



(86) Date de dépôt PCT/PCT Filing Date: 2005/09/21
(87) Date publication PCT/PCT Publication Date: 2006/05/04
(45) Date de délivrance/Issue Date: 2014/03/18
(85) Entrée phase nationale/National Entry: 2007/04/24
(86) N° demande PCT/PCT Application No.: EP 2005/010173
(87) N° publication PCT/PCT Publication No.: 2006/045381
(30) Priorité/Priority: 2004/10/26 (DE10 2004 052 102.6)

(51) Cl.Int./Int.Cl. *H04N 9/31* (2006.01),
G03B 21/00 (2006.01), *G09B 9/32* (2006.01),
G09B 9/36 (2006.01)

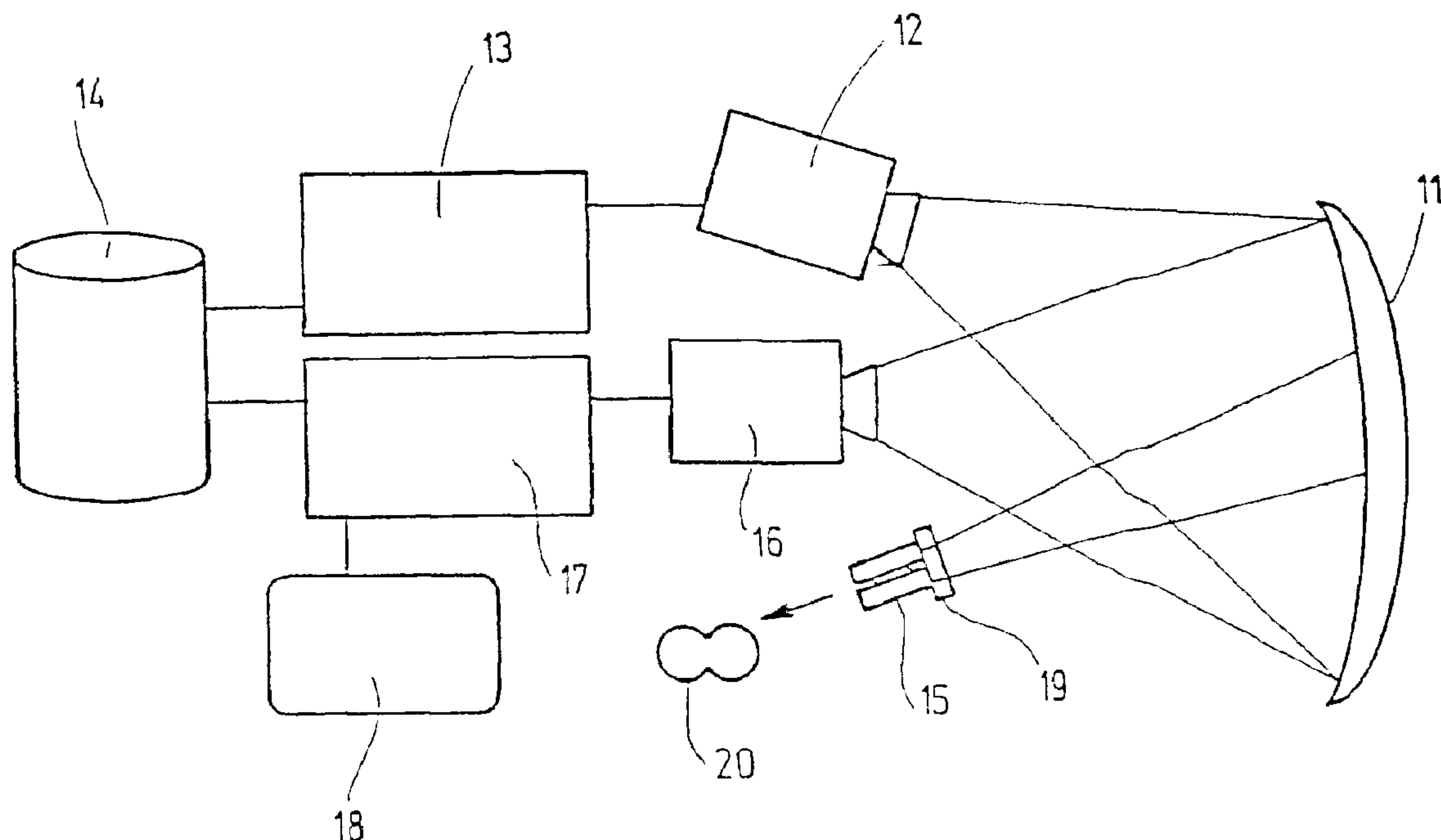
(72) Inventeurs/Inventors:
BURGGRAF, HUBERT, DE;
PLASS, WILFRIED, DE;
PASCHOLD, MICHAEL, DE;
BORN, HANS, DE

(73) Propriétaire/Owner:
RHEINMETALL DEFENCE ELECTRONICS GMBH, DE

(74) Agent: FETHERSTONHAUGH & CO.

