for example with an autofocussing means. This "focussing" yields a focussed image with a size which depends solely on the distance between the lens system and the article/object field. This size of the focussed image of the article/object field can only be changed by changing the distance between the article/object field and the lens system (larger distance : smaller image - smaller distance : larger

image). Changing the focal length of a lens system with a zoom means on the other hand yields an enlargement or reduction in the size of the image of the article/object field without changing the distance between the lens systems and the article/object field, therefore only by changing the focal length using zoom means. Therefore both the "focussing" of a lens system with an autofocussing means as well as adjusting the zoom means imply a change of the focal length. Nevertheless an autofocussing means and a zoom means are not the same.

This principle can be established on the objective lenses of cameras: an autofocus camera without the zoom function can display a certain tree sharply focussed as larger or smaller, in any case only when the camera is at one time nearer, then again farther away from the tree. In both cases it takes pictures with different focal length. A camera with a zoom objective lens on the other hand can photograph the tree from one location, one time larger, then again smaller - it also does this with different focal lengths, but it also has a zoom means. Since a zoom means requires an additional lens group with an positioning mechanism in the lens system, the much higher price, the different (lower) light intensity and the generally greater dimensions of these lens systems are self-explanatory.

Other details, features and advantages of the invention derive from the following description of preferred embodiments of the vision aid (telescopic spectacles) of the invention using schematics.

Figure 1 shows a vision aid;

Figure 2 shows a vision aid with illumination means;

Figure 3 shows one embodiment in which the objective lens distance is variable;

Figure 4 shows a vision aid with its assigned laser light source; and

Figures 5, 6 show a headset for the vision aid;

Figures 7, 7a and 7b show one embodiment with a device in front of the sensor for the autofocussing means;

Figure 8 shows an embodiment in which two lens systems are housed in a common tube;

Figure 9 shows in a schematic one embodiment of the vision aid with a means for preventing the entry of outside (infrared) light into the receiving part of the infrared autofocussing means,

Figure 10 shows in a view similar to the one from Figure 9 another embodiment of the means for preventing the entry of outside (infrared) light into the receiving part of the infrared autofocussing means, and

Figure 11 schematically shows in the form of a schematic the arrangement of a transparent display in the beam path of the vision aid.

Figure 1 shows a vision aid ("telescopic spectacles") consisting of two tubes 1, eyepiece parts 2, an autofocussing means 4 mounted in the middle in this embodiment with an infrared diode 5 and a receiving unit 6. The tubes 1 can be fixed to one another, or as shown in Figure 1, can be connected by crosspieces 17 which can be moved lengthwise. An external switch 3 and an external electronic unit 7 can be connected to the vision aid by cable, or, as in this embodiment, without a cable, for example by a radio transmitter 8 and radio receiver 9 or otherwise.

Figure 1 further shows two bent boards which are housed in the tubes 1 as guides 12 on which optical elements 11 can be moved back and forth by positioning motors 10 such that the refraction property of their respective position yields the angle 13 between the beams paths 14 which emerge from the tubes which is

necessary for each selected working distance A. The optical elements 11 with an appropriate shape can be housed in the tubes 1 or placed in front of them. The optical elements 11 can also be movable on straight or bent boards. The optical elements 11 can also be arranged only to be able to rotate or to tilt. The measurement principle for the position of the optical elements 11 is delivered by the autofocussing means 4. The computation of the position of the optical elements 11 which is necessary at the time for parallax equalization is performed by the electronic unit 7. The electronic unit 7 also determines the position of the lens system of the focussing unit 14 which is optimum for each working distance A. This position is likewise brought about by the positioning motors 10.

Furthermore, Figure 1 shows a lens system 15 using which after activation the magnification factor ("zoom") of the vision aid can be changed continuously by the external switch 3 or via voice control.

All other functions of the vision aid can also be activated, deactivated or changed by means of the external switch 3 or via voice control.

If necessary, additional information, for example the vital signs of the patient, computer tomography or x-ray data or pictures, measurement scales or the like can be inserted into the optical plane 16 which is located within the two tubes 1. Alternatively or in addition, displays 18 can also be mounted next to one eyepiece 2 or next to the two eyepieces 2; additional information can be displayed via the displays. The insertion of information can take place stereoscopically, i.e. with individual images corrected with respect to parallax and/or eye distance and can be held as an entire or partial picture ("freeze-frame").