(54) Titre : **SYSTEME DE VISION**

(54) Title: **VISION SYSTEM**



(57) **Abrégé/Abstract:**

The invention relates to a vision system for representing synthetically generated images for the stimulation of night vision appliances, especially in training simulators for driving or flight training, and lighting and observation operations in night vision conditions. Said system comprises an image generator (17) for generating image signals of a synthetic image, at least one projector (16) which is fed with the image signals and used to project the image onto at least one projection screen (11), and a night vision appliance (15) for visualising the projected image. The aim of the invention is to create a technically less complex, cost-effective visual system, whereby the projected image is visualised through the night vision appliance (15) in an undisturbed manner when the night vision appliance is stimulated correctly. To this end, the at least one projector (16) comprises a laser source producing a laser projection beam, that radiates an optical wavelength (X) in the non-visible spectral region and within the spectral sensitivity of the night vision appliance (15). The image signals are modulated onto the laser source, which is preferably a laser diode. Preferably, a narrow-band interference filter (19) adapted to the optical wavelength (X) of the laser source is mounted upstream of the night vision appliance (15).



Abstract

The invention relates to a vision system for representing synthetically generated images for the stimulation of night vision appliances, especially in training simulators for driving or flight training, and lighting and observation operations in night vision conditions. Said system comprises an image generator (17) for generating image signals of a synthetic image, at least one projector (16) which is fed with the image signals and used to project the image onto at least one projection screen (11), and a night vision appliance (15) for visualising the projected image. The aim of the invention is to create a technically less complex, cost-effective visual system, whereby the projected image is visualised through the night vision appliance (15) in an undisturbed manner when the night vision appliance is stimulated correctly. To this end, the at least one projector (16) comprises a laser source producing a laser projection beam, that radiates an optical wavelength (X) in the non-visible spectral region and within the spectral sensitivity of the night vision appliance (15). The image signals are modulated onto the laser source, which is preferably a laser diode. Preferably, a narrow-band interference filter (19) adapted to the optical wavelength (X) of the laser source is mounted upstream of the night vision appliance (15).

21712-293

1

DESCRIPTION**VISION SYSTEM****Technical Field**

The invention relates to a visual system for representing synthetically generated images for the stimulation of night vision appliances, in particular in training simulators for driving or flight training, and lighting and observation operations in night vision conditions.

Night vision appliances refer to both thermal image cameras which are usually permanently installed in vehicles, and night vision goggles and binoculars with residual light intensifier which are worn by people.

Prior Art

In a known flight simulator (US 5,380,204) equipped with a night vision appliance for night flight training, an image generator generates video signals of a synthetic image which is shown on a display arrangement consisting of several screens. Preferably, the screens of cathode-ray tubes (CRT displays) are used, however, projection screens of television projectors may also be used. The various screens can be viewed by the flight student through night vision goggles which have a light-sensitive range in visible and in the near infrared spectral region of up to 920 nm. A monochromatic image is produced by the image generator and shown on the CRT display. Gray filters are mounted upstream of the CRT display or the night vision goggles to weaken the image brightness, so that the dynamic range of the CRT display is shifted downward, i.e. toward less brightness.

In a known vision system for stimulation of real night vision goggles (US 6,196,845 B1), a highly resolved and brighter night

21712-293

2

vision image is projected with an additional projection channel on the screen as a so-called "projection patch" in the respective actual line of sight. The contrast of the "projection patch" is thereby distorted by means of near
5 infrared video signals in order to offer the night vision goggles a typical near infrared image and to thus simulate the spectral characteristics of the night vision goggles. The additional projection channel requires that a so-called OTW (out of the window) image and a green image be projected on the
10 screen for direct viewing with the naked eye, whereby the OTW image is also produced by the image generator and presented by means of a further projection channel.