The additional information delivered in video form can be displayed faithfully to location in relation to a viewed object. This can be done by the use of optical, electromagnetic or other

positioning systems jointly with inertial sensors. One such system can also be used to determine the location of objects, for example, surgical instruments, relative to a patient, and to display it via one optical plane in the beam path of the vision aid or via externally mounted displays.

These inertial sensors, linear or angle encoders or also ultrasonic, infrared, or other systems can also be used to record the current parameters of the vision aid, such as for example the magnification area, distance to a viewed object, etc., and are used and/or displayed for modification of additional computer-generated or optical information.

The vision aid as claimed in the invention can furthermore be equipped with a device for illumination of the working area. The light required for this purpose can be routed by means of fiber optics from the external light source via the headset forward into the vicinity of the objective lens plane of the vision aid. On the end of the optical fiber a lens system can be attached which focusses the emerging light to the selected working distance and magnification factor such that the working field is illuminated optimally in size and intensity. The measurement data can be recovered via internal or external sensors. Alternatively or in addition, light can also be coupled by means of fiber optics into the optical system of one tube 1 or the two tubes 1 such that within the optical system it is routed coaxially to the optical beam path 14 to the object. In this way a parallax angle between the optical beam path 14 and the illumination of the working area is avoided.

The above described matching of light intensity and size of the illuminated surface for matching to the magnification chosen at the time and to the respective working distance can take place within the optical system of the vision aid.

Figure 2 schematically shows the coupling of light for coaxial illumination of the object field. Here light is routed into the optical elements 21 from an external light source 19 via optical

fibers 20. These elements 21 cause coaxial alignment of the light beam 23. Illumination which is optimum for each working distance in intensity and amount is ensured via positioning motors 10 which are connected without cables, or as in this application example, by means of cables 24, to the external electronics 7 for purposes of transmitting positioning data, by a lens system 22.

Often, for example in microsurgery, matching of the 3-D effect to the respective application or to the surface structure of the object area being viewed at the time is desirable. The vision aid as claimed in the invention solves this problem with a device with which the distance between the objective lenses of the vision aid can be changed as the distance between the eyepieces 2 remains the same. Figure 3 schematically shows one embodiment of the vision aid as claimed in the invention with a device 25 for adjustment of the distance of the tubes 1 which are interconnected by crosspieces 17 of variable length from one another with a uniform distance 26 of the eyepieces from one another and thus of the 3-D effect which arises for the user. This device 25 is made in this embodiment as a component on which the eyepieces 2 can be pushed diametrically opposed in order to keep the distance between them constant when the distance 27 of the tubes 1, therefore of the objective lenses from one another, changes, without losing the imaging of the object area in doing so. This effect can however also be achieved by movable optical components in front of the objective lenses or within the tubes 1.

In order to vary the magnification area of the vision aid, in addition to the optical system, interchangeable eyepieces or interchangeable objective lenses can be used in the tubes 1 or alternatively thereto.

In medical diagnostics a process is used which is called photodynamic diagnosis. Here a photosensitive substance is used which accumulates in certain, for example malignant tissue sites, and afterwards by irradiation with light of a certain

wavelength - for reasons of its penetration depth of roughly 5 mm, normally red laser light is used - it is made visible. Another possibility consists in using the different autofluorescent properties of healthy and malignant tissue parts under light with a certain wavelength in order to make visible existing carcinomas or precarcinogenic tissue parts. Currently a number of systems are known which achieve these objects, generally using an endoscope or a surgical microscope. Although use of this technology, for example during open surgeries, would also be advantageous, there have for a long time been no head-mounted vision aids which would allow their use in this diagnosis. The vision aid as claimed in the invention can be made in one embodiment such that filters can be introduced in the beam path of the optical system which enable or facilitate the perception of certain reflection properties of the viewed object area which have arisen by irradiation with light of a certain wavelength. For cases in which the reflection differences of the viewed object field, for example the autofluorescence of tissue sites, cannot be detected purely visibly, one embodiment of the vision aid can be equipped with an internal and/or external receptor, for example a camera chip, which receives the light routed from the light source directly or via an external or internal coaxial fiber optic system to the viewed object and which is reflected by it, analyzes it via internal or external software applications and in doing so assigns different colors to the healthy and suspicious tissue parts. These colors can again be reflected either into the tube 1 or into the two tubes 1 of the optical system and can be viewed there by the user. The colors can also be reproduced via external displays or monitors, optionally with reflecting-in of a locating mark which indicates the position and size of the light beam on the object. For example, in open surgical tumor removal this can lead to improvements of the radicalness of removal or early detection of carcinomas.

Figure 4 schematically shows a vision aid which consists of tubes, eyepieces 2, and connecting crosspieces 17 which can be moved lengthwise, in the optical systems of which there are two

filters 28 at a time. The filters 28 can be pushed manually or by motor, for example, by lateral displacement on a board, into their action position and away from it.

Furthermore, Figure 4 shows a laser light source 29 with an optical fiber 20 which in the objective embodiment illuminates the object field 30 from one position between the two tubes 1 of the vision aid and penetrates to under the surface of the object field 30. The light 31 reflected by a (surface) carcinoma 32 has properties other than the light 33 reflected by the healthy tissue. These differences are displayed either by reflection-out, analysis and color coding and re-reflection-in of the image or, as is shown in Figure 4, by filters 28 which have been pushed into their action position.

In the known, head-mounted vision aids, for a long time the problem of the tilting moment which is produced by the weight of the vision aid and its necessary distance from the eyes of the user was unsolved. The vision aid as claimed in the invention in one embodiment (Figures 5 and 6) solves this problem by attaching a bent diagonal brace 35 which runs over the lengthwise axis from the rear part to the front part of the headset 34 and/or a weight 36 which is attached to the rear part of the headset 34. In this way the center of gravity of the sensitive forehead and nose area of the user is shifted away to the unproblematical center of the head and thus also to the lengthwise axis of the head which is more desirable in ergonomic terms.

Figure 5 shows a headset 34 with the diagonal brace 35 and a counterweight 36.

Figure 6 shows a schematic vertical section of the headset 34. Here it can be seen how the tilting moment 38 which is triggered by the weight of the vision aid 37 and the distance from the eyes of the user is balanced by the counterweight 36 with the diagonal brace 35 with a length which can be adjusted by an adjustment means 41. The weight can be displaced along the

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lines 39 of force to the lengthwise axis 40 of the user on the center of his head.

Especially for high magnifications in head-mounted vision aids the problem of "shaking" and "fuzziness" occurred in the past. The vision aid as claimed in the invention solves this problem in one preferred embodiment by active or passive vibration damping.

It can happen that the user of the vision aid when viewing an object would like to see sharply, not the area detected by the middle-accentuated autofocus, but another area which is located for example on the edge of the image. The vision aid as claimed in the invention can therefore be equipped with a device for detection of the location of the pupil of the user, coupled to multiple autofocus ranges and a pertinent control unit.

There are circumstances among which it would be desirable for the user of a head-mounted vision aid to be able to control functions of the vision aid and/or external devices without his needing to touch the switch. Voice control which can be used for this purpose cannot be used under all conditions. For this reason, in the relevant areas of the headset of the vision aid as claimed in the invention electrodes are mounted which pick up the brain currents of the user and use them for controlling the described functions of the vision aid and/or reconstruction of the images perceived by the user.

Furthermore, in relevant areas of the headset biofeedback sensors can be mounted which can establish the status of the user. The information obtained therefrom can then be used in the most varied ways, for example to warn a surgeon in the case of excess stress or exhaustion and fatigue.

In the embodiment shown in Figure 7, Figure 7a and Figure 7b, in the autofocussing means 4 which is made as an infrared (IR) system, on the receiving unit 6 thereof there is a device which prevents the infrared radiation 43, 44 which does not originate

from the autofocussing means 4 or belong to it and which is not reflected by the object field 30 from being able to reach the autofocus receiving unit 6. These reflected infrared rays 48 which do not belong to the autofocussing means 4 can originate from the passive infrared image guidance or navigation systems 42.