Description of the Invention

Some embodiments of the invention may create a vision system
15 with the use of a night vision appliance in which a view through the night vision appliance is obtained independent of the presence of additional projection images on the projection screen, such as OTW projection image or OTW and green projection image.

20 According to one embodiment of the invention, there is provided a vision system for representing synthetically generated images for the stimulation of night vision appliances, as well as lighting and observation operations in night vision conditions, comprising at least one image generator for generating image
25 signals of a synthetic image, at least one projector which is fed with the image signals for projecting the image onto at least one projection screen, and a night vision appliance for visualizing the projected image, whereby the at least one projector has a laser source which produces a laser
30 projection beam and radiates the laser light having an optical

21712-293

2a

wavelength (λ) in the non-visible spectral region and within the spectral sensitivity of the night vision appliance, and the image signals are modulated onto the laser light, wherein a narrow-band interference filter adapted to the optical

5 wavelength (λ) of the laser source is mounted upstream of the night vision appliance, wherein the transmission wavelength (λ) of the interference filter is equal to the optical wavelength (λ) of the laser source, and wherein the bandwidth of the interference filter is adapted to the stability of the laser

10 source and is 10 nm to 30 nm.

The vision system according to the invention has the advantage that the vision system of the invention can be used both as a stand-alone device exclusively for the stimulation of the night vision appliance and, in addition, as an add-on device in a

15 stimulation of night vision scenes visible with the naked eye in so-called OTW images. The technical expenditure of the vision system of the invention is very low in comparison to the known vision system with night vision properties, since additional OTW images and green images do not also have to be

20 generated for the night vision and projected on the projection screen. When used as an add-on device, the infrared image generated for the night vision appliance can be projected on the same projection screen in the same size as the OTW image, as it is not visible to the naked eye and can only be seen with

25 the night vision appliance.

As a result, the technically complex "head-tracker" for the accurate visual point projection of the so-called projection patch, which is absolutely essential in the aforementioned known vision system, can be omitted. As the momentary OTW image is generated relative to the point of vision and also the projection image for the night vision appliance relative to the same point of vision, the viewer can observe all areas of the projection screen with the night vision appliance by turning the head, without it being necessary to change the generated image.

Practical embodiments of the vision system according to the invention with advantageous further developments and designs of the invention can be found in the additional claims.

According to a preferred embodiment of the invention, a narrow band interference filter which is adapted to the optical wavelength of the laser source is mounted upstream of the night vision appliance. By means of the narrow band interference filter which is adapted with its transmission wavelength to the optical wavelength of the laser source and whose narrow band is adapted to the stability of the laser source, the projected image can be seen through the night vision appliance, separated and undisturbed by environmental influences, e.g. stray light and outside light, or an OTW projection image visible with the naked eye, with good stimulation of the night vision appliance. By masking the outside light, the image projected for stimulation of the night vision appliance can be shown on the same screen together with a visible OTW image simulated with the night scenes, without it being necessary to manipulate the brightness of the OTW image or of the simulation room. Therefore, two different images can be simultaneously offered to the vision system user, one as image through the night vision appliance and one as OTW image for the naked eye. This is advantageous since, in actual operation, viewing possibilities are given both through the night vision appliance and also downward, past the night vision appliance and laterally through the window of an aircraft

cockpit or a pilot's cabin and onto the cockpit instruments (peripheral vision). For certain applications, it is also possible to offer the user an image through the night vision appliance which also deviates completely from the OTW image visible with the naked eye with respect to the contents. The simulation room does not have to be darkened for the night vision training, since outside light and stray light influences are suppressed by the interference filter and the projected OTW image also does not influence the image area visible through the night vision appliance.

According to an advantageous embodiment of the invention, the laser source of the projector is a laser diode, which can be directly and easily power-modulated. Furthermore, the laser diode enables a low weight and volume as well as low production costs of the projector.

Brief Description of the Drawings

The invention is described in greater detail in the following with reference to an embodiment illustrated in the drawings, showing:

- Fig. 1 a block diagram of a vision system to illustrate synthetically generated images for stimulation of night vision goggles (NVG: Night Vision Goggles),
- Fig. 2 a diagram of the spectral sensitivity of the night vision goggles in the vision system of Fig. 1,
- Fig. 3 a block diagram of a vision system according to Fig. 1 which is expanded by a further NVG channel.

Methods for Carrying Out the Invention

The vision system illustrated in the block diagram in Fig. 1 is preferably used in flight simulators for training pilots in day and night flight. However, the same construction can also be used in association with other training simulators in which night vision conditions occur, e.g. in simulators for land vehicles or for tactical training and lighting. In the flight simulator, the pilot sits in the simulated cockpit of an airplane or a helicopter and sees through at least one window in the cockpit onto at least one projection screen situated outside of the cockpit on which an image of a surrounding scenario which is synchronized to the flight movement is projected which, in reality, corresponds to the vision through the at least one cockpit window (OTW: out of the window).

Therefore, in a known manner, the vision system comprises at least one projection screen 11, at least one projector 12 allocated to the projection screen 11, an image generator 13 to generate image signals of a synthetic, visible, colour image and a data base 14 with stored terrain models, object models and textures as well as control data for coordinating the control of the aircraft and the vision system. The image generator 13 accesses the data base 14 and generates image signals of a selected scenario for day or night vision with the naked eye, the so-called OTW (out of the window) vision. The image or video signals are fed into the projector 12 and visualized by the projector 12 on the projection screen 11.

For certain applications, the training of night flights with night vision appliances is required, in the special case here with night vision goggles (NVG). The night vision goggles 15 are e.g. fastened to the helmet of a helicopter pilot and enable both the view through the night vision goggles 15 and a peripheral view with the naked eye laterally and downward past the night vision goggles 15, so that the pilot can identify parts of a

visible image shown on the at least one projection screen 11 as a night scenario with the naked eye and read the cockpit instruments.

To simulate the original night vision goggles 15 through the image projected on the screen such that the pilot is provided with a true-to-life image 20 of the image detail discernible through the night vision goggles 15, the vision system has, in addition, a laser projector 16 for the projection of an image which is non-visible to the naked eye and only visible with the night vision goggles 15, which is also projected on the projection screen 11 and superimposed on the visible image of the night scene projected on the screen. A projection channel of this type will be called NVG channel in the following. The image projected through the night vision goggles 15 for viewing, the so-called NVG image, is projected at least in the same size as the visible image of the night scene and not only in the size of the detail ascertainable with the night vision goggles 15, so that the pilot may view the entire image little by little in sections by turning his head. The laser projector 16 has a laser source generating a laser beam with an optical wavelength λ in the non-visible spectral region of the spectral sensitivity of the night vision goggles 15.

In Fig. 2, by way of example, a diagram of the pattern of the spectral sensitivity of night vision goggles commonly used in military operations. As can be seen in Fig. 2, the spectral sensitivity of the night vision goggles here is between about 625 nm and about 900 nm, i.e. it extends from the visible red range into the non-visible infrared range. The optical wavelength λ of the laser source is now selected in such a way that it is in a range of between $\lambda=810$ nm and $\lambda=830$ nm, which is no longer visible with the naked eye and in which the night vision goggles 15 preferably have their sensitivity maximum.

In the embodiment of the vision system shown, a separate image

21712-293

7

generator 17 is allocated to the laser projector 16, said image generator 17 accessing the data base 14 as the image generator 13 for the visible image. In addition to the data for the image generation, specific data for night vision goggles, such as material and reflection properties, are also stored in the data base 14. Moreover, the image generator 17 accesses a transformation unit 18 in which the specific representation characteristics of the type of night vision goggles used, parameters of the vision system and parameters for special effects are stored. The transformation unit 18 can alternatively be integrated in the image generator 17, as symbolically illustrated in Fig. 3. The image generator 17 produces image signals which are modulated, optionally modified with data taken from the transformation unit 18, with the light of the laser source with the optical wave length λ in the infrared range. The laser source of the laser projector 16 preferably has a laser diode which can easily be power-modulated with the image signals. A GaAs laser diode is preferably used as a laser diode.

As schematically illustrated in Fig. 1, a narrow-band interference filter 19 which is adapted to the optical wavelength λ of the laser source of the laser projector 16 is mounted upstream of the night vision goggles 15. Preferably, the transmission wavelength of the interference filter 19 is selected equal to the optical wavelength λ of the laser source and the bandwidth of the interference filter 19 adapted to the stability of the selected optical wavelength λ of the laser source. If, for example, the optical wavelength λ of the laser source is selected in the range of between $\lambda=810$ nm and $\lambda=830$ nm, then the bandwidth of the interference filter 19 is fixed at about 10 - 30 nm. Spurious and outside light influences are suppressed in the night vision goggles 15 by the interference filter 19, so that the OTW vision is suppressed in the night vision goggles 15 and flight training is also possible in night vision conditions during daylight with the night vision goggles 15 and the simulation room does not have to be darkened. It is no longer

necessary to provide special instrument and cockpit lighting which is compatible with the night vision goggles 15.