Therefore unwanted influencing of the autofocus system 4 is prevented by the device which is made for example as a filter, especially a polarization filter 45 (Figure 7), as a tube 47 which is pointed toward the object field (Figure 7b), or as a louver or grating attachment 46 (Figure 7a) which is pointed straight or at a slant.

In the embodiment of the vision aid as claimed in the invention shown in Figure 8, the two lens systems 51, 52, therefore the right and left lens system, are accommodated in a common tube 50 (mono-tube). The lens systems 51, 52 which are accommodated in the common tube 50 are for example protected by covers 53 on one or both ends of the tube 50 against the penetration of contamination and against the incidence of outside light and scattered light. Thus for example it is possible to work with the vision aid as claimed in the invention without being adversely affected by the incidence of outside or scattered light.

A common tube 50, as it shown by way of example in the embodiment from Figure 8, offers the advantage that the vision aid does not require moving parts which are located outside. This among others has the advantage of better stability, invulnerability of the vision aid to impact, tension and twisting. Moreover, the vision aid can be made sealed against penetration of moisture in the embodiment from Figure 8 so that protection against penetrating water splashes results and it becomes possible to place the vision aid as claimed in the invention in a disinfection solution. Finally there is no danger that parts can fall out of the vision aid as claimed in the invention onto the surgical field.

As in the other embodiments of the vision aid as claimed in the invention, the parallax angle is equalized when the focal length is changed by optical elements 11 within the common tube 50, as has been described in conjunction with the other embodiments (especially Figure 1).

Especially in surgeries, for example surgeries on the human brain, in which the surgeon cannot directly view the surgical field, but only via auxiliary devices, infrared-controlled devices are used to follow the location of instruments relative to the patient and to display it on a monitor. These devices (infrared tracking means) have proven extremely effective. When a vision aid as claimed in the invention is used at the same time with one such infrared tracking means there is the danger that the infrared light emitted by the infrared tracking means will adversely affect the likewise infrared-controlled autofocussing means of the vision aid. To correct this situation, in the vision aid as claimed in the invention parts can be assigned to the autofocussing means which prevent the incidence of the outside light or scattered light, especially light from the infrared tracking means 60. This has been explained in principle further above using Figures 7, 7a and 7b. When using the vision aid as claimed in the invention in industry the infrared portion of daylight can also be disruptive. In order to prevent any adverse affect on the autofocussing means 4 of the vision aid as claimed in the invention by disruptive infrared light, in one embodiment of the invention according to the vision aid measures are taken to prevent the incidence of disruptive infrared light which can originate for example from the infrared tracking means 6 and/or by daylight.

One embodiment of one such means is shown in Figure 9. It consists of several louvers which are aligned parallel to one another and which project over the entry opening 63 of the infrared receiver of the autofocussing means 4 so that the infrared receiver 6 of the autofocussing means 4 of the vision

aid as claimed in the invention cannot receive obliquely incident infrared light 61, since it is prevented from entering the receiver 6 by the louvers 62 which are located in front of the receiver 6. Only infrared rays aligned parallel to the direction of viewing of the infrared receiver 6 can be incident on the receiver 6.

To prevent, for example, when using infrared trackers, the infrared scattered light which is used in surgical navigation systems and which is intended for position-finding of surgical instrument into the receiving unit 6 of the autofocussing means 4 of the vision aid as claimed in the invention [sic] and thus to avoid the disruptions of the focussing process caused by infrared scattered light, the embodiment shown in Figure 10 can also be used. In this embodiment, in front of the receiver 6 of the autofocussing means there is a tubular diaphragm 65 similar to the sun visor which is used in front of the objective lenses of a camera. Figure 10 shows that infrared light 61 which originates from the infrared tracking means 60 cannot reach the receiver 6 of the autofocussing means 4. Only the infrared light 66 which is reflected by the object plane 30 (object field) and which is emitted by the infrared means 5 which belongs to the autofocussing means 4 of the vision aid as claimed in the invention can reach the receiver 6. The infrared light 61 emerging from the infrared tracker 60 which is conventionally mounted over the head cannot enter the entry opening 63 of the infrared receiving unit 6 of the autofocussing means of the vision aid as claimed in the invention. The tube 65 pointed towards the object field in front of the receiving part 6 of the autofocussing means 4 can be coated on the inside with light-absorbing material to intensify the effect or can be made of one such material.