Of course, it is possible to operate the projection of the infrared image for the night vision appliance as stand-alone equipment, i.e. without additional projection of the OTW vision. In this case, the image generator 13 and the projector 12 are omitted.

It is also possible to do without the image generator 17 for the laser projector 16 in the vision system shown in Fig. 1. In this case, the image signals for the laser projector 16 are diverted from the image generator 13 which generates the night scene for the OTW image. These image signals are modified prior to being fed into the laser projector 16 with reference to the parameters stored in the transmission unit 18.

The vision system shown in the block diagram in Fig. 3 only differs from the block diagram of Fig. 1 by a second NVG channel, so that the same components are provided with the same reference symbols. This vision system takes into consideration the fact that the pilot and co-pilot see the same image details on the projection screen 11 with differing angles of vision. Therefore, an additional NVG channel, which consists of an image generator 21 (with integrated transformation unit 18) and a further laser projector 22 for the image projection, is provided for the co-pilot. Image generator 21 and laser projector 22 are designed identical to the image generator 17 and laser projector 16 for the pilot. The image generator 21 also accesses the data base 14 and generates the same image scene as the image generator 17 which is, however, relative to the visual point of the co-pilot and not to the vision point of the pilot, as the image generated by the image generator 17. The two laser projectors 16 and 22 have orthogonal polarization directions, so that the NVG image projected by the laser projector 22 is turned by 90° in relation to the NVG image projected by the laser projector 16. The co-

21712-293

9

pilot has the same night vision goggles 15 with the interference filter 19 mounted upstream as the pilot. A polarization filter 23 or 24, respectively, is mounted upstream of each of the night vision goggles 15, whereby the polarization directions of the two polarization filters 23, 24 are turned by 90° in relation to one another and the polarization direction of the polarization filter 23 corresponds to the polarization direction of the laser projector 16 and the polarization direction of the polarization filter 24 to the polarization direction of the laser projector 22. The two polarization filters 23, 24 ensure that the pilot can see with his night vision goggles 25 only the NVG image projected by the laser projector 16 relative to his vision point and the co-pilot through his night vision goggles 15 only the NVG image projected by the laser projector 22 relative to his vision point image area by image area over the entire projection screen 11. The true-to-life image of an image area of the NVG image relative to the vision point of the co-pilot, which is provided to the co-pilot through his night vision goggles 15, is designated with 20' in Fig. 3.

To also improve the stimulation of the night vision goggles 15 with respect to the cockpit and/or instrument lighting, several infrared light-emitting diodes 25 are distributed in the cockpit whose emitted light can only be seen through the night vision goggles 15. Gallium arsenide (GaAs) light-emitting diodes are used, for example, as infrared light-emitting diodes 25.

21712-293

10

CLAIMS:

1. A vision system for representing synthetically generated images for the stimulation of night vision appliances, as well as lighting and observation operations in
5 night vision conditions, comprising at least one image generator for generating image signals of a synthetic image, at least one projector which is fed with the image signals for projecting the image onto at least one projection screen, and a night vision appliance for visualizing the projected image,
10 whereby the at least one projector has a laser source which produces a laser projection beam and radiates the laser light having an optical wavelength (λ) in the non-visible spectral region and within the spectral sensitivity of the night vision appliance, and the image signals are modulated onto the laser
15 light, wherein a narrow-band interference filter adapted to the optical wavelength (λ) of the laser source is mounted upstream of the night vision appliance, wherein the transmission wavelength (λ) of the interference filter is equal to the optical wavelength (λ) of the laser source, and
20 wherein the bandwidth of the interference filter is adapted to the stability of the laser source and is 10 nm to 30 nm.
2. The vision system according to claim 1, wherein the image projected by the projector onto the projection screen for viewing with the night vision appliance is essentially larger
25 in area than the image detail shown in the night vision appliance.
3. The vision system according to claim 1 or 2, wherein the optical wavelength (λ) of the laser source is in the infrared range.

21712-293

11

4. The vision system according to claim 1 or 2, wherein the optical wavelength of the laser source is in the range of the maximum sensitivity of the night vision appliance.

5. The vision system according to claim 3 or 4, wherein
5 the optical wavelength (λ) of the laser source is in the range of between 810 nm and 830 nm.

6. The vision system according to any one of the claims 1 to 5, wherein the laser source is a laser diode.

7. The vision system according to claim 6, wherein the
10 laser diode is a gallium arsenide (GaAs) laser diode.

8. The vision system according to any one of the claims 1 to 5, wherein a polarization filter is mounted upstream of the night vision appliance and wherein the projector has a polarization direction corresponding to the polarization
15 direction of the polarization filter.

9. The vision system according to claim 8, wherein a second projector is provided which has a polarization direction orthogonal to the first projector and which projects an image onto the screen that deviates from the image projected by the
20 first projector, and wherein a second night vision appliance is provided with a polarization filter mounted upstream of it, whose polarization direction is turned by 90° in relation to the polarization filter mounted upstream of the first projector.

25 10. The vision system according to claim 9, wherein both images projected by the projectors represent the same night scene which is generated relative to another vision point in each image.

21712-293

12

11. The vision system according to any one of the claims 1 to 10, wherein infrared light-emitting diodes are arranged within the successive, discernible region with the night vision appliance in front of the projection screen.

- 5 12. The vision system according to any one of the claims 1 to 11 for representing synthetically generated images for the stimulation of night vision appliances in training simulators for driving or flight training.