Alternatively to the embodiments shown in Figures 9 and 10, it is also possible to prevent the incidence of outside light (incident of infrared radiation) by various (polarization) filters.

In order to reflect information into the visual field of the vision aid as claimed in the invention, there are various possibilities. The disadvantages of known possibilities for reflecting data and other information into the visual field of the vision aid as claimed in the invention are that the reflected data or other information (computer tomography and magnetic resonance images) cannot be displayed with enough brightness and contrast to allow the users of the vision aid as claimed in the invention to work without fatigue.

Figure 11 schematically shows one embodiment of the vision aid as claimed in the invention, with which data and other information can be easily reflected into the visual field of the vision aid as claimed in the invention. In the embodiment shown in Figure 11, in the beam path between the objective lens 70 and eyepiece 71 of the vision aid as claimed in the invention, preferably between the telecompressor 72 and the teleconverter 73, there is a transparent display 74. This transparent display 74 shows an inverted image of the main display 75 if there is not a beam splitter 80 between the teleconverter and the eyepiece. In this connection the beam splitter is an optical means which partially reflects light beams, therefore deflects them for example by 90°, and is partially transparent to the light beams. One such beam splitter 80 can be a porro prism or a partially transparent mirror. This results in that at the location at which data and other information are inserted into the visual field of the vision aid as claimed in the invention, the image produced by the vision aid is masked out. In this way the graphics (inserted data and other information) become brighter and have higher contrast because they do not overlay the image. In the embodiment shown in Figure 11 the main display 75 accepts information from external sources, for example magnetic resonance image devices or computer tomography devices, digital x-ray devices, etc. and reflects it via projection optics and the beam splitter 80 into the beam path of the vision aid as claimed in the invention.

In the embodiment shown in Figure 11, it is therefore important that the object image be attenuated or darkened wherever the information of the main display 75 is imaged so that the data and other information are more easily visible on the main display 75.

In summary, one preferred embodiment of the invention can be described as follows.

A vision aid in the form of telescopic spectacles has two lens systems which each comprise at least one objective lens 70 and one eyepiece 71. An autofocussing means is assigned to the lens systems and it changes the focal length of the lens systems for focussing them according to the distance of the telescopic spectacles from the object. Furthermore, a means for changing the magnification factor by changing the focal length of the lens systems ("zoom") and finally a means for matching the parallax between the lens systems of the vision aid to the focal length which has been set according to the distance of the telescopic spectacles from the object are assigned to the lens systems. The parallax is matched using adjustable optical elements 11 which are provided in the beam path of the lens systems and with which the angle 13 between the beam paths 14 which run out of the lens systems 1 to the object can be changed.

Claims

1. Vision aid in the form of telescopic spectacles with two lens systems which each comprise at least one objective lens (70) and one eyepiece (71), with an autofocussing means (4) which changes the focal length for focussing the lens systems (1) according to the distance of the telescopic spectacles from the object, with a means (15) for changing the magnification factor of the lens systems ("zoom"), with a means for matching the parallax between the lens systems (1) of the vision aid to the focal length which has been set according to the distance of the telescopic spectacles from the object, and with adjustable optical elements (11) located in the beam paths (14) of the vision aid, characterized the optical elements (11) which are provided in the beam path of the vision aid for changing the angle (13) between the beam paths (14) which run out of the lens systems (1) to the object can be moved alongside curved paths or are arranged to be able to tilt.
2. Vision aid as claimed in claim 1, wherein the optical elements (11) can be moved transversely to the beam path in the lens systems.
3. Vision aid as claimed in claim 1 or 2, wherein the optical elements (11) are lenses or groups of lenses.
4. Vision aid as claimed in one of claims 1 to 3, wherein the optical elements (11) are prisms or groups of prisms.
5. Vision aid as claimed in one of claims 1 to 4, wherein the lens systems (51, 53) are located in one tube (1) at a time.
6. Vision aid as claimed in one of claims 1 to 4, wherein the lens systems (51, 53) are located in a common tube (50).

7. Vision aid as claimed in claim 6, wherein the lens systems (51, 53) are covered by a cover (53) which is located adjacent to the eyepiece (71) and/or to the objective lens (70).

8. Vision aid as claimed in one of claims 1 to 7, wherein the optical elements (11) are located within the tube (50) or within the tubes (1).
9. Vision aid as claimed in one of claims 1 to 8, wherein the optical elements (11) are located in front of the plane of the objective lens.
10. Vision aid as claimed in one of claims 1 to 9, wherein information in video and/or text form can be inserted into at least one optical plane (16) which is located in one of the lens systems.
11. Vision aid as claimed in one of claims 1 to 10, wherein next to at least one of the two eyepieces (2) there are displays (16) for display of information in image and/or text form.
12. Vision aid as claimed in one of claims 1 to 11, wherein a display means (18), for example, a display, to which the images acquired by the vision aid can be transmitted, is connected to the vision aid.
13. Vision aid as claimed in claim 12, wherein the display means (18) is located outside the vision aid.
14. Vision aid as claimed in claim 11 or 12, wherein the images acquired by the vision aid can be transmitted by an optical element, for example, a beam splitter, or by reflection out of at least one of the two beam paths of the vision aid to the display means (18).
15. Vision aid as claimed in one of claims 1 to 14, wherein video or text insertions containing information can be stereoscopically inserted into the two beam paths of the tubes (1).

16. Vision aid as claimed in one of claims 1 to 15, wherein the images or the text parts can be inserted as individual images corrected by the eye distance and parallax.

17. Vision aid as claimed in one of claims 1 to 16, wherein the inserted information can be selected by changing the viewing angle of the vision aid to the viewed object.
18. Vision aid as claimed in one of claims 1 to 17, wherein measurement devices and/or sensors, such as optical or electromagnetic position-finding systems or inertial sensors, such as accelerometers or angular velocity sensors, are assigned to the vision aid.
19. Vision aid as claimed in one of claims 11 to 18, wherein anatomical, functional and technical information, such as video data, EKG, can be inserted faithfully to position as information.
20. Vision aid as claimed in one of claims 11 to 19, wherein the data can be inserted via interactive determination of the location of medical devices and/or instruments relative to the patient.
21. Vision aid as claimed in one of claims 1 to 20, wherein the images which are inserted into the beam path of at least one lens system or in displays (18) mounted next to the eyepieces (2, 71) can be displayed and fixed as entire or partial images.
22. Vision aid as claimed in one of claims 1 to 21, wherein a measurement scale is reflected into an intermediate image plane (16) of the objective lens.
23. Vision aid as claimed in claim 22, wherein the measurement scale of the respectively set focal length and magnification of the objective lens is selected accordingly.

24. Vision aid as claimed in one of claims 1 to 23, wherein changing the focal length and/or the magnification factor can be controlled by speech-dependent control.
25. Vision aid as claimed in one of claims 1 to 24, wherein on the vision aid there is a light source with an aperture angle which can be matched to the respective magnification of the vision aid such that the size of the illuminated field corresponds to the field of vision of the vision aid.
26. Vision aid as claimed in claim 25, wherein the light source is a light source which is supplied via a group (20) of optical fibers from an external light source (29).
27. Vision aid as claimed in claim 25 or 26, wherein the aperture angle of the light source and the intensity of the emerging light can be changed by a lens system located in the tubes or on the light source and/or a shutter.
28. Vision aid as claimed in one of claims 1 to 27, wherein light from a light source (19) can be coupled-in by a beam splitter (21) or the prism surface of a prism reversal system (21) and emerges through the optical system of the vision aid toward the object.
29. Vision aid as claimed in one of claims 1 to 28, wherein the distance of the objective lenses (70) of the lens systems from one another can be changed at a constant distance of the eyepieces (2) from one another.
30. Vision aid as claimed in claim 27, wherein the distance of the objective lenses (70) from one another is provided by a connection (17) with an adjustable length between the tubes (1) which hold the lens systems with a constant connection (17) between the eyepieces (2) of the lens systems.
31. Vision aid as claimed in claim 30, wherein the

distance of the objective lenses (70) from one another can be changed by parallel adjustment of the tubes (1) and wherein the eyepieces (2) can be adjusted on the tubes (1) in opposite directions.