1 / 2

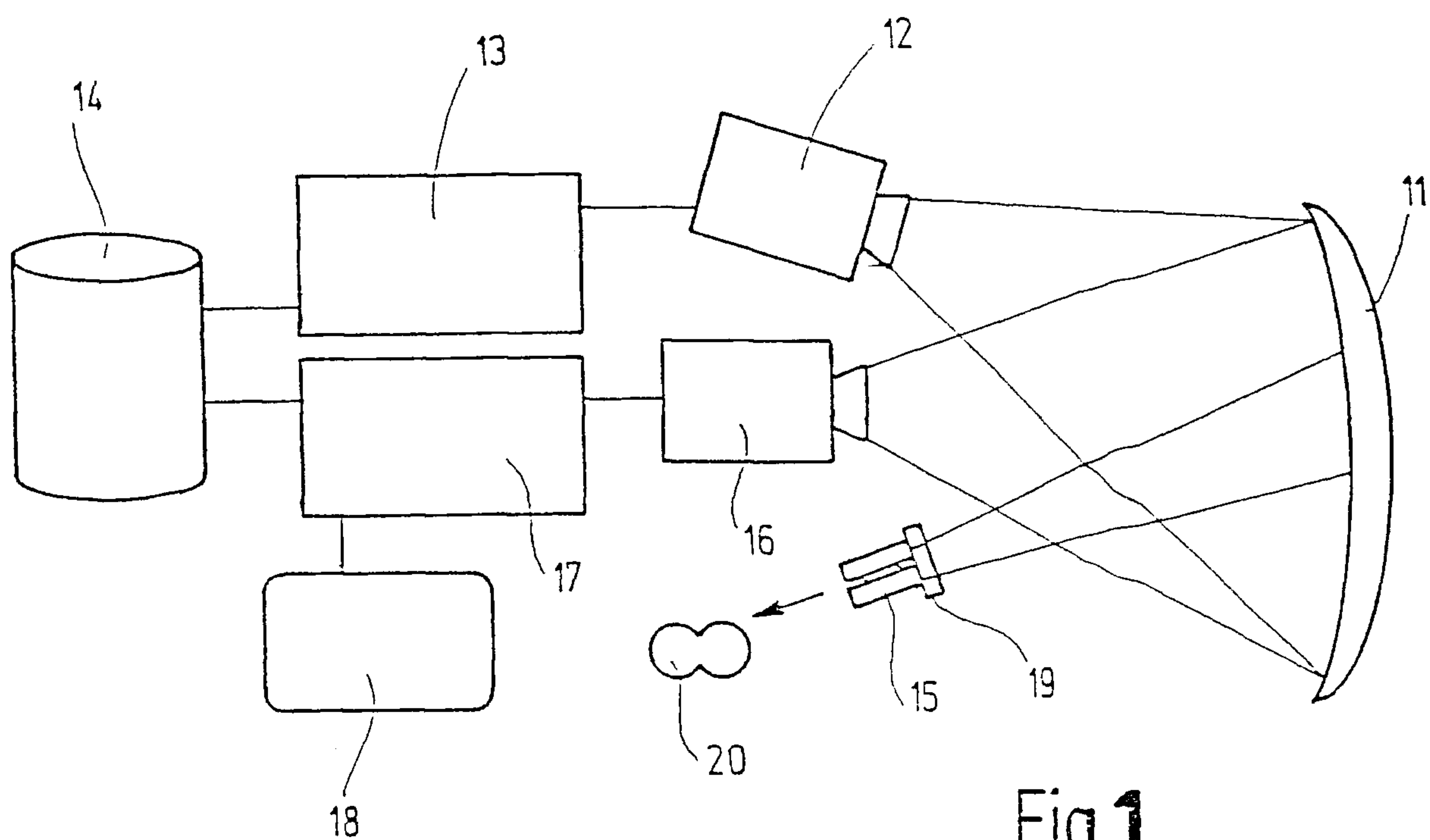


Fig.1

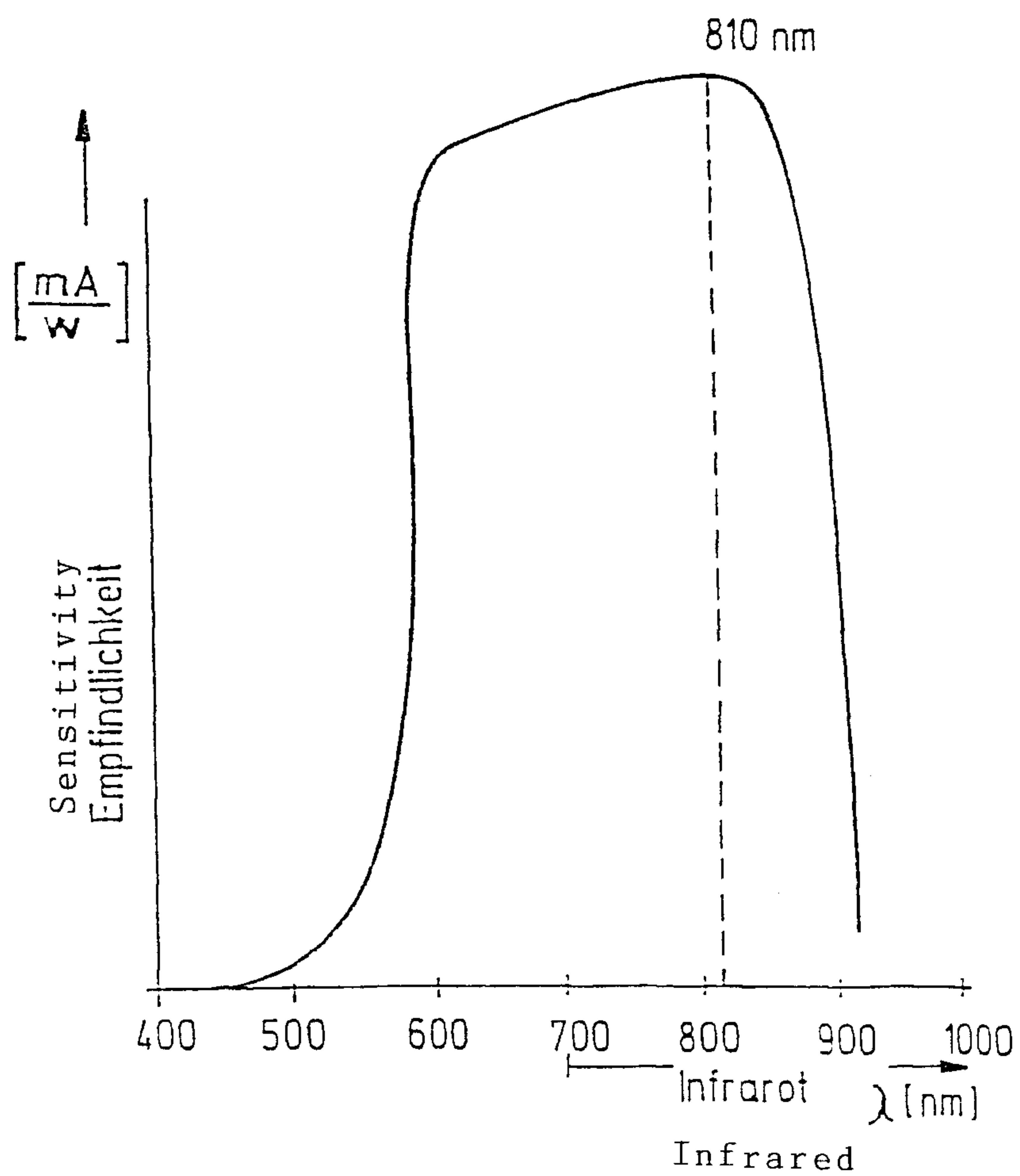


Fig.2

2 / 2

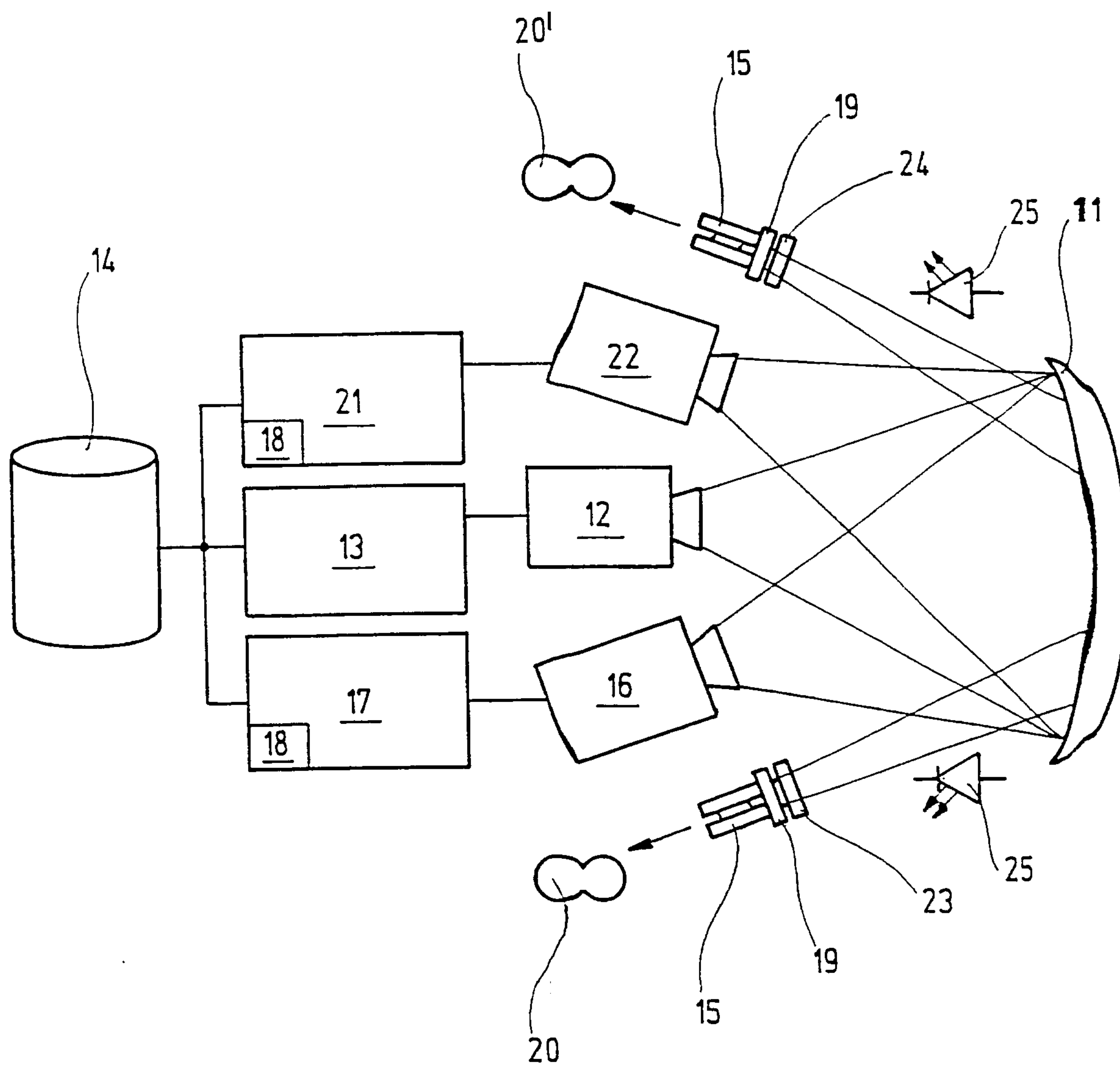


Fig.3