32. Vision aid as claimed in one of claims 1 to 31, wherein the eyepieces (2) are made as interchangeable eyepieces and/or the objective lenses (70) are made as interchangeable objective lenses.
33. Vision aid as claimed in one of claims 1 to 32, wherein in the vision aid there is at least one means for detecting the location of the pupil of the user which is coupled to the autofocussing means, and wherein the distance (A) between the vision aid and object is acquired for actuating the autofocussing means in the viewing angle dictated by the location of the pupil.
34. Vision aid as claimed in one of claims 1 to 33, wherein there are filters (28) in at least one of the two lens systems.
35. Vision aid as claimed in claim 34, wherein the filters (28) can be moved into and out of their action position.
36. Vision aid as claimed in one of claims 1 to 35, wherein in at least one lens system a laser beam proceeding from a laser means, optionally coupled into the beam path of the lens system, is pointed at the object (30).
37. Vision aid as claimed in claim 36, wherein coupling of the laser beam in an intermediate image plane is provided with a locating mark so that the diameter and the position of the laser beam in the object field can be displayed.
38. Vision aid as claimed in one of claims 1 to 37, wherein the vision aid is attached to a headset (34).
39. Vision aid as claimed in claim 38, wherein on the

headset (34) there is a diagonal brace (35) with a variable length which runs from the forehead to the back of the head.

40. Vision aid as claimed in claim 38 or 39, wherein on the headset (34), there is at least one counterweight (36) which entirely or partially equalizes the weight of the vision aid, optionally adjustably.
41. Vision aid as claimed in one of claims 1 to 40, wherein light-of-sight stabilization is assigned to the beam paths through the lens systems.
42. Vision aid as claimed in claim 41, wherein the light-of-sight stabilization is made as active or passive vibration damping.
43. Vision aid as claimed in one of claims 38 to 42, wherein on the headset (34) for the vision aid there are electrodes which detect brain currents and wherein the electrodes are coupled to a control with which the functions of the vision aid can be controlled.
44. Vision aid as claimed in claim 43, wherein the control is coupled to external devices, for example robots.
45. Vision aid as claimed in claim 44, wherein coupling takes place via wire broadcasting or infrared.
46. Vision aid as claimed in one of claims 1 to 45, wherein on the headset (34) there are biosensors, EEG sensors and/or sensors for measuring the resistance of the skin and acquiring the vital signs of the user of the vision aid.
47. Vision aid as claimed in one of claims 1 to 46, wherein on the eyepieces (2) of the vision aid there are holding devices for optical vision devices, for example spectacle glasses.

48. Vision aid as claimed in claim 47, wherein the vision devices held by the holding device are located next to the eyepieces.
49. Vision aid as claimed in one of claims 1 to 45, wherein the lens systems of the two beam paths are housed in a common tube.
50. Vision aid as claimed in one of claims 1 to 49, wherein on the receiving unit (6) of the autofocussing means (4) there is a device (45, 46, 47) which is transparent solely to the infrared signals (44) which have been reflected by the object field (30).
51. Vision aid as claimed in claim 50, wherein the device is a filter (45).
52. Vision aid as claimed in claim 51, wherein the filter is a polarization filter (45).
53. Vision aid as claimed in claim 50, wherein the device is a tube (47, 65) which is pointed toward the object field (30) and which is located on the receiving part (6) of the autofocussing means (4).
54. Vision aid as claimed in claim 50, wherein the device is a louver (63) or grating attachment (46) which is located on the receiving part (6) of the autofocussing means (4).
55. Vision aid as claimed in claim 54, wherein the louver (63) or grating attachment (46) is a louver (63) or grating attachment (46) which is pointed in a straight line.
56. Vision aid as claimed in claim 54, wherein the louver or grating attachment is an obliquely pointed louver or grating attachment.
57. Vision aid as claimed in one of claims 1 to 56, wherein in the beam path of at least one lens system (51, 53) there is

a transparent display (74) and wherein virtual displays are reflected into the beam path of the lens systems out of the main display (75) via a beam splitter (80).

58. Vision aid as claimed in claim 57, wherein the beam splitter (80) is a prism, especially a porro prism, or a semitransparent mirror.